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*Original Article*

# Acute Mediastinitis – Outcomes and Prognostic Factors of Surgical Therapy (A Single-Center Experience)

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**Purpose: The aims of this work were the retrospective analysis of a cohort of patients with acute mediastinitis treated at the authors' worksite over a 15-year period and the identification of factors that significantly affect the outcomes of the therapy.**

**Methods: During the period 2006–2020, 80 patients with acute mediastinitis were treated. Within the cohort, the following were observed: the causes and the type of acute mediastinitis, length of anamnesis, comorbidities, diagnostic methods, time from the diagnosis to surgery, types and number of surgical procedures, results of microbiological tests, complications, and outcomes of the treatment.**

**Results: The most common type of acute mediastinitis was descending mediastinitis (48.75%). A total of 116 surgical procedures were performed. Ten patients in the cohort died (12.5%). Patients older than 60 years were at a 6.8 times higher risk of death. Patients with more than two comorbidities were at a 14.3 times higher risk of death. The presence of yeasts in the culture material increased the risk of death by 4.4 times.**

**Conclusion: Early diagnosis, removal of the cause of mediastinitis, sufficient mediastinal debridement, and multiple drainage thereof with the possibility of continual postoperative lavage are essential for the successful treatment of acute mediastinitis.**

**Keywords:** acute mediastinitis, esophageal perforation, descending necrotizing mediastinitis, stent, lavage

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## Introduction

Acute mediastinitis (AM), which occurs relatively rarely, is a potentially fatal diffuse inflammatory process in the mediastinum. The causes include esophageal perforation, descending infection from the neck (descending mediastinitis or descending necrotizing mediastinitis [DNM]), infection of the sternotomy, infection spreading from the pleural cavity during empyema, or bloodstream spread of infection from other locations.[1–4] Esophageal perforation is usually reported as the most common cause of AM (together with infection of the sternotomy), with an annual incidence of three cases per 1 million people.[2,3,5] The majority (50%–75%) of these perforations are iatrogenically sustained during an endoscopic procedure (diagnostic or dilation), whereby the most common cause of spontaneous esophageal perforation is the Boerhaave syndrome (up to 33% of all perforations).[1,3,5–7] In the past, DNM was mainly of odontogenic origin. However, with advancements in dental hygiene, the predominating infections are currently oropharyngeal.[2,7–11] AM mainly affects individuals in their 50s or 60s, more often men, with risk factors such as diabetes mellitus type 2, alcohol or drug abuse, obesity, immunodeficiency, renal failure, or liver cirrhosis.[1,6,10,12] The infection is usually polymicrobial, aerobic and anaerobic, in which case the dominating strains are *Streptococcus* sp., followed by mycotic superinfections in up to half of the cases.[1,4,7–14] The originally high mortality rate for AM of up to 50% has today fallen to below 20%.[7,11]

The aims of this work were the retrospective analysis of a cohort of patients with AM treated at the authors' worksite over a 15-year period and the identification of factors that significantly affect the outcomes of the therapy.

## Materials and Methods

During the period 2006–2020, 80 patients with AM of various types and causes were treated. Postoperative mediastinitis after sternotomies (cardiosurgical procedures) and surgeries of the esophagus (failed anastomosis), which we, like Kluge,[7] consider to be individual entities, were not included.

Twenty-one patients (26.25%) underwent their first surgical procedure at a different facility before treatment of AM. Of these, 19 people had DNM (nine tonsillectomies + drainage of the deep neck spaces, eight individual drainages of the neck, and two individual tonsillectomies) and two people had esophageal perforation (drainage of the pleural cavity was performed in both the cases).

### Diagnosis and treatment strategy

The diagnosis of AM was determined based on the medical history, clinical examination, computed tomography (CT), magnetic resonance imaging, and esophagoscopy. The diagnosis of DNM was determined according to the criteria defined by Estrera et al.[15] The extent of DNM was evaluated by CT perioperatively and was classified according to the criteria defined by Endo et al.[16]

The patients were hospitalized in the intensive care unit (ICU) or the Department of Resuscitation. They were cared for by a thoracic surgeon, anesthesiologist-intensivist, otorhinolaryngologist, dental surgeon, pulmonologist, roentgenologist, endoscopist, and microbiologist. The treatment plan was drawn up in agreement with this multidisciplinary team, always with the goal of controlling the source of the infection, surgical debridement of the affected area, and the administration of antibiotics; it was updated daily. The strategy for the surgical approach was determined individually based on the cause and type of AM, its extent according to CT findings, and the clinical state of the patient. The CT exam was performed at regular intervals or repeated as needed. Based on the result, the treatment plan was potentially adjusted, including possible indicated reoperations. All the patients in the ICU or Department of Resuscitation were monitored in the standard way with nutrition applied parenterally, later also enterally; standard laboratory parameters and blood cultures checked regularly; and samples of the tissue affected by the inflammation taken repeatedly for microbiological assessment. The patients were initially given broad-spectrum bactericidal antibiotics, with the treatment later adjusted based on the results of the microbiological examination of the harvested samples.

### Surgical therapy

When treating DNM Type I according to Endo (injury to the upper mediastinum up to the level of the tracheal carina), transcervical drainage from the collar mediastinotomy (cervicotomy) was performed as standard. If maximum inflammation occurred around the trachea, we indicated videomediastinoscopy. We proceeded the same way when treating AM developed by per continuitatem spread. Type IIA according to Endo, which affected upper and lower anterior mediastinum, just like Type IIB (affected posterior lower mediastinum), was treated by anterolateral, posterolateral, or bilateral thoracotomy.

If the perforation of the esophagus was spontaneous or iatrogenic or caused by a foreign body, with anamnesis less than 12 hours, primary suture of the defect (if possible) was performed, which in some cases was secured by implanting a stent. If anamnesis of the perforation was longer (>12 hours) and the result of esophageal suture was considered to be uncertain, a primary stent was implanted. Using a stent was always accompanied by adequate debridement and drainage of the mediastinum via thoracotomy, thoraco-phreno-laparotomy, laparotomy, or cervicotomy. In the case of a concurrent pathology of the esophagus (tumor, untreated achalasia, stricture) or in the cases of delayed diagnosis of advanced AM, esophagectomy without immediate replacement was indicated, i.e. with a cervical esophagostomy, gastrostomy, or jejunostomy. In critically ill (unstable) patients, only drainage of the mediastinum was undertaken, with the definite management of the esophageal perforation delayed.

Sufficient debridement and drainage of the mediastinum, including establishment of a continuous lavage, were an integral part of the surgical management of AM. During the cervicotomy, soft drains (no pressure on the vessels) were exclusively used and in such numbers that would perfectly drain all the areas affected by the inflammation. The drains were then used to lavage these areas one to two times a day with a disinfectant solution (e.g. Betadine solution, Prontosan solution, Microdacyn solution) until the bacterial cultures were negative; due to the risk of erosion of the vessels, the drains were left in the wounds for a maximum of 3 weeks. Wide Tygon drains with a diameter of at least 32 French were used during the transthoracic drainage. A continuous retrosternal drainage from the suprasternal notch to the xiphoid process proved useful in Endo Type IIA (**Fig. 1** on the right), as did the so-called rendezvous cervical–mediastinal–thoracic drainage (**Fig. 1** on the left) in Endo Type IIB. During the upper drain (irrigation) runs from the suprasternal notch to the mediastinum paratracheal or paraesophageal to the level of the azygos vein, the two lower drains usually derive the lower mediastinum and pleural cavity. There are lateral holes along the drain that are spaced 2–3 cm apart for irrigation or suction. In both cases, the mediastinum is continuously or intermittently lavaged from the jugular ends of the drains with disinfectant solution.

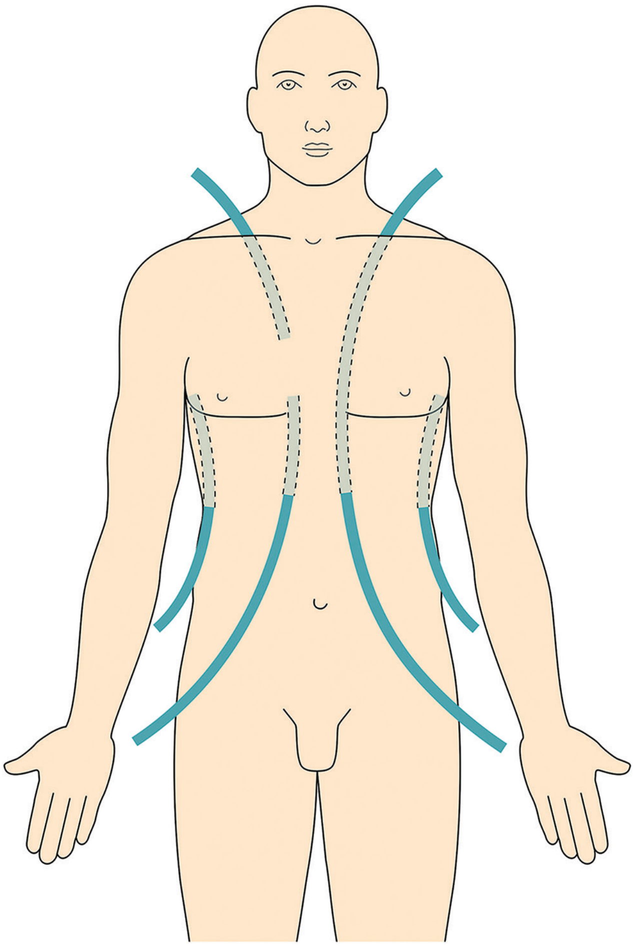

**Fig. 1** Diagram of lavage drain of mediastinum – type Endo IIB (left) and type Endo IIA (right).

## Statistical analysis

We statistically analyzed the effect of age, duration of anamnesis, time from making the diagnosis to the surgery, number of performed interventions, number of comorbidities, and number of positive bacteriology results on the treatment outcome of AM. A statistical analysis was performed using SAS software (SAS Institute Inc., Cary, NC, USA). The Kruskal–Wallis test was used to compare the distributions of the investigated variables among the tested groups. The frequency differences were examined by applying the chi-squared test and Fisher's exact test. The clinical impact of the examined factors on the success of the treatment was expressed using the odds ratio. The appropriate cut-off values for the age, duration of anamnesis, time from making the diagnosis to the surgery, number of performed interventions, number of comorbidities, and number of positive bacteriology results were found by applying logistic regression. Statistical significance was set to alpha = 5%. This retrospective study did not require any consent from the Ethics Committee.

**Table 1 Etiology of AM**

| Etiology of AM | Number | Percentage |
|---|---|---|
| Descending mediastinitis | 39 | 48.75 |
| Peritonsillar/retropharyngeal abscess | 23 | 28.75 |
| Odontogenic | 13 | 16.25 |
| Others | 3 | 3.75 |
| Esophageal perforation | 34 | 42.50 |
| Iatrogenic | 15 | 18.75 |
| Boerhaave syndrome | 10 | 12.50 |
| Foreign body | 5 | 6.25 |
| Others (tumor, diverticulum, ulcer) | 4 | 5.00 |
| Per continuitatem | 7 | 8.75 |
| Sternoclavicular joint infection | 5 | 6.25 |
| Others | 2 | 2.50 |

AM: acute mediastinitis

## Results

**Table 1** shows the classification of types and causes of AM. A detailed analysis of the cohort is presented in **Table 2**. A total of 116 surgical interventions were performed. A detailed overview thereof, their relation to the individual types of AM, and respective outcomes are presented in **Table 3**. Fifty-two patients (65%) underwent only one surgery, 20 patients (25%) underwent two surgeries, and eight patients (10%) underwent three surgeries.

A total of 54 different pathogens were identified during the microbiological examination of the sampled materials. The most common pathogenic strain in the whole cohort was *Streptococcus* sp. (47 cases) and *Streptococcus anginosus* (17 cases). A detailed overview of the microbiological outcomes is presented in **Table 4**.

A statistical analysis was conducted for the whole cohort and for the individual subgroups of AM on the basis of esophageal perforation and DNM. The analysis of the whole cohort revealed that the oldest patients were statistically significantly in the subgroup of esophageal perforations and the youngest in the subgroup of DNM (p-value = 0.0296). The statistically significant shortest anamnesis of AM occurred in patients with esophageal perforation (p-value = 0.0023). A statistically significant higher number of pathogens was found in patients with DNM (p-value = 0.0024). The patients with DNM also had a statistically significantly higher incidence of gram-positive aerobic organisms and gram-negative anaerobic organisms (p-value = 0.0103, more precisely p-value = 0.0001). In contrast, the patients with esophageal perforation had a statistically significantly higher incidence of yeast (p-value = 0.0417). The risk factors for death are presented in **Table 2**.

## Discussion

As severe as AM is, it occurs relatively rarely. For instance, Deu-Martín et al. reported that the incidence of DNM in Barcelona in 2006 was 5.1 patients per 1 million people.[17] This corresponds with our annual incidence rate, which is on average 4.8 patients per 1 million people. Abbasi et al. reported the incidence rate of DNM with deep neck infection to be between 1.5% and 3.6%.[18] Although the majority of references in literature point to perforation of the esophagus as the most common cause of AM (disregarding infection of the sternotomy as a separate entity), our cohort was slightly predominated by DNM cases.[2–6,13,19] In agreement with the cited authors, we observed almost half of the esophageal perforations to be iatrogenic and one-third to be spontaneous. Congruently with the latest trends, inflammations of oropharyngeal origin predominated among the DNM cases (59%).[1–3,5–11]

The fundamentals of AM therapy are early removal of its cause, sufficient surgical debridement and mediastinal drainage, administration of broad-spectrum bactericidal antibiotics, and intensive care, including mechanical lung ventilation.[1,9,18,19] Our opinion on how to treat DNM Type I according to Endo corresponds with the majority of recommendations, i.e. to perform drainage from cervicotomy or via videomediastinoscopy.[1,3–5,9–11,14,20–22] However, when treating Type IIA and IIB according to Endo, we prefer access by thoracotomy, which in our opinion provides the best view in the mediastinum and also allows the best debridement and drainage.[12] It is also faster for an easier adhesiolysis and palpation during dissection and debridement of the mediastinum.[14] On the other hand, it should be noted that the debridement and drainage of the whole mediastinum often require bilateral thoracotomy, which poses an additional risk of possible contamination of the so far uninfected pleural cavity (although in our experience, it is usually already infected in Type II according to Endo).[8] In agreement with Kang et al. and others, during sternotomy and clamshell thoracotomy, we fear osteomyelitis of the sternum or its dehiscence. We also consider these approaches problematic in terms of subsequent healing should repeated revision surgeries be needed (unlike thoracotomy).[1,5,11,14,20,21,23] Cutting through a healthy bone (i.e. sternum) in infected terrain is not, not just in our opinion, the correct surgical approach.[23] Although access into the posterior mediastinum is limited with sternotomy (more on the left), the anterior mediastinum is easily accessible.[1,20,22]

**Table 2 Characteristics of the patient group**

| Variables | All | | DNM | | | EP | | | PC | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % of all | % of DNM | No. | % of All | % of EP | No. | % of all | % of PC |
| Gender | | | | | | | | | | | |
| Male | 53 | 66.25 | 25 | 31.25 | 64.10 | 23 | 28.75 | 67.65 | 5 | 6.25 | 71.40 |
| Female | 27 | 33.75 | 14 | 17.50 | 35.90 | 11 | 13.75 | 32.35 | 2 | 2.50 | 28.60 |
| Total | 80 | 100 | 39 | 48.75 | 100 | 34 | 42.50 | 100 | 7 | 8.75 | 100 |
| Median of age (years) | 56 (19–85) | | 51 (19–85) | | | 63 (38–83) | | | 55 (20–78) | | |
| Comorbidities (patients) | 60 | 75.00 | 27 | 33.75 | 69.25 | 29 | 36.25 | 85.30 | 4 | 5.00 | 57.15 |
| Arterial hypertension (cases) | 34 | 42.50 | 13 | 16.25 | 33.35 | 18 | 22.50 | 52.95 | 3 | 3.75 | 42.90 |
| Type II diabetes mellitus (cases) | 15 | 18.75 | 7 | 8.75 | 17.95 | 6 | 7.50 | 17.65 | 2 | 2.50 | 28.60 |
| Obesity (cases) | 17 | 21.25 | 9 | 11.25 | 23.10 | 5 | 6.25 | 14.70 | 3 | 3.75 | 42.90 |
| Median of body mass index | 29 (17–43) | | 29 (19–43) | | | 27 (17–39) | | | 30 (27–32) | | |
| Median length of case history (days) | 2 (0–12) | | 3 (0–9) | | | 1 (0–8) | | | 3.5 (0–12) | | |
| Diagnostics | | | | | | | | | | | |
| CT | 74 | 92.50 | 39 | 48.75 | 100 | 29 | 36.25 | 85.30 | 6 | 7.50 | 85.70 |
| CT + esophagoscopy | 4 | 5.00 | 0 | 0 | 0 | 4 | 5.00 | 11.75 | 0 | 0 | 0 |
| MRI | 1 | 1.25 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1.25 | 14.30 |
| Esophagoscopy | 1 | 1.25 | 0 | 0 | 0 | 1 | 1.25 | 2.95 | 0 | 0 | 0 |
| Median number of CT examinations for one patient | 4 (1–10) | | 4 (1–10) | | | 3 (1–10) | | | 3 (2–5) | | |
| Median time from diagnosis to operation (hours: minutes) | 4:55 (0:00–21:42) | | 4:51 (0:09–21:42) | | | 4:47 (0:00–21:21) | | | 9:31 (4:14–20:09) | | |
| Complications (patients) | 51 | 63.75 | 23 | 28.75 | 59.00 | 26 | 32.50 | 76.50 | 2 | 2.50 | 28.60 |
| Sepsis (cases) | 25 | 31.25 | 12 | 15.00 | 30.80 | 12 | 15.00 | 35.30 | 1 | 1.25 | 14.30 |
| MOF (cases) | 13 | 16.25 | 5 | 6.25 | 12.80 | 7 | 8.75 | 20.60 | 1 | 1.25 | 14.30 |
| Pneumoniae (cases) | 13 | 16.25 | 6 | 7.50 | 15.40 | 7 | 8.75 | 20.60 | 0 | 0 | 0 |
| Median length of drainage (days) | 14.5 (0–89) | | 13.5 (1–34) | | | 17 (0–89) | | | 12 (8–22) | | |
| Median length of hospitalization (days) | 28 (1–148) | | 30 (1–91) | | | 28 (3–148) | | | 27 (14–45) | | |

**Table 2 Continued**

| Variables | All | | DNM | | | EP | | | PC | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % of all | % of DNM | No. | % of All | % of EP | No. | % of all | % of PC |
| Exitus | 10 | 12.50 | 3 | 3.75 | 7.70 | 7 | 8.75 | 20.60 | 0 | 0 | 0 |
| Risk factors for death | | | | | | | | | | | |
| Age >60 years | OR: 6.8; CI: 1.33–34.33; p-value = 0.0154 | | OR, CI: n/a; p-value = 0.0241 | | | – | | | – | | |
| >2 comorbidities | OR: 14.3; CI: 1.72–119.57; p-value = 0.0042 | | OR, CI: n/a; p-value = 0.0498 | | | – | | | – | | |
| >3 comorbidities | – | | – | | | OR: 7.1; CI: 1.12–45.52; p-value = 0.0375 | | | – | | |
| Diabetes mellitus type 2 | OR: 6; CI: 1.47–24.55; p-value = 0.0173 | | – | | | – | | | – | | |
| Presence of yeasts in the culture material | OR: 4.4; CI: 1.11–17.40; p-value = 0.0407 | | – | | | – | | | – | | |
| Coronary heart disease | OR: 8.7; CI: 1.82–41.17; p-value = 0.0120 | | – | | | OR: 19.5; CI: 1.61–236.61; p-value = 0.0211 | | | – | | |
| Cardiac arrhythmia | OR: 8.5; CI: 1.05–68.89; p-value = 0.0742 | | – | | | – | | | – | | |
| Stroke | OR: 8.5; CI: 1.05–68.89; p-value = 0.0742 | | – | | | – | | | – | | |

DNM: descending necrotizing mediastinitis; EP: esophageal perforation; PC: per continuitatem; CT: computed tomography; MRI: magnetic resonance imaging; MOF: multi-organ failure; OR: odds ratio; CI: 95% confidence interval; n/a: not available (zero frequency)

Understandably, video-assisted thoracoscopic surgery is associated with a lower morbidity rate than open procedures and, according to some, provides a better view. However, in advanced cases, it may not allow the necessary extent of debridement.[2,21,22] It is for this reason that it is not performed in our facility. However, we do agree with the opinion of Sandner and Börgermann, and others that it should be reserved for the initial stages of AM with minor findings and should be indicated selectively.[2,4,10,11,20,21] Percutaneous CT-guided drainage is used to manage smaller residual inflammatory collections. In our cohort, there was not a single patient in whom the extent of AM was so small that CT-guided drainage alone would be enough.

The use of stents in the treatment of esophageal perforations is still subject to discussions. Abu-Omar et al. recommend using them only in selected cases – for example in stable patients with minor contamination of the mediastinum within 24 hours after the perforation, or to limit a large leakage from the perforation or to bridge the time to final management in unstable patients.[1] We are aware of the controversy surrounding our approach to using stents. However, like some other authors, our experience has been quite positive.[3,5,6,19] In our facility, we indicate stents mainly for perforations that are spontaneous, iatrogenic, or caused by a foreign body, insofar as the duration of perforation anamnesis does not allow its safe suture and insertion of a stent is technically possible. We also implant them individually as a backup in cases of primary suture of the esophageal perforation if the outcome of the suture is deemed to be uncertain. Unfortunately, in our clinic, the incidence of patients in whom the safe suture of the esophagus is impossible or uncertain is relatively high, which means we indicate the placement of a stent more frequently than usual. We endoscopically implant fully coated nitinol stents with sufficiently wide openings on the proximal and distal ends. This ensures the required tightness and significantly reduces the risk of stent migration. The stents are left in situ for 6–8 weeks, followed by extraction. Using

**Table 3 Surgical treatment of AM**

| Etiology of AM | | 1st surgery | No. | 2nd surgery | No. | 3rd surgery | No. | Outcome |
|---|---|---|---|---|---|---|---|---|
| DNM | Endo I | CM | 24 | VMS | 1 | – | – | 22* |
| | | | | RTM | 2 | – | – | 2† |
| | | | | LTM | 2 | – | – | |
| | | | | CM | 3 | LTM | 1 | |
| | | CM + PST | 1 | – | – | – | – | * |
| | | CM + RTM | 2 | LTM | 1 | RTM | 1 | * |
| | | | | RTM | 1 | – | – | * |
| | | CM + BTM | 1 | RTM | 1 | – | – | * |
| | | RTM | 1 | – | – | – | – | * |
| | Endo IIA | CM | 1 | RTM | 1 | LTM | 1 | * |
| | | CM + BTM | 1 | LTD | 1 | – | – | * |
| | Endo IIB | CM + RTM | 8 | CM | 1 | – | – | 7* |
| | | | | LTM | 2 | RTM | 1 | 1† |
| | | | | CM + BTM | 1 | CM | 1 | |
| Esophageal perforation | Iatrogenic | CM | 3 | – | – | – | – | * |
| | | LTM | 1 | LTM | 1 | – | – | † |
| | | LPM | 1 | – | – | – | – | * |
| | | S + TD | 1 | – | – | – | – | * |
| | | RTM + S | 2 | – | – | – | – | * |
| | | CM + LPM + S | 1 | – | – | – | – | * |
| | | TPLM + S + NFP | 1 | – | – | – | – | * |
| | | C | 1 | – | – | – | – | * |
| | | LPM + S | 1 | LTM | 1 | – | – | * |
| | | TPLM | 1 | – | – | – | – | * |
| | | S | 1 | – | – | – | – | † |
| | | E | 1 | – | – | – | – | * |
| | Boerhaave syndrome | LPM + ES + S | 2 | LTD | 1 | – | – | * |
| | | | | LPM | 1 | – | – | * |
| | | LTM + S | 2 | S | 1 | RTM + ES + NFP | 1 | † |
| | | | | LTM | 1 | – | – | * |
| | | TPLM + ES + S + NFP | 4 | – | – | – | – | 3* |
| | | | | | | | | 1† |
| | | S | 1 | – | – | – | – | † |
| | | RTM + S | 1 | – | – | – | – | † |
| | Foreign body | VMS + S | 1 | – | – | – | – | * |
| | | TPLM + ES + S + NFP | 1 | LTM | 1 | LTM | 1 | * |
| | | CM + RTM + S | 1 | RTM | 1 | – | – | * |
| | | CM | 2 | – | – | – | – | * |
| | Others | CM | 1 | RTM | 1 | – | – | * |
| | | E | 1 | – | – | – | – | † |
| | | S | 1 | – | – | – | – | * |
| | | RTM + ES + RLL | 1 | RTM + ES | 1 | S | 1 | * |
| Per cont. | SC joint infection | CM | 5 | CM | 1 | – | – | * |
| | Others | CM | 2 | – | – | – | – | * |

AM: acute mediastinitis; Per cont.: per continuitatem; DNM: descending necrotizing mediastinitis; SC: sternoclavicular; CM: cervical mediastinotomy; VMS: videomediastinoscopy; RTM: right thoracotomy + mediastinotomy; LTM: left thoracotomy + mediastinotomy; PST: partial sternotomy; BTM: bilateral thoracotomy + mediastinotomy; LTD: left thoracotomy + decortication; LPM: laparotomy + mediastinotomy; S: stent; TD: thoracic drainage; TPLM: thoraco-phreno-laparotomy + mediastinotomy; NFP: Nissen fundoplication; C: clipping; E: esophagectomy; ES: esophageal suture; RLL: right lower lobectomy; *: alive; †: death

coated biodegradable stents did not prove successful for us due to the more difficult insertion and, in our opinion, insufficient radial pressure on the esophageal wall, which causes looseness and a high risk of migration. We think that by implanting a stent, it is possible to preserve the native esophagus for the patients, even in those cases where safe suture of the perforation is not possible. We consider this to be more beneficial for the patient

**Table 4 Bacteriology of AM**

| Variables | All | DNM | EP | PC |
|---|---|---|---|---|
| Number of identified pathogens | | | | |
| Gram-positive aerobes | 19 | 10 | 15 | 2 |
| Gram-negative aerobes | 9 | 6 | 5 | 0 |
| Gram-positive anaerobes | 7 | 7 | 1 | 0 |
| Gram-negative anaerobes | 14 | 11 | 7 | 0 |
| Yeasts | 5 | 3 | 5 | 0 |
| Total | 54 | 37 | 33 | 2 |
| Number of AM cases including stated pathogens | | | | |
| Gram-positive aerobes | 58 | 32 | 19 | 7 |
| Gram-negative aerobes | 12 | 5 | 7 | 0 |
| Gram-positive anaerobes | 15 | 14 | 6 | 0 |
| Gram-negative anaerobes | 26 | 21 | 5 | 0 |
| Yeasts | 18 | 6 | 13 | 0 |
| Number of identified pathogens in one case of AM | | | | |
| None | 14 | 1 | 13 | 0 |
| One | 20 | 10 | 3 | 7 |
| Two | 13 | 7 | 6 | 0 |
| Three | 15 | 11 | 4 | 0 |
| Four | 16 | 9 | 7 | 0 |
| More than four | 2 | 1 | 1 | 0 |

DNM: descending necrotizing mediastinitis; EP: esophageal perforation; PC: per continuitatem; AM: acute mediastinitis

compared to possible resection and replacement of the esophagus. We primarily used a stent in 21 patients (out of which seven served as a backup for the suture of the esophagus), with only one case of failure due to migration; the other repeated surgeries in these patients were performed out of the necessity to manage persisting inflammatory changes in the mediastinum, not the need to remediate the respective esophageal perforations. Of the patients with esophageal perforation who were treated by implantation of a stent, five died. However, the causation in all the cases was unresponsive sepsis in polymorbid patients in whom the perforation of the esophagus had already been managed. In our facility, we do not have any experience with endoscopic vacuum therapy, which has been increasingly recommended in recent years.[1,5,19] Clipping was successfully used in one case of an immediately diagnosed iatrogenic perforation during an endoscopic dilation of a benign esophageal stenosis.

Due to the small number and diversity of patients, prospective studies of AM are not possible in practice. The statistical processing of relatively small, heterogeneous groups is also considered difficult. Nevertheless, certain conclusions can be found in literature. The factors resulting in a poor prognosis of AM usually include age of the patient, causation of AM, presence of severe comorbidities, delay in diagnosis and treatment, wrongly chosen treatment, and microbiological findings.[1,4,6,10,17,20] The extent of DNM directly affects mortality, whereby the difference between the injury to the upper and lower mediastinum is determinant.[1,7,10,20] The highest lethality among esophageal perforations occurs in combination with the Boerhaave syndrome (which corresponds with our results – four deaths out of seven cases of esophageal perforations occurred in patients with the Boerhaave syndrome). This is probably due to the frequent delay in determining the right diagnosis, followed by perforation of the esophageal tumor.[1,4,6] Delayed diagnosis, i.e. over 24 hours, significantly increases lethality.[1,3,4]. In our cohort, as in the case of Jabłoński et al. and de Oliveira et al., we found a statistically significant increase in the number of pathogenic species, more precisely the gram-positive aerobic organisms, in patients with DNM compared to other types of AM.[4,13] When making comparisons with the same work of Jablonski et al., it should be noted that they did not identify any specific pathogen or pathogenic strain that correlates with a higher risk of death, whereas in our patients with esophageal perforation, the presence of yeast in the cultures statistically significantly increased lethality.[4] All the other outcomes are in agreement with the above cited authors, whereby the risk of death was statistically significantly higher in patients over 60 years of age and with three or more comorbidities. We did not confirm the effects of the other discussed factors.

## Conclusion

The successful treatment of AM depends on the early diagnosis and rapid surgical management of this not so common disease, whereby the aim is to remove the cause and to provide sufficient debridement of the mediastinum, including quality drainage.

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