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Review Article

The Right Time for Chest Tube Removal in the Patient with Cardiac Surgery: A Systematic Review

Abbas Heydari[1], Zahra Sadat Manzari[1], Masoud Abdollahi[2]*

[1]Nursing and Midwifery Care Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.

[2]Department of Medical-Surgical Nursing, Faculty of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran.

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ABSTRACT

Background: Chest tube insertion is recommended after cardiac surgery, and inserted annually for a large number of these patients. In addition to its benefits, the chest tube may have risks that are mismanaged. One of these risks is the possibility of pleural effusion, which can occur in high rates. Therefore, we conducted a systematic review to properly manage the chest tube and reduce its complications.
Methods: This systematic review of cohort study asked the question: Is there enough evidence to determine the right time to remove the chest tube? We searched ISI Web of Science, PubMed, Scopus and Embase from 1 January 2015 to 30 September 2019 to identify retrospective or prospective cohort studies.
Results: Three studies recommended early chest tube removal and two studies late removal. Of course, early and late removals in the studies had different meanings and time frames that were examined).
Conclusion: More evidences and studies are needed to determine the right timing and management of the chest tube removal but our systematic review based on the available evidences revealed that if the chest tube removal occurs about 24 hours postoperatively, and with less than 100 ml drainage within the last 8 hours, it will reduce the risk of pleural effusion and improve many other outcomes.

The importance of chest tube insertion after open-heart surgery is not covered. Chest tube insertion is routine after heart surgery, according to statistics published by the International Classification of Diseases, chest tube placement is performed annually for 133,000 US hospitalized patients, that is contemplative [1-2] and yet there is no guideline for management of chest tube removal [3]. Proper management of chest tube improves factors such as reduced pericardial and pleural effusion rates, decreases patient pain, chest tube replacement, and length of hospital stay, and on the other hand, it improves respiratory status and many more [3-5]. Given the fact that timely management of chest tube removal has many benefits and there are indeed prediction models for heart surgery [6-7] but there is controversy over the right time for nurses and surgeons because these models are not specific and practical [8-10]. For example, some surgeons find it helpful from the empirical evidence to remove the chest tube early, and others believe that delaying it has more benefits [11]. This is strongly influenced by the fact that perhaps there is a lack of credible evidence and research about this issue [12-14]. However, we know that pleural effusion is likely after the chest tube removal, but there is no consensus on the choice of the appropriate diagnostic test to identify pleural effusion [15-16]. This is another reason that makes it difficult to decide the right time to chest tube removal. It has even been suggested that taking X-ray after chest tube removal does not help the patient's management and is recommended in the presence of clinical symptoms [17-19].

Given the above, it is difficult to make decisions about the timing of chest tube removal, so the present systematic review aimed to compare the effect of early and late chest tube removal on pleural effusion in patients undergoing coronary artery bypass graft surgery.

The authors declare no conflicts of interest.

*Corresponding author.
E-mail address: abdollahim971@mums.ac.ir

Methods

This systematic review is based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A wide search of databases including ISI Web of science, PubMed, Scopus and EmBase was performed from January 2015 to September 2019 which were published in English [20]. A preliminary search of all of the mentioned sites revealed 290 studies and in our study, two studies from Google Scholar were added by expert opinion. Full details of the search strategy are provided in Supplement 1. Only studies in English were included.

Study Eligibility

Studies that compared early vs. late chest tube removal in patients undergoing open heart surgery were included. The main outcome was pleural effusion after removal of the chest tube, and other outcomes of interest were: pericardial effusion length of hospital stay. Case reports, abstracts only, meeting abstract, letters, reviews, and incomplete reports were excluded.

Data extraction

Two reviewers independently evaluated the relevance of the identified studies, by scanning the titles and abstracts and if a study met the inclusion criteria, the full text will be obtained. Then eligible studies extracted information such as first author, year of publication, study design, type of surgery, methods of study, type of intervention, and outcomes. The details of the studies and data were abstracted in the (Table 1) (supplement 2).

Study Quality

Two reviewers assessed the quality of all studies based on a Newcastle-Ottawa Quality Assessment Form for Cohort Studies in (Table 2) (supplement 3) [21]. The maximum score was 9, and the minimum score 0. The score of 7 or more indicated high quality, a score of 4 to 6 moderate quality, and a score 3 or less low quality. The reviewers resolved the disagreement through discussion until they reached consensus.

Results

A total of 391 citations were identified through database searches (Figure 1). Then, 124 studies were removed for being duplicate. A number of 267 titles and abstracts were screened. Finally, 25 full-text articles were studied, of which five were selected for inclusion.

Early vs. Late chest tube removal

Studies that recommend early chest tube removal

Three studies from the reviewed studies showed that early chest tube removal did not affect the increase in pericardial effusion. In the first group of Abramov et al. (2005), meantime of removal of chest tubes was 25 hour and drainage was less than 100 ml over the past eight hours there was less pericardial effusion than the second group, where meantime of removal of chest tubes was 48 hour and drainage was less than 100 ml.

The study by Gercekoglu et al. (2003) conducted in both retrospective and prospective phases, showed that there was no statistically significant difference about pleural effusion between the two study groups and early chest tube removal does not affect the occurrence of pleural effusion. The mean time for chest tube removal in the early group was 23 hours and for the late group 48 hours with drainage of less than 50 mL in the last 5 hours.

The last study in the group recommending the early removal of the chest tube was the study of Sadeghi et al. (2009). In this study, the meantime for chest tube removal was 23 hours postoperatively for the early group, and 40 hours for the late group. No pleural effusion was observed in either group.

Studies that recommend late chest tube removal

The Andersen et al. (2015) study showed that there was a correlation between early chest tube removal and the development of pleural effusion. The time for early chest tube removal was midnight or maximum was two o'clock in the morning after surgery which is less time consuming than the studies mentioned above and this time for late chest tube removal was the next morning (Maximum 24 hours). Gür et al. (2018) showed that there was a significant relationship between early chest tube removal and pleural effusion as a complication. There were also two groups in this study with a mean time of 2.3 days for early removal with less than 150 ml drainage for the last 24 hours and a mean time 4.1 days for late removal with less than 50 ml drainage in the last 24 hours.

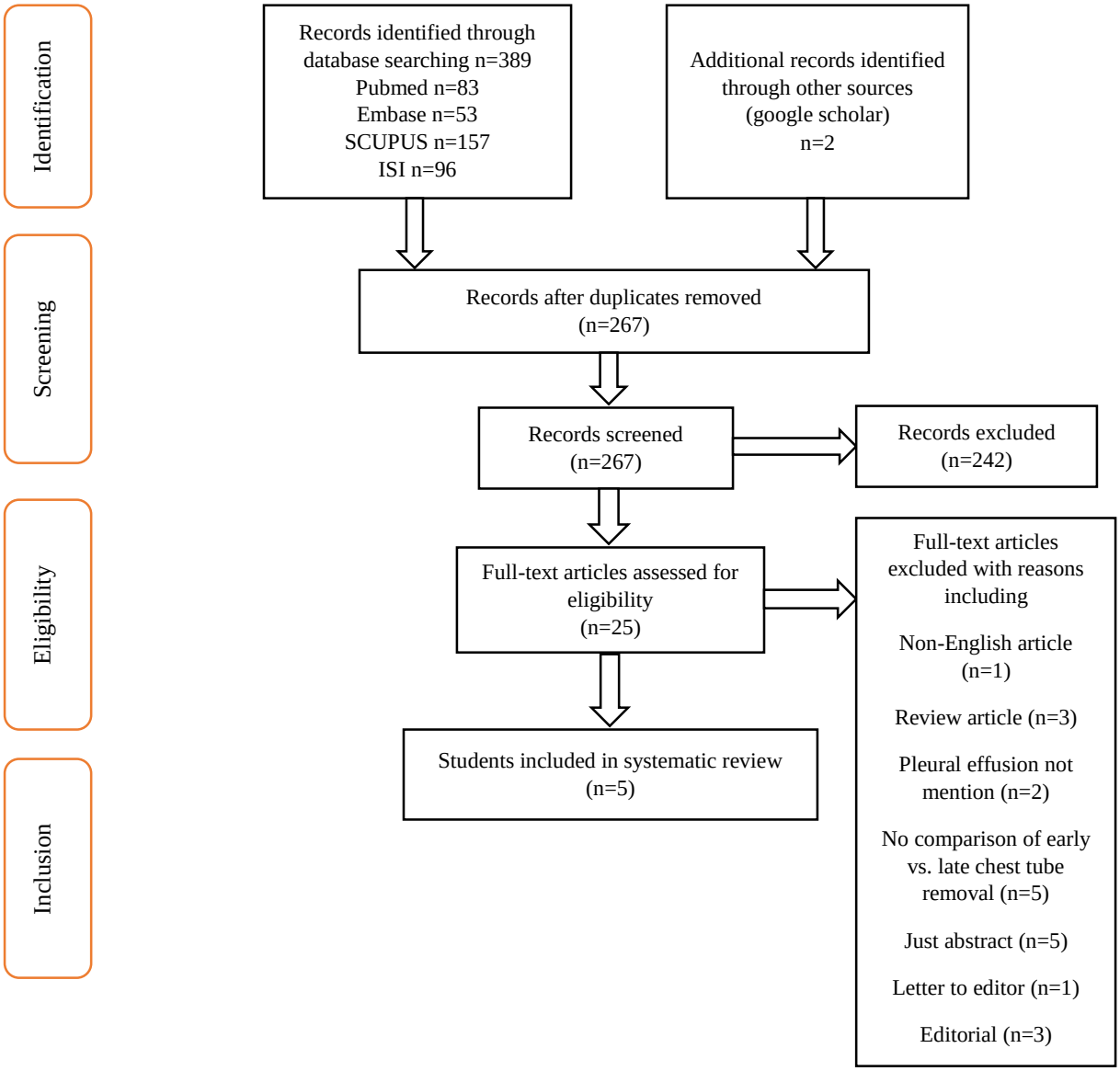
Table 1- Cohort studies have compared early and late chest tube removal

First Author's Year	design	sample	Early	Late	Outcomes (pleural effusion)		Conclusion
					Early	Late	
Abramov 2005	Cohort	83	Group 1: CTR in first 24 hours postoperatively	Group 2: CTR in 48 hours postoperatively	18 (46)	20 (37)	Early chest tube removal did not involve significant residual effusions.
Andreasen 2015	Cohort	1232	Group 1: had their chest tubes removed around midnight on the day of surgery	Group 2: kept their tubes until next morning	76(385)	51 (398)	Early chest tube removal develops pleural and/or pericardial effusions.
Gercekoglu 2003	Cohort	First part: 2359 Second part:80	Group 1: consisted of patients whose chest tubes were removed as soon as the macroscopic appearance of the drainage fluid turned to serosanguineous	Group 2: consisted of patients whose chest tubes were removed at the second postoperative day	Pro* 0 (40) Ret* 0(485)	0 (40) 0 (1,874)	It is safe to remove the chest tubes as soon as the macroscopic appearance of the drainage fluid turns to serosanguineous
Mirmohammad-Sadeghi 2009	Cohort	307	Group 1: chest tubes were removed within the first 24 hours after surgery	Group 2: chest tubes were removed in the second 24 hours after surgery	0 (107)	0 (200)	Early extracting of chest tubes when there is no significant drainage doesn't increase the risk of creation of pleural effusion.
Ali Kemal Gür 2018	Cohort	446	Group 1: (the last 24-hours drainage follow-up was under 150 ml)	Group 2: (the last 24-hours drainage follow-up was under 50 ml)	11 (210)	6 (236)	Early removal of the drains after cardiac surgery leads to the development of pleural effusion

Table 2-The quality assessment with Newcastle-Ottawa Quality Assessment Form for Cohort Studies

First Author, year	Representativeness of the exposed cohort	Selection of the non-exposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at start of study (for side effects)	Comparability of Cohorts on the Basis of the Design or Analysis	Study Controls for Any Additional Factor	Assessment of Outcome	Was Follow-Up Long Enough for Outcomes to Occur	Adequacy of Follow-up of Cohorts	Total
Abramov 2005	1	1	1	1	1	0	1	1	1	8
Andreasen 2015	1	1	1	0	1	0	0	1	1	6
Gercekoglu 2003	1	1	1	1	1	0	1	1	1	8
Mirmohammad-Sadeghi 2009	1	1	1	1	1	0	0	1	1	7
Ali Kemal Gür 2018	1	1	1	0	1	0	0	1	1	6

Figure 1- PRISMA flowchart of the search and study selection process.



Discussion

We have presented the results of cohort studies that compare early versus late chest tube removal following open-heart surgery. We judged three studies to be of high quality [15, 22-23], and two studies to be of moderate quality [11, 24]. Articles with a relatively lower quality level emphasized on late chest tube removal.

There is no sufficient evidence on the timing of chest tube removal after open-heart surgery. Hence, some authors suggest removing them after 24 hours postoperative and some authors recommended to remove the chest tube after 48 hours postoperative [11, 15, 22-24]. Three studies from the studies reviewed showed that early chest tube removal does not increase risk of pleural effusion [15, 22-23]. But two studies have stated that there is a link between early chest tube removal and pleural effusion [11, 24].

This variation in results is probably since that in the first three studies that recommended early chest tube removal, the timeframe for early in these studies were 24 hours and for late 48 hours while, this is different in the Andersen et al. (2015) study and the time to early chest tube removal in this study is up to 14 hours, which is shorter and earlier than the first three studies and maybe the reason for more occurrence of pleural effusion. On the other hand, the timeframe for group late Chest tube removal of Andersen et al. (2015) study that approximately 24 hours, is consistent with timeframe of the early chest tube removal group in the three studies

agree with the early chest tube removal in this systematic review. In this group of Andersen et al. (2015) study less pleural effusion has been observed which is in line with the results of the group early chest tube removal in three studies agrees with the early chest tube removal. A recent systematic review of a similar issue in our study has shown that other properties, such as the chemical composition of pleural fluid, can be a predictor for the timing of chest tube removal. Also, the removal of chest tubes can occur only when the fluid is completely serosanguineous and lacks blood and chylous [14].

According to our query, no intervention study was found on this issue and if available, it appears to be very low or not in English. Due to the growing perspective of evidence-based treatment, interventional studies are referred to as the gold standard for evaluating the effectiveness of an intervention or treatment [25]. Therefore, it is necessary to conduct interventional studies with high validity and controlled conditions on this topic to suggest the precise time to remove the chest tube in patients undergoing open-heart surgery. It is also recommended that writing a guideline can help improve the treatment process for these patients.

Another issue to consider is the diagnosis of pleural effusion after chest tube removal. In the studies investigated in our review, there was a disagreement that some study used Chest X-ray as a diagnostic test and some used CT scans. Even in the Abramov study, which used both diagnostic tests to detect pleural effusion, there were variations in results [15-16]. Therefore, further research is needed to clarify this issue.

Because of the complexity of the issue and the relevance of multiple factors to pleural effusion, it is also recommended to look for other indicators to determine when to remove the chest tube. However, it has been suggested that the occurrence of pleural effusion may vary depending on the geographical location of individuals [26-27].

Conclusion

There is not adequate evidence to support the right time to discontinue a chest tube in a patient with heart surgery. However, this systematic review revealed that if the chest tube removal occurs about 24 hours postoperatively, and with less than 100 ml drainage within the last 8 hours, it reduced the risk of pleural effusion and improve many other outcomes such as hospital stay, and decrease need for analgesia, physiotherapy, oxygen and decrease nursing care hours. Further multicenter trials with standardized methodology and even a guideline are needed to specify the best time for chest tube removal and proper care from a chest tube.

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