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Surgical and nonsurgical outcomes for treating a cohort of empyema thoracis patients: A monocenteric retrospective cohort study

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ABSTRACT

Background: There are several studies reporting high success rates for surgical and nonsurgical treatments of empyema separately. The aim of current retrospective cohort study is to find the best treatment in low socio-economic areas.

Material and methods: A total of 149 patients were treated in the referring hospital from January 2002 to December 2008. The current retrospective cohort study was carried out by nonsurgical (medically & thoracenthesis & chest tube drainage with or without fibrinolytic agents) and surgical (VATS & open thoracotomy decortication methods) procedures in single center performed in thoracic and respiratory medicine wards. The independent *t*-test on demographic data was the statistical test tool.

Results: The complete cure and mortality rates for 130 patients were 27% (35 out of 130 patients) and 0.3% (1 out of 130 patients), respectively. Thirteen out of 149 patients that were estimated to be at stage II underwent VATS decortication. The results showed zero success rates for this procedure which was then converted to open thoracotomy decortication. And, 113 patients who underwent thoracotomy decortication had a cure rate of 96.4% (109 patients) and mortality rate of 1.8% (2 patients). Four (3.5%) patients needed thoracoplasty, 2 died and 2 (1.8%) needed open window thoracostomy resulted in empyema necessitans that remained uncured. Total hospitalization lengths for the patients treated by tube thoracostomy and thoracotomy decortication were (15.4 ± 2.1) and (6.2 ± 1.8) days ($P < 0.001$), respectively. The success rates between surgical and nonsurgical treatments were 98.2% and 27.1%. And, the difference between them was significant ($P < 0.001$).

Conclusion: Because of the advanced stages of empyema in our patients, thoracotomy decortication procedure is often the first rank choice with success rates higher than nonsurgical techniques. However, nowadays, the success rates of nonsurgical and VATS management of empyema thoracis are mostly reported in the literature.

1. Introduction

The sterile pleural space infected by various bacteria can produce empyema thoracis [1]. These infections are para-pneumonic effusion, secondary to trauma, complications of postoperative thoracic surgery, and extension of neighboring infections [1]. On the occasions that the empyema is not well-treated or is complicated, significant levels of mortality and morbidity are the results [2]. A range of therapeutic options are available for treatment such as percutaneous aspiration, chest tube drainage, and video-assisted thoracoscopic surgery (VATS) and open thoracotomy decortication procedures.

Some studies showed high success rates for treating empyema by VATS decortication and nonsurgical management of empyema (i.e, tube thoracostomy & antibiotics with or without instillation of fibrinolytic agents) [3].

At the multiloculation and early stages of fibrinopurulent states when the peel was not formed yet, VATS decortication would be the common procedure [3,4]. Also, some surgeons reported favorable results for VATS decortication at stage III of empyema that the results were the same for open thoracotomy decortication. But, the ability of VATS to adequately decorticate the lung at stage III remained controversy. Moreover, in situations of delayed referral, empyema patients treated by VATS decortication were mostly converted to be treated by open thoracotomy decortication [5]. On the other hand, the most successful therapy for advanced stages of empyema is thoracotomy decortication when thick peel is formed [6,7].

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Although, all of the existing studies were based on single treatment procedure without any comparisons (i.e., surgical or nonsurgical) and hence, their results could not be reliable for choosing the best one. There are several cohort studies carried out on empyema [8–17] from which only two of them were retrospective [14,17] and they were analyzing the risk of aortic aneurysm [14] as well as the characteristics of medically and surgically treated patients in terms of chest pain, IV antibiotics, chest tube, and intrapleural fibrinolytics [17]. A retrospective cohort study is used for comparing medical treated groups for whom the information for the outcomes are recorded in a long period of time to be analyzed later in the near future [18]. However, this type of study may suffer from treatment selection or information biases. The research questions are “what are the outcomes of surgical and nonsurgical treatment of empyema?”, and “what is the best management procedure for empyema patients in low socioeconomic areas?”. The purpose of the current study is to perform a retrospective cohort analysis of the experiences obtained from treating the empyema thoracis in the low socioeconomic area to assess the cure and success rates by excluding and including mortality rate, respectively. Both surgical (VATS, thoracotomy decortication) and nonsurgical (tube thoracostomy and antibiotics, with or without fibrinolytic agents) procedure were performed which were serially conducted on the referral cohort during a period of time.

2. Material and methods

The current retrospective cohort study was carried out on serially admitted hospitalized patients with empyema thoracis in a single center (Imam Reza Referral Hospital, Tabriz University of Medical Sciences, Northwest of Iran) from January 2002 to December 2008 and the research was registered at the publicly available database (i.e., ResearchRegistry.com) with the No. 2939. The study was approved by the Medical Ethics Committee of the University. Also, this study was complied with the STROCSS guideline for strengthening the reporting of cohort studies in surgery [18].

Three stages of post infectious pneumonia and empyema which were used as clinical parameters for therapy of empyema included the followings [19,20]:

Stage I- Dry or exudative stage that lasts for one to five days (treated nonsurgically), *Stage II*- Fibrinopurulent state that occurs within the first three weeks of infection (treated surgically: VATS or open thoracotomy decortication), *Stage III*- This is also known as organizing stage that can happen after three weeks when a thick pleural peel develops (treated by open thoracotomy decortication). Any failed treatment of stage I or VATS surgery was treated by open thoracotomy decortication.

The treatment options included surgical and nonsurgical procedures. The former treatments were VATS decortication, and mini-thoracotomy or standard thoracotomy decortication whereas, the latter ones were combinations of antibiotics, thoracenthesis, instillation of fibrinolytic therapy with drainage, and toilet of pleural cavity [5].

Nonsurgical management of patients was performed in the Respiratory Medicine Ward and surgical treatment of patients was carried out in the Thoracic Ward of Academic referral Hospital affiliated with Tabriz University of Medical Sciences. All patients were followed up six to twelve months in the subspecialist clinic of the hospital.

The inclusion criteria were based on European Association Cardio-Thoracic Surgeon (EACTS) guideline which suggested choices for diagnosis and treatment of any stages of empyema thoracis [5]. All patients with chest symptoms, pleuritic chest pain, dyspnea, bacterial pleural effusion, and septic conditions with empyema were included. Patients who underwent VATS decortication and were converted to open thoracotomy during or after operation were also included. Additionally, the patients whom their nonsurgical treatments were failed were included.

And, the exclusion criteria were as follows:

- Patients with empyema necessitans (2 patients).
- Patients were clinically unstable and hence, were not suitable for general anesthesia (1 patient)
- Patients with cardiopulmonary compromises and empyema (1 patient).

The first two patients involved in advance stages of empyema (such those of Hippocrates's patients) did not satisfy the abovementioned criteria, and regarding the other two patients, they did not have stable conditions and hence, they refused to be treated.

153 patients at the acute and chronic stages of empyema thoracis with following characteristics were first included; *(i)* post pneumonic infections (142 patients), *(ii)* trauma sequels (8 patients), and *(iii)* extension of suppuration process from neck, mediastinum and abdomen (3 patients).

The cohort groups included 130 and 113 patients which were treated nonsurgically and surgically, respectively. The management on nonsurgical group was carried out medically with or without thoracentesis or instillation of any types of fibrinolytic agents. And the treatment on surgical group was performed using open thoracotomy decortication which had three subgroups including 13 patients treated by VATS procedure, 94 uncured patients of nonsurgical management group, and 6 patients treated by open thoracotomy decortication. All the patients especially the surgical treated patients were preoperatively managed by chest physiotherapy, flexible bronchoscopy, and antibiotics.

The surgical group of patients was under general anesthesia and treated via standard posterolateral thoracotomy. During decortication, lung tearing parenchyma was sutured by nylon or PDS (3-0) sutures. VATS procedure was done at the estimated stage (II) using three or four 5 mm to 10 mm ports and thoracoscopic dissector or scissor made by Storz and Olympus instrument. Five experienced thoracic surgeons holding academic degrees carried out the open thoracotomy decortication procedure while VATS decortication procedure was carried out by three thoracic surgeons. Full expansion of lung after decortication was measured for recording as a successful treatment. Then, the septic and malnutritional patients were transferred to Intensive Care Unit (ICU) for two to five days. They were then managed in the thoracic ward while they had received antibiotics. The outcomes of two procedures were obtained by resolution and progression of empyema, recurrences, mortality, failure or converted procedures to open thoracotomy decortication, success and cure rates. Outcome measures were involved by primary and secondary endpoints. Primary endpoint was successful treatment of two procedures at the first management of empyema. Secondary endpoint was observed after failure or unsuccessful treatment.

The data were collected from the hospital medical records of the patients and analyzed in terms of incidence, symptoms and signs, methods of therapy, and outcomes. The data were presented as standard deviation (SD) and N (%). Variables were analyzed with the independent samples T-test for continuous variables and Chi–square or Fisher exact test for quantitative variables. P-values less than 0.05 were considered statistically significant. The statistical package for social science (SPSS 16) was used for analyses.

3. Results

In this retrospective cohort study, the patients were admitted one by one in the abovementioned period of time to the referral hospital. 149 patients with empyema thoracis were treated at the referral center while 88 (59%) were male (mean age 42.11 $\pm$ 10.25 years) and 61 (41%) were female (mean age 39.59 $\pm$ 9.24 years). Out of 149, 130 patients (70 males and 60 females) with a mean age of 43.12 $\pm$ 6.2 years were treated nonsurgically. The cure rate was 27% (35 patients including 20 males and 15 females) and one died due to sepsis. The remaining 94 patients were left uncured and included for thoracotomy

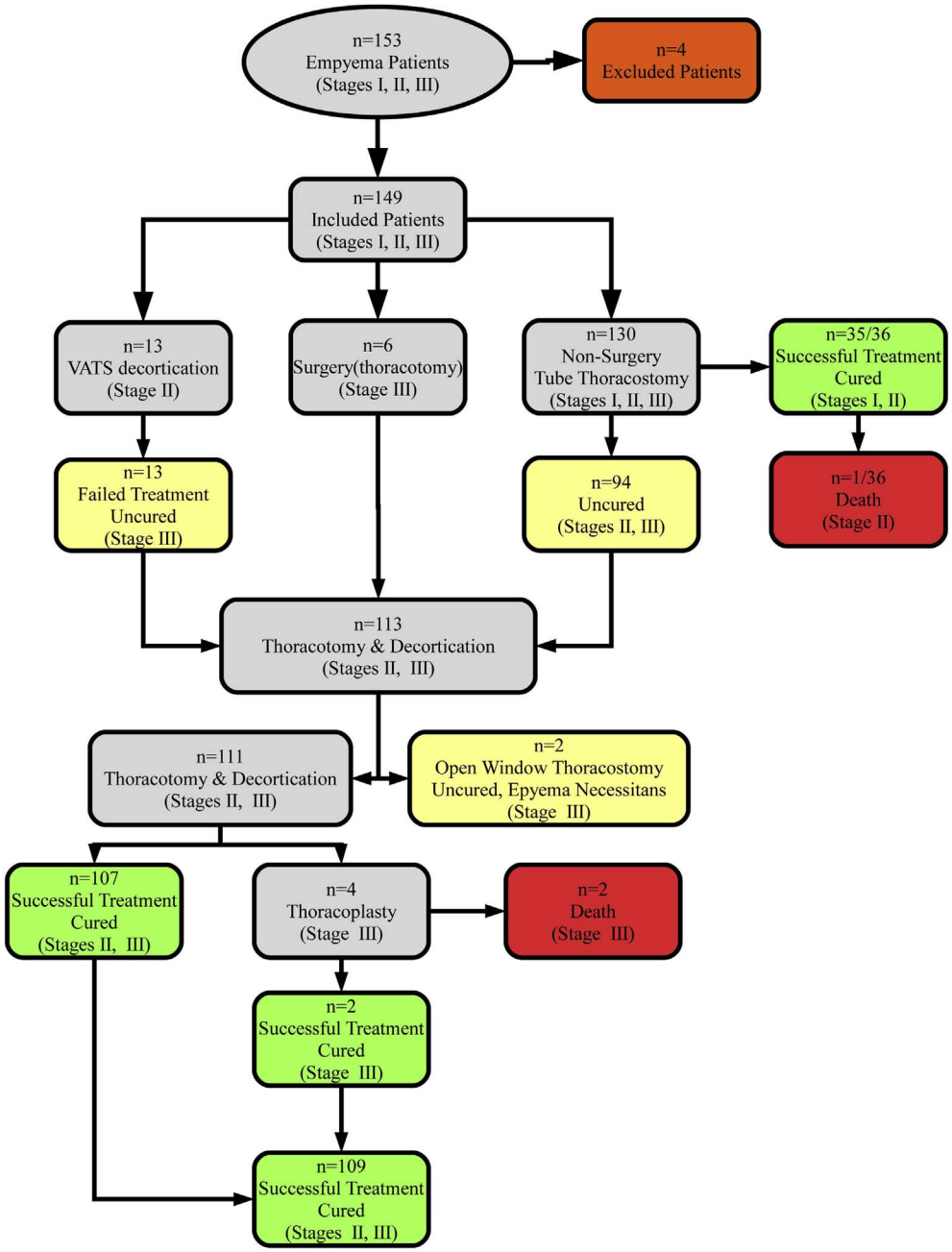

Fig. 1. Flow chart of patients enrolled in the study and their assigned procedures.

decortication procedure. From 149 patients, 13 (10%) patients who were estimated to be at the fibrinopurulent stage were treated by VATS therapeutic decortication. Due to chronic phase, the advanced stages of empyema thoracis, and development of thick peel, VATS decortication procedure failed and the patients who were truely at stage III were then required conversions to thoracotomy decortication procedure under the same anesthesia few days later. Moreover, 6 out of 149 patients were estimated to be at stage III and were scheduled for open thoracotomy decortication (extensive debridment of PEEL, decortication of parietal and visceral pleura). Totally, 113 patients (69 males and 44 females) with mean ages of (35.20 ± 5.7 years) were treated by thoracotomy decortication procedure. And, Fig. 1 illustrates the management of patients and the stages of empyema thoracis.

Statistically, there were no significant differences in terms of ages and sexes in both groups. The ages of patients were ranged from 6 to 78 years. The cure rates for incidence of surgical and nonsurgical treated patients were 109/113 and 35/130. The signs and symptoms of patients were as following: 1) cough: 128 (86%) patients, 2) chest pain: 121 (81%) patients, 3) dyspnea: 91 (61%) patients, 4) fever: 122 (82%) patients; and laboratory signs of leukocytosis and anemia were seen in 106 (71%) and in 110 (74%) patients, respectively (i.e., some patients had more than one symptom). The average value of hemoglobulin was 10.9 g/dl (range 7.8–13.5 g/dl). And, the incidence rate of right to left empyema was 80 to 49, respectively.

Initially, before starting the treatment procedures, patients had chest radiography (100% of patients), chest computerized tomography (CT) (106 (70.9%) of patients) and sonography (75 (50.3%) of patients). The complications of surgery and mortality in patients were compared. One and two of nonsurgical and surgical treated patients died due to sepsis, respectively. There were post-operative air leakages in 49 patients (43.3%) of thoracotomy decortication group while it had been observed in only 5 (3%) nonsurgical patients. The mean times for the air leakage in nonsurgical and surgical treated patients were 9.1 ± 1.6 days and 4.3 ± 0.7 days, respectively. There were

Table 1
Demographic and postoperative complications in treatment of empyema thoracis in non-surgical and surgical patients (N = 149)[a].

Parameters	Non-surgical Approaches N = 130 (%)	Surgical Approaches N = 113 (%)	P-Value
Sex			
Male	70 (52.8)	69 (61)	0.25
Female	60 (46.1)	44 (38.9)	0.25
Age			
Years	43.12 ± 6.2	35.20 ± 5.7	0.17
Cure rate[b]	35 (27)	109 (96.4)	< 0.001
Postoperative air leak	5 (3)	49 (43)	< 0.001
Hospitalization time			
Days	15.4 ± 2.1	6.2 ± 1.8	< 0.001
Success rate[c]			
Live	35 (27.1)	111 (98.2)	< 0.001
Death	1 (0.3)	2 (1.8)	

[a] Data was presented as mean SD & N (%).
[b] **Cure rate:** is the rate of patients cured from the total patients which do not include patients who were died even after the successful treatment.
[c] **Success rate:** is the rate of patients treated successfully in the total patients which also include the dead successful patients.

statistically significant differences in terms of prolonged air leak (PAL) times between two groups ($P < 0.001$). The postoperative air leaks and pneumothorax in thoracotomy decortication patients were treated by chest tube drainage. The success rates of surgical and nonsurgical treated patients were 98.2% (111 patients) and 27.1% (35 patients) ($P < 0.001$), respectively (Table 1).

Four (3.5%) patients of surgical treated group were managed eventually by any types of thoracoplasty procedure. One of them with developed bronchial and cutaneous fistula was managed by thoracoplasty which was closed spontaneously, and two of them died. Two patients required open window thoracostomy and empyema necessitans was resulted and hence, remained uncured. Among all patients, only three of them required segmentectomy or lobectomy. The mean hospitalization time in nonsurgical treated patients was more than surgical treated patients (15.4 ± 2.1 days versus 6.2 ± 1.8 days) ($P < 0.001$). In all hospitalization time period, appropriate intravenous antibiotics were added to the treatment regimen. During postoperative period, chest tubes were removed when air leakage or drainage were not evident or complete expansion of lung was achieved. There were no biases on selection of the type of surgery techniques including tube thoracostomy, VATS decortication, and thoracotomy decortication procedures. Mean value of follow-up period for the patients was 8 months which ranges from 2 to 18 months.

4. Discussion

The current study reveals the incidence of chronic and advanced stages of empyema thoracis in low socio-endemic area once it has been diagnosed. Therefore, in the treatment of empyema, thoracotomy decortication is the common used procedure. The patients who underwent VATS therapeutic decortication, required conversion to open thoracotomy either during or after the operation due to the VATS failure. Nearly, one fourth of patients at the early stages of empyema were treated with nonsurgical techniques.

In the literature, the VATS was applied for only diagnosing the pleural empyema at its early stages, and nowadays, thoracoscopic surgery of empyema is often used to tear down the loculations in situations that the therapy has failed after using antibiotics and chest tube drainage [6]. However, in the conditions of unsuccessful thoracoscopic surgery, conversion to open thoracotomy is inevitable if complete drainage or expansion of lung is not achieved [6].

Unfortunately, no clinical signs, laboratory tests and imaging results are able clearly to distinguish the transition of the fibrinopurulent stage to organized empyema phases. Consequently, making a decision for an appropriate treatment procedure between VATS and open thoracotomy decortication is still debatable [21]. This can also be observed in thirteen patients of this study who were first treated by VATS decortication procedure while they were truely at stage III (Fig. 1). To do so, clinicians should recall that the probability of conversion to thoracotomy in patients undergoing VATS decortication for presumed stage II empyema can be increased from 22% to 86% between twelfth and sixteenth day of appearance of clinical signs [21]. Also, in this study, some estimated stages of fibrinopurulent, stage I, and stage III were treated nonsurgically (Fig. 1). Besides these, 94 nonsurgical failed treated patients required conversion to thoracotomy and decortication. Crasna and Yu reported that Roberts thoracoscopically treated the empyema patients by VATS decortication with a conversion rate of 61.6% to open thoracotomy [22]. However, when stage II of empyema was treated at first by VATS procedure, the rates for mortality and morbidity would be low [22]. In the current study, the incidence rate of VATS decortication converted to open thoracotomy is 100%. Therefore, our study lacks focusing on VATS procedure for treatment, because of advanced stages of empyema present in patients of this study.

Moreover, some of the literature reports are indicative of the fact that the VATS decortication is less effective at fibrotic and organized stages; however, it may be useful at the early fibrinopurulent stages [3,23]. On the other hand, the incidence of converting VATS to open thoracotomy decortication is high in the literature (i.e., 38.1%) and it is worth mentioning that it should not be interpreted as a failure for this treatment [24–26].

When the results of this study are compared to single treatment studies of the literature, there are various studies that are in favor of the results achieved in the current study. It has been reported that 39%–58% of patients with primary empyema required open thoracotomy decortication with low morbidity and mortality rates [19,22,27].

Eight randomized controlled trial studies of the literature (one study comparing only open thoracotomy *vs.* thoracostomy tube drainage and seven studies comparing VATS *vs.* thoracostomy tube drainage) have been reviewed, meta-analyzed, and reported with conflicting results; however, neither a universally acceptable primary modality nor a gold standard of their protocol is available [28]. Drainage is the initial treatment modality for the exudative phase. Debridement via VATS is a first safe option, reliable, and effective method at early stage II [3,20,29,30]. And, conversion of VATS decortication to open thoracotomy is more frequent in chronic empyema. Thoracotomy and decortication can only prevent ongoing infections and late restriction at the organized stage [7,23,31].

On the other hand, open window thoracostomy is commonly used in high risk patients [7,23,31] and it has also occurred in two patients of the current study.

Moreover, Mark's study showed complexity of empyema thoracis treatment and focused on performing surgical treatment of incomplete evacuation of pus and advanced stages of empyema thoracis that confirms the results obtained from the complex treatments of current study's patients [32].

European Association Cardio-thoracic surgeons (EACTS) guideline focuses on higher success rate for VATS decortication (68%–93%) at the early stages of empyema thoracis (stages I, and II). However, it demonstrates some limitations in patients with a symptomatic history of disease over five weeks that were presumed to be at stage III [5].Also, this study is in favor of EACTS guideline and all thirteen patients at the advanced stages which performed by VATS decortication procedure required conversion to open thoracotomy decortication. And, the results of this study are also indicative of the fact that 96.4% of the patients were successfully treated by thoracotomy decortication procedure with low mortality and morbidity rates.

Our findings show that mortality event is not statistically significant

as confirmed by Redden et al. Moreover, statistical significant reduction of complications for surgical treated patients was observed while compared to nonsurgical treated ones [28]. Also, in the patients of low socio-economic areas, nonsurgical treatment of advanced empyema usually failed in producing favorable results which have been also confirmed by the current study's results [33–35]. On the other hand, by comparing the cure rate and hospitalization times of nonsurgicall treated patients of current study and surgical treated patients (Table 1), there were no significant differences between them. And, this means that surgical treated patients of this study have better results than nonsurgical treated patients, though VATS decortication procedure was unsuccessful. The lack of fibrinolytic therapy complications in the pooled data makes our study incomparable to the literature reported results.

Indeed, shortcomings of health organization systems in low socio-economic countries are another factor that may affect the empyema treatment and hence, the results of this study cannot be compared to those of developed countries [36,37].

The strength of this study is the outcomes of surgical and non-surgical management of empyema thoracis treatment in low socio-economic areas. Several limitations must be considered while assessing the current reported results. Single center nature of this study does not provide adequate information and the existence of possible biases will affect the selection criteria that may also have influences on the results. Surgeon's preferred method, lack of non-randomized clinical study and selection of only English language articles can be other limitations to mention a few. None of patients underwent diagnostic VATS surgery; and, this may be another limitation of this study. Consequently, further experimental validation studies are necessary to be performed in low socioeconomic areas and large multi-centers with large sample series to confirm our results.

5. Conclusion

Due to advanced stages of empyema in low socio-endemic areas, thoracotomy-decortication procedure is used more frequently and with higher success rates than nonsurgical techniques. . However today, the success rate of nonsurgical and VATS management was mostly reported in the literature.

Ethical approval

Medical Ethics Committee of the Tabriz University of Medical Sciences.

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Author contribution

Study Design: Mohsen Sokouti.

Data collections: Mohsen Sokouti, Massoud Sokouti, Babak Sokouti.

Data Analysis: Morteza Ghojazadeh, Massoud Sokouti, Babak Sokouti.

Writing: Mohsen Sokouti, Morteza Ghojazadeh, Massoud Sokouti, Babak Sokouti.

Conflicts of interest

None.

Guarantor

1. Babak Sokouti.
2. Mohsen Sokouti.

Trial registry number – ISRCTN

NA.

Research registration unique identifying number (UIN)

researchregistry2939.

Informed consent

Informed consent was obtained from all individual participants included in the study.

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