

## Sternal Metastasis from Serous Ovarian Carcinoma - A Narrative Review Highlighting the Importance of Multidisciplinary Management in These Cases

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Abbreviations:

CT: computed tomography;  
MRI: magnetic resonance imaging;  
PET-CT: positron emission  
tomography-computed tomography.

### Introducere

#### *Metastază sternală de carcinom ovarian - review privind importanța managementului multidisciplinar în aceste cazuri*

*Introducere:* Metastazele sternale de carcinom seros ovarian sunt afecțiuni extrem de rare, în literatura de specialitate fiind publicate mai puțin de 10 articole referitor la acest subiect. Scopul prezentului articol este acela de a prezenta un caz de metastază sternală de carcinom seros ovarian apărută tardiv la o pacientă operată pentru carcinom seros ovarian în urmă cu aproximativ 6 ani și de a realiza un review al literaturii de specialitate în ceea ce privește importanța managementului multidisciplinar în aceste cazuri.

*Material și Metodă:* Am încercat să realizăm un review al literaturii de specialitate referitor la articolele publicate despre metastazele sternale de carcinom seros ovarian pe o perioadă de aproximativ 30 de ani, între 1.01.1994 - 31.12.2023. În acest sens am folosit următoarele baze de date : Pubmed și Web of Science Clarivate, folosind ca și cuvinte cheie: metastaze sternale, cancer ovarian.

*Rezultate:* În urma studiului literaturii de specialitate am identificat doar 10 articole care să prezinte cazuri clinic apărute după cancer ovarian operat, chimiotratat. Am prezentat de asemenea cazul unei paciente în vârstă de 70 de ani care a fost diagnosticată cu o metastază sternală de carcinoma seros ovarian, punând accent pe managementul terapeutic al cazului.

*Concluzii:* Metastazele sternale de carcinom seros ovarian reprezintă

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afecțiuni extrem de rare. În aceste cazuri, dacă metastazele sternale sunt unice, iar pacienta nu prezintă metastaze la alte niveluri și nici semne de recidivă locală, rezecția sternului poate constitui o opțiune terapeutică viabilă în tratamentul acestor paciente.

**Cuvinte cheie:** metastază sternală, carcinom seros ovarian, rezecție perete toracic

## Abstract

*Introduction:* Sternal metastases of serous ovarian carcinoma are extremely rare conditions, with less than 10 articles published in the medical literature on this subject. The aim of this article is to present a case of late-onset sternal metastasis of serous ovarian carcinoma in a patient who underwent surgery for serous ovarian carcinoma approximately 6 years before and to provide a review of the literature regarding the importance of multidisciplinary management in such cases.

*Material and Method:* We aimed to conduct a review of the specialized literature concerning published articles on sternal metastases from ovarian serous carcinoma over a period of approximately 30 years, from January 1, 1994, to December 31, 2023. For this purpose, we utilized the following databases: PubMed and Web of Science (Clarivate Analytics), using the keywords: sternal metastases, ovarian cancer.

*Results:* Following our review of the specialized literature, we identified only 10 articles that reported clinical cases of sternal metastases occurring after ovarian cancer surgery and chemotherapy. Additionally, we present the case of a 70-year-old female patient diagnosed with sternal metastasis from ovarian serous carcinoma, with an emphasis on the therapeutic management of the case.

*Conclusions:* Sternal metastases of serous ovarian carcinoma represent extremely rare conditions. In such cases, if sternal metastases are solitary, and the patient does not present metastases at other sites nor signs of local recurrence, sternum resection may constitute a viable therapeutic option in the treatment of these patients.

**Key words:** sternal metastasis, serous ovarian carcinoma, thoracic wall resection

## Introduction

Bone metastases are commonly encountered in clinical practice among neoplastic patients. Most frequently, bone metastases occur in patients with lung, breast, renal, or prostate cancers (1). Sternal metastases represent approximately 40% of all metastatic tumors located in the thoracic wall. There are very few clinical studies in the literature regarding sternal metastases, with the majority of published clinical studies being case reports. Sternal metastases are most commonly located in the sternal body, with rarer occurrences at the level of the manubrium and xiphoid process (2).

The most common sources of sternal metastases are breast cancer, malignant melanoma, and thyroid cancer (3). Ovarian cancer is one of the most prevalent types of cancer in women. Although patients with ovarian cancer frequently present with distant metastases, bone metastases are extremely rare in clinical practice (4,5). Sternal metastases can be solitary or multiple and may also represent the sole metastatic site of the primary disease (6,7). Most commonly, sternal metastases are found in patients with multiple bone metastases. Due to the disseminated stage of neoplastic disease, these tumors are often deemed inoperable, with very few cases of successful resection of these metastases reported in the literature (8,9).

## Material and Method

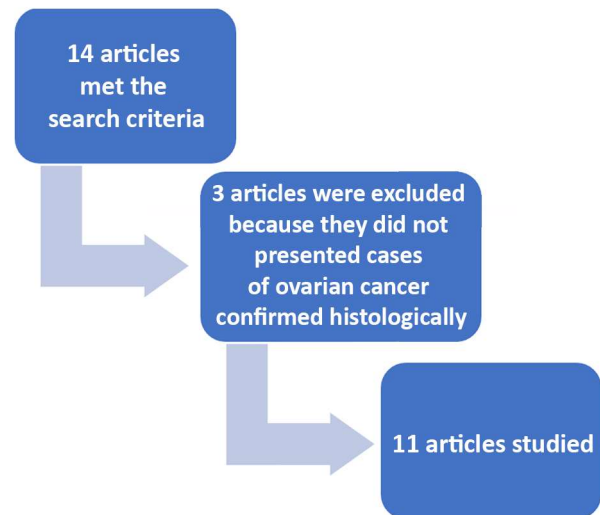
For this review, we used PubMed and Web of Science (Clarivate Analytics) as our primary databases. In these databases, we searched for all articles published over a 30-year period concerning sternal metastases from ovarian serous carcinoma, using the following key words: sternal metastases, ovarian cancer. The inclusion criteria for this study comprised only full-text articles that reported cases of patients with a confirmed histological diagnosis of ovarian cancer and presenting sternal metastases. We excluded studies published as abstracts, as well as those published in languages other than English. Based on these criteria, the authors examined the two databases and reviewed all articles that met the inclusion criteria, while those that did not meet these criteria were excluded from the study.

Also, in our manuscript, we wanted to present a clinical case of a late-onset solitary sternal metastasis of serous ovarian cancer in a patient who underwent surgery for serous ovarian carcinoma and subsequently received long-term platinum-based chemotherapy. Additionally, we aim to conduct a review of the specialized literature regarding the occurrence of this condition and the importance of a multi-disciplinary therapeutic approach in such cases.

## Results

Following the literature review, we identified only 14 articles that matched the specified keywords. Based on the inclusion and exclusion criteria, we excluded three articles (*Fig. 1*).

Of these, ten were case reports, and the eleventh article presented two cases of sternal metastases from ovarian serous carcinoma. Our primary focus was on the therapeutic management used in these cases, with particular emphasis on surgical treatment. The articles that met the search criteria are listed in *Table 1* (2,6-15).



**Figure 1.** Flow chart for study selection

## Case Report

A 64-year-old female patient was diagnosed with a pelvic tumor. Initially, an exploratory laparoscopy was performed, which revealed the presence of an ovarian tumor mass, and a biopsy was conducted. Histopathological examination diagnosed a serous ovarian carcinoma. Taking this into consideration, neoadjuvant chemotherapy was initiated with Paclitaxel and Carboplatin (Paclitaxel 175 mg/m<sup>2</sup>, Carboplatin AUC 5, every 21 days, for 3 cycles). Subsequently, curative surgical intervention was performed, including total hysterectomy with bilateral salpingo-oophorectomy. Histopathological examination of the resected specimen identified bilateral

**Table 1.** Manuscript published in databases

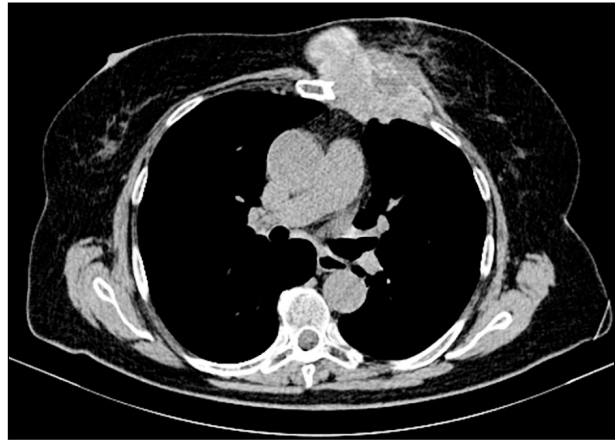
Author	Journal	Year
Sohn et al.	Nuclear medicine and molecular imaging	2010
Srinivas et al.	Indian Journal of Surgical Oncology	2017
Ho et al.	Clinical Nuclear Medicine	2011
Noguchi et al.	Gynecologic Oncology	1994
Chiu et al.	Journal of Reproductive Medicine	2008
Zhang et al.	Saudi Medical Journal	2013
Ak et al.	International Journal of Gynecological Cancer	2021
Pavlakakis et al.	International Journal of Gynecological Cancer	2006
McGrath et al.	Pathology	2012
Siemon et al.	Journal of Surgical Oncology	2019
Lahlou et al.	Radiology Case Reports	2024

seromucinous borderline ovarian tumors with foci of microinvasion in the ovarian stroma and uterine tube, along with invasive and non-invasive omental implants and involvement of an omental lymph node. The therapeutic regimen was completed with 3 cycles of adjuvant chemotherapy with Paclitaxel and Carboplatin.

Following oncological therapy, the patient underwent regular clinical and radiological surveillance. The tumor marker CA-125 remained within normal limits, and imaging investigations (thoraco-abdomino-pelvic CT, abdomino-pelvic MRI) did not indicate the presence of any tumor recurrence for 6 years. After this period, during a routine follow-up visit, the patient presented to the oncologist reporting the presence of a tumor mass in the mid-third of the sternum measuring approximately 8 cm in diameter, painful on palpation, symptom not alleviated by usual analgesic medication. The tumor marker CA-125 showed elevated levels (49.98 U/ml). Thoraco-abdomino-pelvic computed tomography revealed the presence of a solid tumoral mass, with calcifications, measuring 89/62 mm, located in the anterior left thoracic wall, beneath the pectoralis major muscle, with invasion of the sternum and anterior ends of the left ribs III-IV, without pathological changes of the abdominal and pelvic organs, as highlighted in *Fig. 2*.

Initially, a biopsy was performed at the site of the tumor formation, which revealed a proliferation of tumoral cells with features of low-grade serous carcinoma, relatively low mitotic index, with a maximum of 10 mitoses /10HPF, focal areas of hobnail cells, minimal necrotic areas, as well as intratumoral hemorrhage. Immunohistochemical examinations for p53 wild type and WT1 were diffusely positive.

Considering the histopathological result, tumoral recurrence, and disease-free interval, the oncologist recommended the administration of 6 cycles of Paclitaxel + Carboplatin + Bevacizumab chemotherapy. Periodical clinical and imaging evaluations were performed according to up-to-date protocols. Throughout



**Figure 2.** Axial CT of the chest which highlights the presence of the sternal tumor.

the treatment, we noticed a decrease in the tumoral marker CA-125, reaching normal levels 6 months after the initiation of the oncological treatment. A thoracic CT scan performed at 6 months from the initiation of chemotherapy revealed a space-occupying process in the left anterior thoracic wall within the sternum, which had significantly decreased in size to 22/57/45 mm, with calcifications and irregular contour, posterior to the pectoralis muscle, without clear demarcation from it, with invasion of the left anterior ribs III and IV, as highlighted in *Fig. 3*.

Considering the excellent response to treatment, confirmed by the CT scan, subsequent maintenance therapy with Bevacizumab 15 mg/kg was administered for a total of 18 cycles. To evaluate the effectiveness of the treatment, a PET-CT scan was recommended



**Figure 3.** Axial CT of the chest 6 months after the onset of chemotherapy that highlights the decreased of the tumoral size

to the patient; however, the patient declined to undergo this imaging investigation. Upon completion of Bevacizumab treatment, the multidisciplinary team recommended surgical treatment of the anterior thoracic wall lesion. This decision was based on the reduction in size of the tumor during therapy, the absence of other metastases, and the solitary character of the tumor.

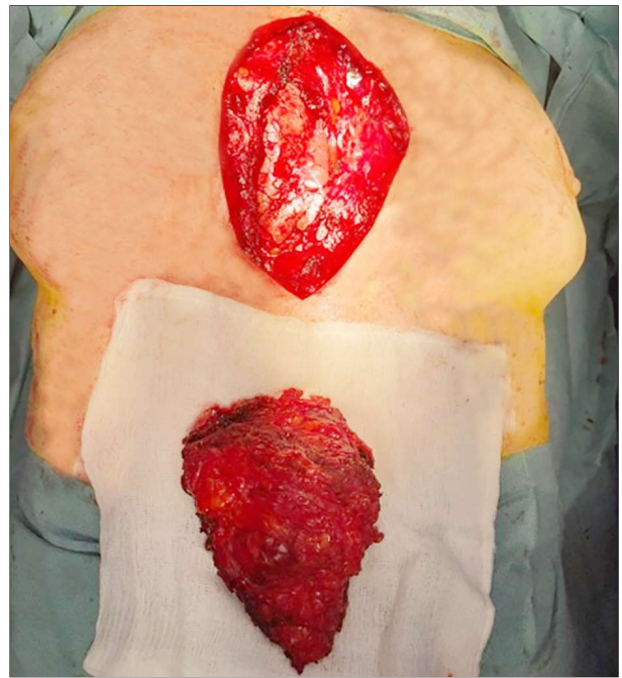
Following appropriate preoperative preparation, surgical intervention was performed, consisting of en bloc resection of the tumor formation from the sternum, subtotal sternum resection, and resection of the anterior ends of left ribs II-V. A 1 cm stump remained at the superior portion of the sternal manubrium. Thoracic wall reconstruction was achieved using a Parietex™ Optimized Composite mesh and three metal bars. The patient's postoperative course was uneventful, being discharged 7 days after the procedure (*Fig. 4*).

Examination of the resection specimen revealed a tumor formation measuring approximately 55 mm in diameter. Microscopic examination exhibited tumor cells with eosinophilic cytoplasm, vesicular nuclei, nucleoli, marked pleomorphism, arranged in areas with papillary, micropapillary, glandular, and pseudoglandular features, as visible in *Fig. 5*. The tumor cells were positive for CK7 and WT1 but negative for PR, ER, p53, podoplanin, TTF1, and CTK20. The final histological diagnosis confirmed a sternal metastasis of serous carcinoma, with histological and immunophenotypic features suggestive of metastatic ovarian serous carcinoma. Histological examination of the resected borders did not reveal the presence of tumor cells at this level (*Fig. 6*).

After the surgical procedure, the patient opted against any additional oncological treatment and survived for one year post-surgery, showing no evidence of tumor recurrence in either the thoracic or abdomino-pelvic areas.

## Discussion

Clinically diagnosing sternal metastases can



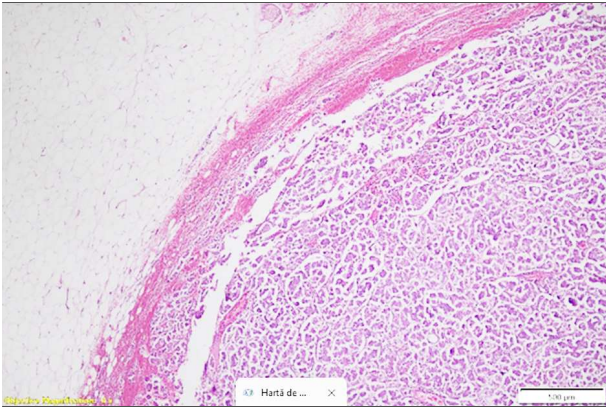
**Figure 4.** Intraoperative view (resection of the sternal tumor and the thoracic wall)

often be challenging, as clinical examination alone may not provide definitive information regarding the etiology of sternal lesions. Therefore, histological diagnosis is mandatory in such cases. Primary tumors of the thoracic wall (e.g., chondrosarcomas, osteosarcomas, chondromas) or metastatic lesions are most commonly encountered in the sternum (16,17). The most prevalent metastases to the thoracic wall originate from breast cancer (18).



**Figure 5.** Intraoperative view – reconstruction of the thoracic wall





**Figure 6.** Histologic examination of the resection specimen, Hematoxylin-Eosin, magnification 4x

However, literature reports have documented sternal tumors where histological examination revealed lymphomas, melanomas, glioblastomas, hepatocarcinomas, cholangiocarcinomas, and thyroid carcinomas. (19-24)

Additionally, benign conditions such as sternal abscesses or extrapulmonary tuberculosis should also be considered in the differential diagnosis (25,26).

Ovarian cancer commonly metastasizes through peritoneal spread to abdominal organs or via lymphatic dissemination to paraaortic and pelvic lymph nodes. Extra-abdominally, the most frequent sites of ovarian cancer metastases include the lungs, pleura, or central nervous system (27). Bone metastases in ovarian cancer most frequently occur in the vertebrae but can also manifest in the femur, skull bones, or ribs (28). Few cases of sternal metastases from ovarian cancer have been reported in the literature. Unlike cases reported in the literature, where sternal metastases occurred concurrently with either abdominal tumor recurrence or multiple metastases, in our case, at the time of sternal metastasis diagnosis, the patient showed no signs of abdominal tumor recurrence (12,13,29).

Currently, radiological examinations play a crucial role in diagnosing sternal tumors. These investigations facilitate both the identification of sternal tumors and the assessment of adjacent structure invasion. Standard profile X-Ray examination may reveal osteolytic areas, osteolysis, and periosteal

reaction in the sternum. However, standard X-Ray has limited diagnostic use for small sternal tumors and in evaluating invasion of adjacent soft tissues or endothoracic structures (30).

CT thoracic examination remains the imaging modality of choice for diagnosing sternal tumors, allowing for accurate diagnosis of sternal tumor formation and the assessment of surrounding structures invasion, both endothoracic and soft tissues (31). MRI examination of the sternum is rarely used in diagnosing patients with sternal tumors. However, cases have been cited in the literature where patients with breast tumors have incidentally discovered sternal tumor formations following breast MRI examinations, which were subsequently confirmed to be sternal metastases (32). Nuclear medicine plays a particularly important role in diagnosing bone, including sternal, metastases. For a long time, bone scintigraphy has been the preferred diagnostic method for diagnosing bone and sternal metastases. However, in recent years, with the introduction of positron emission tomography-computed tomography (PET-CT) into clinical practice, studies have been published demonstrating that PET-CT has better sensitivity in diagnosing bone and sternal metastases compared to bone scintigraphy (33,34).

Histological examination remains crucial in the clinical evaluation of patients with sternal metastases. Tissue sampling for histopathological examination can be achieved through incisional or excisional biopsy or percutaneous biopsy guided by imaging (ultrasound or CT). While incisional or excisional biopsies pose a risk of postoperative complications, CT-guided percutaneous biopsy is associated with minimal morbidity (35).

The quality of life of patients with sternal metastases is affected both by the pain they experience and by the risk of pathological bone fractures (36). Therapeutic options for patients with sternal metastases are quite limited, partly due to the reduced life expectancy of these patients and partly due to the disseminated nature of their condition (37). Few

patients are candidates for surgical treatment, considering the extent of the disease. However, in patients with solitary sternal metastases, without other distant metastases and without signs of local recurrence, partial or total sternectomy represents a surgical intervention with acceptable morbidity and mortality rates and fairly good long-term postoperative survival (33). Additionally, it is known that the sternum has a relatively poor vascularization, which is why most sternal tumors do not exhibit aggressive growth and rarely invade surrounding anatomical structures (38,39).

The aim of surgical treatment is represented by the en bloc resection of the tumor mass together with the sternum, performed in such a way that the margins of the resection specimen are not invaded by the tumor. In cases of total or partial sternectomy, it is also necessary to perform a reconstruction of the thoracic wall to prevent potential cardiovascular and respiratory complications. In this regard, preventing the occurrence of cardiac herniation and paradoxical movements of the thoracic wall are particularly important (40,41). If feasible, it is preferred for a portion of the sternum to remain in place after sternal resection. The persistence of a portion of the sternum allows for better anchoring of prosthetic materials used in thoracic wall reconstruction, resulting in improved postoperative cosmetic outcomes in selected cases (42-44). In the case presented herein, at the level of the sternal manubrium in its upper portion, a stump measuring approximately 1 cm in length remained.

The reconstruction of the parietal defect in the anterior thoracic wall can be achieved either with prosthetic materials or muscle flaps. Titanium bars are commonly used to prevent paradoxical movements of the thoracic wall, as conventional prosthetic materials do not provide adequate rigidity. Typically, the parietal defect is covered with polypropylene meshes, Gore-Tex meshes, or methylmethacrylate introduced between two polypropylene meshes (Marlex sandwich technique) (45-48).

Prosthetic materials used in the reconstruc-

tion of the thoracic wall after thoracic parietal resections must fulfill certain criteria. The main characteristics include rigidity to prevent paradoxical movements of the thoracic wall, malleability, easy tissue integration, radiolucency, and resistance to infections (49,50). Polypropylene mesh has the advantage of excellent tissue tolerance, good tissue integration, and cost-effectiveness; however, it is usually not efficient when used alone in the reconstruction of large parietal defects (51). The utility of polypropylene mesh in thoracic surgery, besides reconstructing thoracic parietal defects, has been demonstrated in closing bronchial stumps after lung resections, both in clinical and experimental studies (52-54). In our case, we used a Parietex™ Composite mesh for thoracic wall reconstruction. This type of mesh features a resorbable collagen layer on one side, significantly reducing adhesions with the viscera with which it comes into contact. Additionally, the polyester structure of this mesh allows for excellent tissue integration (55).

Recent advancements in medical engineering and 3D printing have enabled the development of custom-made titanium or carbon prostheses for thoracic wall reconstruction following chest wall resections. While titanium implants may affect postoperative radiotherapy efficacy and lack optimal tissue integration, carbon prostheses offer reduced disadvantages (50,56,57).

Musculocutaneous flaps have the advantage of allowing the reconstruction of large parietal defects, whilst also providing excellent long-term tolerance and stability. The most commonly used musculocutaneous flap is the latissimus dorsi flap. However, there are cases reported in the literature where anterior thoracic wall reconstruction was performed using the pectoralis major muscle flap, rectus abdominis muscle flap, or greater omentum (58,59). Another technical variant that has been used in clinical practice involves covering the anterior thoracic wall defect using the mammary gland after its mobilization (60).

The prognosis of patients undergoing sternal resection for metastases in the

sternum is quite favorable, especially when the sternum is the sole site of secondary tumors and surgical resection achieves R0 margins. A study published in 2015 by Ahmad et al. demonstrated that the 5-year survival rate of patients who underwent sternal resection was 73% if the primary tumor was not breast cancer and 58% if the primary tumor was breast cancer (61).

In cases where sternal resection cannot be performed as a palliative method, cryoablation of the tumor can be practiced for palliative purposes, aiming to control pain syndrome and prevent local tumor complications (62). The advantage of the method lies in its minimally invasive nature and its feasibility for percutaneous implementation under CT guidance (63). There is limited literature on this method, with only a few case reports published regarding sternal metastases.

There are also studies in which patients with sternal metastases underwent chemoembolization (64,65). Through the embolization of arteries supplying the tumor, ischemia/necrosis of the tumor mass occurs, resulting in tumor size reduction and alleviation of pain syndrome. Typically, in these cases, the internal mammary arteries are embolized unilaterally or bilaterally, depending on the localization of the tumor. The advantage of chemoembolization compared to radiotherapy in patients with sternal metastases lies in the significantly reduced local complications associated with this procedure (66,67).

Currently, radiotherapy represents the most commonly used palliative treatment modality for patients with sternal metastases. The goal of radiotherapy in these cases is to achieve local tumor control and alleviate pain syndrome. However, the drawback of radiotherapy lies in its non-repetitive nature, and the potential significant adverse effects of radiation on the pulmonary parenchyma, heart, and major vessels in the mediastinum (68,69). To mitigate these effects, an increasing number of medical centers prefer the implementation of stereotactic radiotherapy in such cases (70).

## Conclusions

Sternal metastases from serous ovarian carcinoma are exceedingly rare conditions. In these cases, if the sternal metastases are solitary, and the patient does not present with metastases at other sites or signs of local recurrence, sternectomy and further reconstruction of the thoracic wall may constitute a viable therapeutic option in the treatment of these patients.

*Conflict of Interest:* None.

*Funding:* None.

## Ethical Statement

The case received approval from the Ethical Committee of the George Emil Palade University of Medicine, Pharmacy, Science, and Technology, Târgu Mureș, under reference no. 2851/ 23.02.2024.

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