Acta Scientiarum. Health Sciences
ISSN: 1679-9291
eduem@uem.br
Universidade Estadual de Maringá
Brasil

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Acta Scientiarum. Health Sciences, vol. 38, núm. 2, julio-diciembre, 2016, pp. 173-177
Universidade Estadual de Maringá
Maringá, Brasil

Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1679-9291
ISSN on-line: 1807-8648
Doi: 10.4025/actascihealthsci.v38i2.26972

Institutional protocol to standardize the chest drainage system management, from surgery to nursing care, at a regional hospital in northern Paraná

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ABSTRACT. The purpose of chest drainage is to allow lung re-expansion and the reestablishment of the subatmospheric pressure in the pleural space. Properly managing the drainage system minimizes procedure-related complications. This prospective observational study evaluated adult patients undergoing water-seal chest drainage, admitted to our hospital and accompanied by residents and tutors, aiming to check their care. One hundred chest drainages were monitored. The average age was 38.8 years old. The average drainage time was 6.7 days. Trauma was the prevalent cause (72%) for the indication of pleural drainage. The obstruction of the system occurred in 6% of the cases; 5% subcutaneous emphysema, 1% infection around the drain; 5% accidental dislodgement of the drain, and in 5% of the patients, there were some complications when removing the drain. Failures in chest drainage technique and management were present, and reflected in some complications that are inherent to the procedure, although it is known that there are intrinsic complications. This study aimed to assess the management of closed chest drainage systems and standardize the care provided in such procedure.

Keywords: chest drainage, chest tubes, thoracostomy, thoracic surgery.

Protocolo institucional para padronizar cuidados com o dreno de tórax, desde a intervenção cirúrgica até os cuidados de enfermagem, em hospital regional do norte do Paraná

RESUMO. O objetivo da drenagem torácica é possibilitar a reexpansão pulmonar e o restabelecimento da pressão subatmosférica no espaço pleural. O manejo adequado do sistema de drenagem minimiza as complicações relacionadas ao procedimento. O presente estudo observacional prospectivo avaliou pacientes adultos submetidos à drenagem torácica em selo d'água, internados em nosso hospital e acompanhados por médicos residentes e preceptores, com o objetivo de verificar o manejo com eles. Foram observadas 100 drenagens torácicas. A faixa etária média foi de 38,8 anos. O tempo médio de drenagem foi de 6,7 dias. Houve predomínio da causa traumática (72%) na indicação de drenagem pleural. A obstrução do sistema esteve presente em 6% dos casos; em 5%, houve enfisema subcutâneo; em 1%, infecção peridreno; em 5%, deslocamento acidental do dreno e, em 5% dos pacientes, houve complicação na retirada do dreno. Falhas na técnica e no manejo de drenagem torácica estão presentes em nosso serviço, refletidas em algumas complicações inerentes ao procedimento, embora saibamos que haja complicações que lhe são intrínsecas. O objetivo do estudo foi avaliar o manejo dos sistemas de drenagem torácica fechada e padronizar o protocolo para os cuidados com esse procedimento.

Palavras-chave: drenagem torácica, tubos torácicos, toracostomia, cirurgia torácica.

Introduction

Chest drainage management is one of the most important aspects in the treatment of chest surgery patients and there is no consensus on the ideal strategy to perform it appropriately (Linder et al., 2012).

Under pathological conditions, due to the accumulation of several fluids in the pleural space, there is loss in the respiratory physiology dynamics and consequent restricted ventilation. The purpose of chest drainage is to remove the fluid or air accumulated in the pleural cavity, allowing lung re-expansion and the reestablishment of the subatmospheric pressure of the space, thus avoiding complications. Considered as a relatively simple act, it may lead to complications due to the lack of care that has to be taken (Cipriano & Dessote, 2011).

The conventional closed chest drainage system consists of a drain, a connector, an extension tube, and a collection bottle with air vent, generally graduated and kept at a level that is lower than the chest.

The drains currently used are tubular, multiperforated, siliconized, and semi-rigid. The multiple fenestration facilitates the flow and prevents obstruction as it enlarges the surface for drainage. The connector consists of a tubular piece connecting the drain to the extension tube, and it is usually transparent with bore diameter equal to the rest of the system. The extension tube connecting the drainage system to the collection bottle must have a diameter that is larger than or equal to the rest of the routes, besides being transparent and having appropriate length so as to prevent fluid from siphoning back. The extension tube ends in a catheter submerged in the bottle, and remains submerged in a fluid at a depth of about 2 cm. This column works as a water seal, i.e., a unidirectional valve of the pleural cavity towards the bottle, thus avoiding pneumothorax. The drainage is hampered when the height of the fluid column in the collection bottle is excessive. The air vent allows the air to escape from inside the bottle, thus preventing a closed compartment from being created. For inserting the drain, an incision of about 2 cm, parallel to the intercostal space, is made in the superior border of the rib to avoid injury of the neurovascular bundle. The dissection of the intercostal muscles is made by using hemostatic forceps. The pleural space is inspected with the index finger and the drain moved forward in the appropriated position, apico-posterior, anchoring it with a skin suture, usually a 'U' stitch with Roman sandal suture pattern. It is recommended that a chest X-ray examination be always made immediately after inserting the drain, so that its position and lung re-expansion may be observed (Nishida, Sarrão, Colferai, Tenório, & Bandeira, 2011).

A remarkable improvement of closed drainage has been achieved with a greater understanding of the respiratory dynamics and the subsequent technical improvement (Lo Cicero & Mattox, 1989; Pearson, Cooper, & Deslauriers, 1995; Munnell, 1997). Currently, digital chest drainages have been employed, thus providing more comfort to the patient (ambulatory) and reducing complications existing in conventional drainage. One of the most frequent complications is prolonged air leak, which leads to longer time of chest drainage, longer time of hospitalization, higher complications, and increased hospital costs. Since the first digital chest drainage devices came to the market, there have been many studies aiming to demonstrate that by using this system, the subjective judgment of air leak can be eliminated through objective data provided by the computerized system of the digital device (Mier, Fibla, & Mills, 2011). The successful management of the chest drain and its removal depends on an accurate assessment of the air leak through the patient's drain (Dernevik, Belboul, & Radberg, 2007).

Among the main failures that may take place in chest drainage are: obstruction of the tube (due to clots or fibrin, inappropriate clamping, kinking caused by excessive length of the extension tube), inappropriate positioning, fixation, and connection of the drain, inappropriate height of the water seal, improper positioning of the collection bottle, obstruction of the air vent, negligence when checking oscillation of the water seal (Nishida et al., 2011).

The present study aimed to assess the management of closed chest drainage systems through the analysis of adult patients at the Regional University Hospital of Maringa, Paraná State, as well as to standardize the protocol of care provided in chest drainage and minimize its complications.

Material and methods

This was a prospective observational study that followed up adult inpatients subjected to water-seal chest drainage, under the care of the residents of chest surgery team of Regional University Hospital of Maringa, Paraná State, from August 2012 to July 2013. Data collection was made through observation, and a monitoring record was completed on a daily basis regarding the patient and the procedure made (age, sex, and inpatient care sector, indication for and total period of drainage, positioning of the drain in the x-ray, kinking, fixation with skin suture and with an omental tag of tape, obstruction and presence of a mechanism of obstruction of the drain, adjustment of the extension tube, outer diameter and length, positioning of the collection bottle and permeability of the air vent, adjustment of the system connections, complications related to the drainage). For statistical analysis of the data, the software Statistica 8.0 was used. The study was approved by the Regulation Committee for Academic Activities (Corea) of the Regional University Hospital of Maringa and the Ethics and Research Committee (Copep) of the institution.

Results and discussion

Chest drainages (n = 100) were monitored in 83 patients as some patients required more than one chest drainage. The age varied from 15 to 91 years old, an average of 38.8 years old. With regards to sex, 85% of the patients were male (85/100). The average drainage time was 6.7 days (Table 1).

Table 1. Description of patients in water-seal chest drainage in the Regional University Hospital of Maringa, Paraná State.

Variable	Number
Number of patients	83
Number of drainages	100
Average age, in years	38,81
Average drainage time, in days	6,71
Male patients (%)	85
Patients 40 years of age (%)	50
Patients with more than one chest tube (%)	13

Among the indications for chest drainage, the traumatic cause was prevalent, totaling 72% (72/100) of the cases. In relation to the etiology of the trauma, 27% (27/100) resulted from injury caused by firearms; other 17% (17/100) due to injury caused by cold weapons, amounting to 44% of the causes. The indications of the causes are shown in Figure 1.

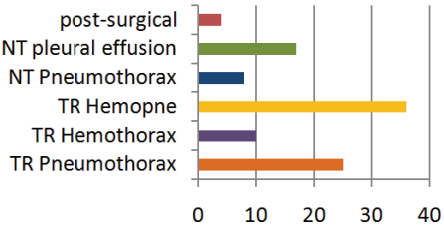

Figure 1. Original indication of the thoracostomy tube. The percentages reflect the number of drainages performed for each indication divided by the total number of drainages performed. TR: Traumatic; NT: Non –traumatic.

Immediate chest x-ray after drainage was observed in 100% of the cases. The location of the drain evidenced that all drains were in the pleural space, and, regarding the direction in the pleural space, 53% (53/100) of the drains were oriented towards the mediastinum, 41% (41/100) apical, and 6% (6/100) subpulmonary. In two patients, kinking of the chest drain was found in the x-ray, with repositioning being required and, in 5% of the patients, subcutaneous emphysema was found, due to the last hole of the drain being inserted in the subcutaneous tissue, thus requiring repositioning.

The fixation of the drain by means of the 'U' stitch in the skin was found in 100% of the patients. An omental tag of tape, as a complementary fixation, was present in 97% (97/100) of the cases. Regarding the length and outer diameter of the intermediate connector, a patient showed unsuitability due to a very thin intermediate connector in relation to the outer diameter of the drain (Figure 2a). The fluid level of the water seal and collection bottom below the level of the thorax was suitable in 100% of the cases. The air vent was obstructed in 2% of the cases (Figure 2b). No undue cracks or holes were found in the drainage system during the time these patients were hospitalized. The obstruction of the drainage system took place in 6% (6/100) of the cases, caused by clamping (one case), siphoning (two cases), and clots and fibrin (three cases). There was no statistically significant association between a more prolonged drainage period with higher occurrence of related obstruction mechanisms (Mann-Whitney *U* test: p-value = 0.7690).

Figure 2. (a) Inappropriate intermediate gauge; (b) obstruction of breath.

Regarding chest drainage complications, the following was obtained: 5% (5/100) of subcutaneous emphysema – due to the drain being located in the subcutaneous cell tissue; one case (1%) of infection around the drain; five cases (5%) of accidental dislodgement of the tube, requiring re-drainage, and in 5% (5/100) of the patients there were some complications when removing the drain, with small pneumothoraces due to the presence of air in the pleural cavity at the time of the removal; however re-drainage was not required.

The distribution of obstructed drainages and the corresponding mechanisms are illustrated in Figure 3. The nature of the complications due to chest drainage found in our study is presented in Figure 4, not differing from other studies in the university environment.

The profile of the individuals undergoing chest drainage revealed prevalence of male, young patients with traumatism, corroborating the relevance of trauma as a generator of morbidity in lower-age population. In the literature, such evidence is a constant, reinforcing the chest trauma, associated

mainly with injuries caused by firearms, cold weapons, or car accidents, as the main causes of mortality of young men. Nishida et al. (2011), in a prospective study performed in 75 patients (totaling 90 chest drainages), evidenced that most were male (76%), with ages varying from 14 to 83 years old, an average of 40.9 years old and predominance of the age group between 21 to 30 years; traumatic cause was the main indication for pleural drainage (68%). In our casuistry, the majority of the traumatic events was caused by firearms. The high demand for such procedure, in an emergency care unit environment, given the requirement commonly associated with the trauma, showed the need for a team qualified in the management of the drainage system in urgency and emergency situations.

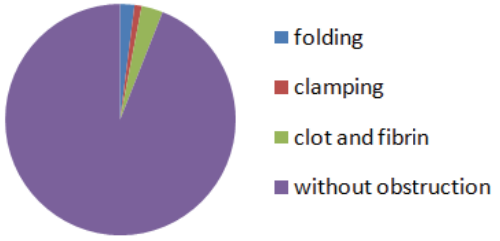

Figure 3. Distribution obstruction tubular thoracostomy and associated mechanisms.

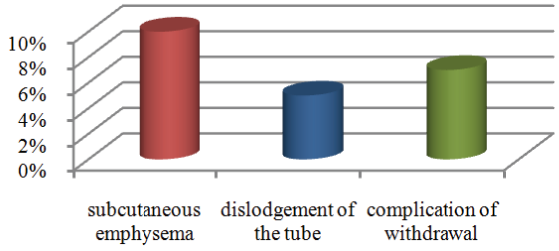

Figure 4. Distribution of complications in tubular thoracostomy.

All patients underwent chest x-ray examination; showing that this is a routine incorporated into the management of the patient after the drainage. The analysis of the positioning of the drain and lung re-expansion is of utmost importance, reflecting in the patients' satisfactory progress.

The 'U' stitch fixation with a non-absorbable suture that consists of skin and subcutaneous tissue was followed routinely, as the literature suggests, although controlled studies on the tube anchoring technique in linear injury are still necessary. In the study by Nishida et al. (2011), the 'U' stitch fixation was used in 100% of the cases.

An omental tag of tape as a tubular securing mechanism, in addition to the skin suture, basically helping prevent volvulus, reduce complaints of local pain caused by traction and accidental dislodgement of the drain, and was a routine procedure in most of the cases. However, the cases (3%) where such procedure were not performed, showed inaccuracy in this matter of utmost importance.

Regarding the outer diameter of the extension tube, an inconvenience due to a diameter smaller than the rest of the routes, causing resistance to the flow, was found in only 1 patient. The relevance of such data is that, according to the Poiseuille law, the fluid flow inside a tube is contingent on the bore and the length of the tube and the pressure gradient established between its ends (Tattersall, Traill, & Gleeson, 2000).

This study did not consider the time of replacement of the content of the collection bottle. A study by Menezes, Rosa, Conti, Santos, and Filho (2003) found that the replacement of the collection bottle and the fluid drained in it with the sterile physiological saline solution, both at 12 and 24 hours intervals, did not show any difference in the colonization rates, regardless of the use of antimicrobial drugs.

Particularly regarding the drain removal technique, it was only evaluated whether there were any complications or not and their nature. The pleural drains work by means of some elementary mechanisms (Munnell, 1997). The intrapleural pressure variation during the respiratory cycle occurs at a rate of -2 cm H_2O to -8 cm H_2O, respectively, at the end of exhalation and inhalation; however, it may reach values of +70 cm H_2O and -54 cm H_2O when coughing or inhaling deeply (Munnell, 1991). Thus, the efflux through the drain is increased when the patient moves in the bed, gets up, and walks around, hence, the importance of keeping the system without clamping in such circumstances. As a communicating vessel system, the flow is established from the highest compartment to the lowest one, wherefore the collection bottle must be at a level that is lower than the patient's chest. Considering that the maximum subatmospheric pressure is of 54 cm of H_2O during deep inhalation and that the drain system is approximately 200 cm long, there is a pressure safety margin of approximately 150 cm of H_2O, even when the drain is temporarily maintained at the chest level, as in a sector transfer situation, reinforcing the non-required obstruction of the tube (Munnell, 1991).

Failures in the chest drainage technique and management were found in the service, which reflected in some complications in the procedure, although it is known that there are intrinsic complications. In view of the foregoing, we suggest the protocol below (Table 2), thus avoiding the complications that are inherent to the chest drainage.

Table 2. Protocol suggested for chest drainage management.

1. The procedure starts by carefully cleansing the entire extent of the hemithorax with antiseptic solution.	9. An omental tag of tape around the drain.
2. Sterile drapes are placed.	10. Prescription of analgesic, which is usually required after the local anesthetic wears off.
3. Local anesthesia with 1% lidocaine by entering the intercostal space previously chosen for drainage, allowing a few minutes for the anesthetic to take effect.	11. Radiographic control of the chest, which must be performed and assessed immediately after the drainage.
4. 1-cm to 1.5 cm skin incision, divulsion of the subcutaneous and muscle planes using curved hemostatic forceps with penetration into the pleural cavity near the superior border of the rib. With the forceps in the pleural cavity, the index finger must be close to the end of the hemostatic forceps ('finger brake'), thus avoiding parenchymal injury caused by a sudden and violent entry.	12. The monitoring of the entire system must be systematized with, at least, medical visits in the morning and in the afternoon to control it.
5. After inserting the forceps, it will be opened so as to obtain appropriate space. In cases of doubt, the index finger may be introduced to digitally explore the cavity; then, the drain will be inserted, and adjusted and prolonged in other curved hemostatic forceps.	13. Drain removal technique a. Place next to bed: surgical tape, gauze, cutting material (scissors or scalpel blade), tincture of benzoin, and antiseptic solution. b. The dressing is removed, the skin is thoroughly cleaned with dry gauze so as to improve the adherence capacity of the adhesive tape. c. Antiseptic cleansing is performed around the drain. d. The suture for drain fixation is sectioned. e. The patient is asked to stop breathing, preferably at the end of forced exhalation. f. The drain is moved by traction with a single, uniform move so as to prevent air from entering through the holes. g. The skin wound is quickly obstructed with the nylon suture fixating the drain, dry gauze, and surgical tape over it. This dressing must be changed only after 24 hours so as to prevent air from entering in the absence of total skin apposition.
6. Adjustment between the drain and the tube connected to the bottle under water seal by using a large-diameter intermediate connector.	
7. Fixation of the drain to the patient's skin with a 2-0 nylon suture ('U' stitch with Roman sandal suture pattern).	
8. The fluid level of the bottle will be marked with an adhesive tape so as to allow the control of drainage output.	

Conclusion

Proper chest drainage management may reduce morbidity associated with the method. For such purpose, the importance of clarification and technical training of the hospital staff responsible for carrying out the procedures concerning the drainage is highlighted; especially in the case of residents in learning. Besides appropriate equipment and materials, therapeutic success is directly related to qualification and continuous training of those providing care to the patient undergoing chest drainage. Failures in chest drainage technique and management are still present in our service, reflected in some complications that are inherent to such procedure, and we will try to suppress them by standardizing a protocol in support to chest drainage management and its peculiarities. New comparative studies are expected to be conducted, after the routine use of the suggested protocol.

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Received on March 10, 2015.
Accepted on July 8, 2015.