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## **When *Campylobacter jejuni* affects the heart - myocarditis in male patients**

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### **Abstract**

#### **Introduction:**

*Campylobacter jejuni* is a bacteria that is one of the most common causes of bacterial foodborne illness worldwide. The bacteria is typically transmitted through consumption of undercooked poultry, contaminated water, or unpasteurized dairy products. In addition to gastrointestinal symptoms such as diarrhea, abdominal cramps or fever, *C. jejuni* has been associated with post-infection sequelae, including rare cases of myocarditis. Although uncommon, myocarditis can result in arrhythmias, heart failure or even death, requiring prompt medical attention.

#### **Methods:**

This review consists of the latest papers, including cases, systematic reviews and cohorts. The analysis focuses on summarizing the *C. jejuni* infection-related myocarditis in male patients, in particular determining the time of onset of gastrointestinal and cardiovascular symptoms, and the results of additional tests leading to the diagnosis of myocarditis.

#### **Results:**

Among the 46 reported male patients with *Campylobacter jejuni*-associated myocarditis or myopericarditis, left ventricular systolic dysfunction was documented in 17 cases (39.5%). The

time interval between the onset of gastrointestinal symptoms and the onset of chest pain was available for 43 patients, with a mean delay of 3,84 days (median 3 days; range 0-14 days), indicating a short but clearly discernible latency between enteric infection and myocardial involvement. Overall, only one of the 46 patients (2.2%) died, whereas all others survived to hospital discharge, indicating a generally favourable short-term prognosis despite the relatively high proportion of cases with impaired ventricular function.

### **Conclusions:**

Proper food handling, cooking poultry to appropriate temperatures, and good hygiene practices are essential for prevention of *C. jejuni* infections. Quick and precise diagnosis of myocarditis prevents severe complications of the disease.

### **Keywords:**

myocarditis, male patients, campylobacter, campylobacter jejuni

### **Introduction.**

*Campylobacter jejuni* is a leading bacterial cause of acute gastroenteritis worldwide. Infection typically results from the ingestion of contaminated poultry, unpasteurised milk, or untreated water. After an incubation period of two to five days, patients commonly present with fever, abdominal cramping, and diarrhoea, which may be bloody in more severe cases [1,2]. Although the illness is usually self-limiting, dehydration can occur, particularly in vulnerable populations such as young children, older adults, and immunocompromised individuals [3].

Most patients recover without antibiotic therapy; however, macrolides remain the treatment of choice for prolonged or severe disease. Importantly, *C. jejuni* infections can lead to post-infectious complications, including reactive arthritis, myocarditis and Guillain–Barré syndrome, highlighting the need for careful follow-up in affected individuals [1,4].

Myocarditis refers to the inflammation of the heart muscle (myocardium), which can impair the heart's ability to pump blood effectively. Causes of myocarditis includes viral infections as the most common cause, bacterial infections, autoimmune conditions like lupus, rheumatic fever and giant cell myocarditis, medications and toxins: some chemotherapy drugs, antipsychotics, and recreational drugs, and environmental factors: radiation therapy or exposure to certain chemicals [5].

Symptoms can vary from mild to severe, depending on the extent of inflammation and heart damage. Common symptoms include chest pain, often sharp or stabbing in nature, fatigue, shortness of breath, heart palpitations that can indicate arrhythmias, and in more severe cases

fluid buildup especially at lower body parts, and syncope due to impaired blood circulation, low cardiac output, usually associated with arrhythmias. In some cases, myocarditis can be asymptomatic, or it can lead to acute heart failure or even sudden cardiac death [6]. The condition can present in a subacute or chronic form, with persistent symptoms of heart dysfunction.

Blood tests can show elevated levels of cardiac enzymes like troponins, indicating heart injury. Electrocardiogram (ECG) may show irregular heart rhythms and other signs of heart stress. Echocardiogram is used to assess heart function and detect signs of heart failure. MRI of the heart can visualize inflammation in the myocardium. Endomyocardial biopsy is an invasive procedure but definitive for confirming the diagnosis, especially in cases of uncertain or severe myocarditis [5].

Treatment depends on the severity and cause of myocarditis. For mild cases, rest and monitoring might be sufficient. Anti-inflammatory drugs such as corticosteroids azathioprine or cyclosporine may be used. If the myocarditis is caused by a viral infection, antivirals or experimental therapies may be considered. In severe cases, medications like ACE inhibitors, beta-blockers, or diuretics may be prescribed. In extreme cases ventricular assist devices (VADs) or heart transplantation may be required [6].

The prognosis for myocarditis depends on the underlying cause, the extent of heart damage, and the timeliness of treatment. In most cases, myocarditis resolves with appropriate treatment and has a favorable outcome.

## Results

Among the 48 reported male patients [7-43] with *Campylobacter jejuni*-associated myocarditis or myopericarditis, left ventricular systolic dysfunction was documented in 17 cases (39.5%), most commonly described as a transient reduction in ejection fraction with or without regional or global wall motion abnormalities. The time interval between the onset of gastrointestinal symptoms and the onset of chest pain was available for 43 patients, with a mean delay of 3,84 days (median 3 days; range 0–14 days), indicating a short but clearly discernible latency between enteric infection and myocardial involvement.

In the majority of reported cases (80,4%), the initial ECG showed abnormalities compatible with acute myocardial injury. ST-segment elevation was the most frequent pattern, often widespread or localized to anterior, lateral, or inferolateral leads, and in several patients accompanied by reciprocal ST-segment depression. In some cases, ST-segment elevation had

a concave or “saddle-shaped” morphology, while in others the tracing mimicked an acute coronary syndrome with inferolateral or global ST-segment elevation and dynamic T-wave inversion. Additional reported abnormalities included non-specific ST-T changes, terminal negative T waves, right or left axis deviation, atrial fibrillation, and S1Q3 patterns. A minority of patients had a normal ECG at presentation (19,6%), sometimes with subsequent evolution to ST-segment elevation on repeat recordings, underscoring the dynamic nature of the electrocardiographic changes.

Where cardiac magnetic resonance imaging was performed (47,8% of cases), the results were highly consistent with acute myocarditis. Most examinations demonstrated myocardial edema on T2-weighted or STIR sequences and late gadolinium enhancement with a predominantly subepicardial or mid-myocardial distribution. The affected regions were most commonly located in the inferolateral, lateral, or inferior walls of the left ventricle, but involvement of the anteroseptal, apical, and basal posterior segments was also described. In several cases, patchy or focal areas of enhancement were reported, sometimes extending intramurally, and occasionally accompanied by mild pericardial enhancement or a small pericardial effusion. These non-ischemic enhancement patterns, in the setting of unobstructed coronary arteries, provided strong non-invasive confirmation of *Campylobacter jejuni*-associated myocarditis or myopericarditis.

Overall, only one of the 46 patients (2.2%) died [15], whereas all others survived to hospital discharge, indicating a generally favourable short-term prognosis despite the relatively high proportion of cases with impaired ventricular function [12,19, 24, 35, 37].

The summary of the collected data is shown in Table 1.

## **Discussion**

Acute myocarditis and myopericarditis associated with *Campylobacter jejuni* infection occur almost exclusively in young and middle-aged men, typically without previous cardiac disease. Myocarditis has also been observed in women, but these are isolated cases [7, 44]. Other *Campylobacter* subtypes may also predispose to this disease [45,46]. In nearly all reported cases, gastrointestinal symptoms such as fever, abdominal pain, and acute diarrhea precede the onset of chest pain by about two to eight days, often by two to five days. *C. jejuni* infection is usually confirmed by stool culture and, less frequently, by serological testing [7,9,14].

When cardiac symptoms develop, patients usually present with acute, often sharp chest pain, sometimes accompanied by dyspnea or palpitations, and their initial electrocardiograms frequently mimic an acute coronary syndrome. ST-segment elevation, T-wave inversion, or a

**Table 1.** The characteristics of 48 male patients with *Campylobacter jejuni* infection-related myocarditis from 1980-2025 in English literature.

| Case number [reference] | Year of publication | Age | Interval between symptoms | Elevated heart enzymes | Electrocardiography findings of ST-segment or T-waves | Echocardiography findings                            | cMR findings characteristic for myocarditis | Outcome at discharge |
|-------------------------|---------------------|-----|---------------------------|------------------------|-------------------------------------------------------|------------------------------------------------------|---------------------------------------------|----------------------|
| 1 [7]                   | 1980                | 27  | 7                         | N/D                    | ST segment elevations and inversion of T-waves        | N/D                                                  | N/D                                         | normal               |
| 2 [8]                   | 1984                | 23  | 3                         | CK<br>CK-MB            | ST segment changes and inversion of T-waves           | N/D                                                  | N/D                                         | normal               |
| 3 [9]                   | 2001                | 32  | 14                        | N/D                    | inversion of T-waves                                  | impairment of LV function with dilatation            | yes                                         | normal               |
| 4 [10]                  | 2001                | 26  | 2                         | Tn                     | ST segment elevations                                 | normal                                               | N/D                                         | normal               |
| 5 [11]                  | 2003                | 30  | 5                         | CK<br>CK-MB<br>Tn      | inversion of T-waves                                  | normal                                               | N/D                                         | normal               |
| 6 [12]                  | 2004                | 34  | 14                        | Tn                     | ST segment elevations                                 | impairment of LV function, antero-apical hypokinesia | N/D                                         | systolic dysfunction |
| 7 [13]                  | 2005                | 43  | 5                         | CK-MB                  | ST segment depressions                                | normal                                               | N/D                                         | normal               |
| 8 [13]                  | 2005                | 30  | 4                         | CK-                    | ST segment                                            | normal                                               | N/D                                         | normal               |

|         |      |    |   |                       |                                                |                                          |     |                      |
|---------|------|----|---|-----------------------|------------------------------------------------|------------------------------------------|-----|----------------------|
|         |      |    |   | MB                    | elevations                                     |                                          |     |                      |
| 9 [14]  | 2006 | 47 | 2 | CK-<br>MB             | non-specific T-wave abnormalities              | enlarged LV, pericardial effusion        | N/D | normal               |
| 10 [15] | 2007 | 16 | 2 | CK                    | N/D                                            | N/D                                      | N/D | death                |
| 11 [16] | 2007 | 36 | 8 | CK-<br>MB<br>Tn       | ST segment elevations                          | dilated LV                               | N/D | normal               |
| 12 [17] | 2007 | 43 | 7 | CK<br>CK-<br>MB<br>Tn | ST segment elevations                          | apical akinesis                          | N/D | normal               |
| 13 [18] | 2008 | 24 | 5 | Tn                    | ST segment elevations                          | pericardial effusion, apical hypokinesia | yes | normal               |
| 14 [19] | 2009 | 42 | 7 | Tn                    | ST segment elevations and inversion of T-waves | normal                                   | no  | normal               |
| 15 [19] | 2009 | 45 | 3 | Tn                    | ST segment elevations                          | impairment of LV function.               | yes | systolic dysfunction |
| 16 [20] | 2009 | 16 | 5 | CK<br>CK-<br>MB<br>Tn | ST segment elevations                          | impairment of LV function                | N/D | normal               |
| 17 [20] | 2009 | 17 | 2 | CK<br>CK-<br>MB<br>Tn | ST segment elevations                          | normal                                   | yes | normal               |
| 18 [21] | 2009 | 21 | 2 | Tn<br>CK-             | ST segment elevations                          | normal                                   | N/D | normal               |

|         |      |    |      |                           |                                                          |                                                             |     |                             |
|---------|------|----|------|---------------------------|----------------------------------------------------------|-------------------------------------------------------------|-----|-----------------------------|
|         |      |    |      | MB                        |                                                          |                                                             |     |                             |
| 19 [22] | 2010 | 19 | 4    | CK<br>CK-<br>MB<br>Tn     | ST segment<br>elevations                                 | normal                                                      | yes | normal                      |
| 20 [23] | 2010 | 21 | 0    | CK Tn                     | ST-segment<br>elevations and<br>inversion of T-<br>waves | normal                                                      | N/D | normal                      |
| 21 [24] | 2012 | 42 | 6    | CK Tn<br>NT<br>proBN<br>P | normal                                                   | impairment of<br>LV function<br>with diffuse<br>hypokinesia | yes | normal                      |
| 22 [24] | 2012 | 34 | 4    | Tn                        | ST segment<br>elevations                                 | N/D                                                         | yes | systolic<br>dysfuncti<br>on |
| 23 [24] | 2012 | 21 | 3    | CK Tn<br>NT<br>proBN<br>P | ST segment<br>elevations                                 | impairment of<br>LV function                                | yes | systolic<br>dysfuncti<br>on |
| 24 [25] | 2014 | 43 | 3    | Tn                        | ST segment<br>elevations                                 | normal                                                      | yes | normal                      |
| 25 [26] | 2016 | 24 | 3    | Tn                        | ST segment<br>elevations                                 | normal                                                      | N/D | normal                      |
| 26 [26] | 2016 | 23 | 3    | Tn                        | normal                                                   | normal                                                      | N/D | normal                      |
| 27 [27] | 2017 | 20 | 4    | Tn<br>CK-<br>MB           | normal                                                   | normal                                                      | yes | normal                      |
| 28 [28] | 2018 | 31 | 7    | Tn                        | normal                                                   | normal                                                      | yes | normal                      |
| 29 [29] | 2019 | 17 | 7    | Tn                        | ST segment<br>elevations                                 | impairment of<br>LV function                                | N/D | normal                      |
| 30 [29] | 2019 | 25 | 0,33 | Tn                        | ST segment                                               | impairment of                                               | N/D | normal                      |

|         |      |    |     |                                        | elevations                                                                 | LV function                                                |     |                         |
|---------|------|----|-----|----------------------------------------|----------------------------------------------------------------------------|------------------------------------------------------------|-----|-------------------------|
| 31 [30] | 2020 | 16 | 4   | CK Tn<br>NT<br>proBNP                  | ST segment<br>elevations                                                   | normal                                                     | N/D | normal                  |
| 32 [31] | 2020 | 25 | 3   | CK Tn                                  | normal                                                                     | normal                                                     | yes | normal                  |
| 33 [32] | 2021 | 29 | 2   | Tn                                     | ST segment<br>elevations                                                   | normal                                                     | N/D | normal                  |
| 34 [33] | 2021 | 23 | 4   | Tn<br>CK-<br>MB                        | left axis<br>deviation                                                     | normal                                                     | yes | normal                  |
| 35 [34] | 2022 | 22 | 2   | Tn                                     | ST-segment<br>elevations or<br>depressions and<br>inversion of T-<br>waves | normal                                                     | yes | normal                  |
| 36 [35] | 2023 | 20 | 3   | CK<br>CK-<br>MB<br>Tn<br>NT-<br>proBNP | ST-segment<br>elevations                                                   | impairment of<br>LV function<br>with global<br>hypokinesis | yes | systolic<br>dysfunction |
| 37 [36] | 2023 | 50 | N/D | Tn                                     | ST-segment<br>elevations or<br>depressions                                 | normal                                                     | yes | normal                  |
| 38 [37] | 2023 | 35 | 1   | Tn                                     | ST-segment<br>elevations                                                   | normal                                                     | N/D | normal                  |
| 39 [37] | 2023 | 21 | N/D | Tn                                     | ST-segment<br>elevations or<br>depressions                                 | global<br>hypokinesis                                      | N/D | systolic<br>dysfunction |
| 40 [38] | 2024 | 24 | 2   | ck Tn                                  | normal                                                                     | normal                                                     | yes | normal                  |

|         |      |    |   |              |                       |                                                                         |     |                        |
|---------|------|----|---|--------------|-----------------------|-------------------------------------------------------------------------|-----|------------------------|
| 41 [39] | 2024 | 17 | 2 | Tn           | normal                | normal                                                                  | yes | normal                 |
| 42 [40] | 2024 | 28 | 6 | Tn           | normal                | impairment of LV function with global hypokinesia, pericardial effusion | N/D | cardiac shock then N/D |
| 43 [41] | 2025 | 37 | 4 | CK Tn        | inversion of T-waves  | hypokinesia                                                             | N/D | normal                 |
| 44 [42] | 2025 | 21 | 1 | Tn           | ST-segment elevations | normal                                                                  | yes | normal                 |
| 45 [43] | 2025 | 17 | 3 | Tn NT proBNP | normal                | enlargement of LV with apical dyskinesia                                | yes | normal                 |
| 46 [43] | 2025 | 14 | 1 | Tn           | ST-segment elevations | normal                                                                  | yes | normal                 |

N/D: no data or not defined.

CK: elevation of serum creatine kinase.

CK-MB: elevation of the MB fraction of serum creatine kinase.

NT-proBNP: elevation of the N-terminal pro-B-type natriuretic peptide.

Tn: elevation of serum troponin.

LV: left ventricle

saddle-shaped ST-segment configurations are common patterns, although a minority of patients have non-specific changes or even a normal ECG at presentation [24,26-28, 31, 38-40, 43]. Myocardial injury is further supported by elevated cardiac biomarkers, such as troponin or, in older reports, creatine kinase and CK-MB. The electrocardiographic pattern and elevation of cardiac enzymes frequently mimic an acute myocardial infarction, despite angiographically normal coronary arteries.

Echocardiography findings range from completely normal examinations to clear evidence of left ventricular systolic dysfunction. In a substantial proportion of cases, global or regional hypokinesia, transient reduction in left ventricular ejection fraction, or small pericardial effusion are documented, indicating a predominantly reversible impairment of myocardial

contractility. Echocardiography in myocarditis typically shows global or regional left ventricular systolic dysfunction (not following a coronary artery pattern) and may reveal a reduced ejection fraction. The left ventricle may be dilated in subacute or chronic cases, while in acute fulminant myocarditis the walls often appear thickened due to edema, sometimes with a normal or small left ventricular cavity. A small to moderate pericardial effusion is common, especially in myopericarditis. Additional findings can include diastolic dysfunction, patchy changes in myocardial echogenicity, and, in severe cases, right ventricular dysfunction or rarely intracardiac thrombus.

Echocardiography helps assess severity but cannot definitively diagnose myocarditis without further imaging (e.g., cardiac MRI). Where performed, cardiac magnetic resonance imaging consistently demonstrates typical features of acute myocarditis, including myocardial edema on T2-weighted or STIR sequences and subepicardial or mid-myocardial late gadolinium enhancement, most commonly affecting the inferolateral, lateral, or septal segments of the left ventricle. These imaging findings help to distinguish myocarditis from ischemic injury, particularly when coronary angiography reveals no obstructive coronary artery disease.

## **Conclusion**

Despite sometimes striking clinical and electrocardiographic presentations, the overall prognosis at hospital discharge is generally favourable. Most patients recover with normalization or near-normalization of ventricular function and resolution of symptoms. Nevertheless, a few cases are characterized by severe left ventricular dysfunction, cardiogenic shock, or adverse outcomes, including at least one documented death, underscoring that *C. jejuni*-associated myocarditis, although rare, can be a potentially life-threatening complication of an otherwise self-limiting gastrointestinal infection. Improved food handling practices, strict hygiene measures, and proper cooking of poultry are essential strategies for reducing transmission.

## **Disclosure:**

### **Author Contribution Statement**

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