Identification of Factors Affecting Complications of Chest Drains in Menoufiya University Hospital

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Abstract: A chest tube or chest drain is an essential life saving measure for the management of pneumothorax, hemothorax and hemopneumothorax developed as a consequence of chest trauma. Despite the enormity of its clinical utility, this procedure carries considerably significant preventable morbidity. The purpose of this study was to identify factors affecting complications of chest drains. Prospective observational study was carried out in Menoufiya university hospital on 52 patients in the emergency department, ICU and cardiothoracic surgical department. Data were collected at the time of drain insertion and continued until drain removal. The period of data collection was 12 months from January 2010. Two structured format were used to collect data pertinent to the study. Sociodemographic and medical data sheet and Patient assessment sheet. The results indicated that the mean (± SD) drain size was (16.2± .83 F), The most common indications for drain insertion were heamothorax (28.8%), for empyema mean tube size (15.28 ± 1.38) was lesser than other conditions but the mean tube duration/days was longer than other conditions (11 ± 3.4). In relation to complications (28.8%) of the sample had no complications ,only(3.8%) of the sample had pneumothorax as secondary to chest drain insertion, while (7.7%), (7.7%), (7.7%), and (9.6%), developed pain, cough, bleeding(minor), surgical emphysema respectively. 4 cases of empyema were recorded (7.7%), this occurred following chest drain insertion into heamothorax and pleural effusion. 6 drains (11.5%) were dislodged through tube management which were draining primary pneumothorax, and 8 drains (15.4 %) were blocked which were draining empyema. less successful resolution occurred with empyema 1(11.1%). The more complications occurred with the more junior nurses (diploma) and less experienced but the more successful rate occurred with nurses with higher education and more experienced (post graduate (master).
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1. Introduction

With the increasing frequency of traumatic chest injuries a large number of patients are dealt with by doctors in emergency department. A chest tube or chest drain is a flexible plastic tube that is inserted through the side of the chest into the pleural space. It is an essential life saving measure for the management of pneumothorax, hemothorax and hemopneumothorax developed as a consequence of chest trauma (Aziz *et al*., 2010).

In chest trauma, the primary aim is to maintain ventilation of lungs for proper oxygenation of body tissues and this cannot be achieved without chest decompression to decrease intra-pleural pressure and allow lungs to expand fully. Various therapeutic options have been reported in literature for management of chest injuries like clinical observation, thoracocentesis, tube thoracostomy and open thoracotomy. Despite the enormity of its clinical utility, this procedure carries considerably significant preventable morbidity (Muslim *et al*., 2008 & Farooq *et al*., 2006).

Complications are classified as insertional, positional or infectious.

Potential complications include misplacement of the tube or mechanical as (blocking or dislodgement), unresolved pneumothorax, empyema, laceration of thoracic vessels, and injury to the lung and heart. (Kinjal *et al*., 2011). Although several risk factors contribute to this tube-related complications like size of tube, technique and approach of insertion, experience of operator, and prehospital tube placement, level of experience is one of the important factors in the development of these complications (Aziz *et al*., 2010, Rivera *et al*., 2009, Huber-Wagner *et al*., 2007).

The purpose of this study was to identify factors affecting complications of chest drains.

2. Methodology:

The study was carried out in Menoufiya university hospital on 52 patients in the emergency department, ICU and cardiothoracic surgical department. Data were collected prospectively at the time of drain insertion and continued until drain removal. Patients completely assessed for the occurrence of complications. Insertional (pneumothorax, pain, bleeding (minor), cough, surgical emphysema, infective (empyema), and

mechanical (blocked and dislodged tube). All adult patients of either gender, at least 20 years of age, were included if they had acute thoracic injuries (blunt or penetrating), empyema, and pleural effusion. Exclusion criteria were patients with e.g., renal failure, congestive heart failure, or ascites and other thoracic visceral (like cardiac and esophageal) injuries and patients with head and neck or thoracoabdominal or limb trauma requiring surgical intervention. Two structured formats were used to collect data pertinent to the study, they were formulated and tested by the researchers

1. Sociodemographic and medical data sheet:

Age, gender, level of education, socioeconomic status, indications for chest drain insertion, size of chest drains inserted, tube duration/days, grade of nurses responsible for managing chest drain and years since graduation.

2. Patient assessment sheet:

It was developed to evaluate patients condition all through the study period at the time of drain insertion and continued until drain removal to detect the occurrence of complications early data collection form started at the time the drain was used until drain removal. The period of data collection was 12 months from January 2010. Data were analyzed using statistical software (SPSS 11.01). Appropriate tests were selected depending on the variables being compared.

3. Results

It is clear from table (1) that (84.6%) of the sample were males. As regarding age, it was found that less than half of the sample aged between 40 - 60 years, university education (38.5%) and half of the sample were employees (50%).

It was observed that the mean (± SD) drain size of (16.2± .83F) was statistically different, as X^2&p value of 20.50 &p value .000 (Table 2) .

The most common indications for drain insertion were heamothorax (28.8%), and primary pneumothoraces (23.1%). (Table 3).

It is observed that mean tube size for pneumothorax (16.08 ± .90) and mean tube duration/days (4.3 ±.65), but for empyema mean tube size (15.28 ±1.38) was lesser than other conditions but the mean tube duration/days was longer than other conditions (11 ± 3.4) (Table 4)

Insertional Complications:

It is clear from table (5) that (28.8%) of the sample had no complications, only (3.8%) of the sample had pneumothorax as secondary to chest drain insertion, while (7.7%), (7.7%), (7.7%), and (9.6%), developed pain, cough, bleeding (minor), surgical emphysema respectively.

Infective Complications:

4 cases of empyema were recorded (7.7%) (table 5), this occurred following chest drain insertion for heamothorax and pleural effusion (Table 6).

Mechanical Complications

Overall, mechanical Complications were recorded in a total of 14 cases because of drain dislodgement, or blockage (Table 5).

6 drains (11.5%) were dislodged through tube management which were draining primary, secondary pneumothorax, and heamothorax, and 8 drains (15.4 %) were blocked which were draining empyema and heamothorax (Table 6).

Successful Resolution:

5 drains (41.7%) were removed for successful resolution for patients with primary pneumothorax, but less successful resolution occurred with empyema 1(11.1%) (Table 6). As (11 ± 3.4) mean tube duration/days, and the mean tube size was (14.28 ± 1.38) (table 4).

It was observed that (46.4%) of total number of nurses managing patients with chest drain had diploma degree and only 3.6% were having post graduate (master) degree, X^2&p value of. 20.7 & .000 (table 7).

Table (Table 8) summarizes the complications and drain successful rate by grade of the nurses. There were high significant differences between the different grades in the complications and drain successful rates. The more complications occurred with the most junior nurses (diploma) and less experienced but the most successful rate occurred with nurses with higher education and more experienced (post graduate)(master).

4. Discussion

It is noticed from the current study that, the majority of the sample were males, it was found that less than half of the sample aged between 40 - 60 years, university education (38.5%) and half of the sample were employees (50%) (Table 1).

It was observed that the mean (± SD) drain size of (16.2± .83F) was statistically different, as x^2&p value of (20.50) & (.000) (Table 2). The most common indications for drain insertion were heamothorax (28.8%) (Table 3) . The result was in agreement with prospective descriptive study conducted by Aziz *et al*. (2010) as the majority of the patients (45%) presented to emergency room with hemothorax this may be due to penetrating injuries were more common causing hemothorax.

Table (1): Sociodemographic Characteristics of Patients in Percentage Distribution.

Item	Total N=52	
	No	%
Sex:		
Male	44	84.6
Female	8	15.4
Age:		
20-	13	25
40-	24	46.2
60-80	15	28.8
x- ± SD	43.8 ± 1.2	
Occupation:		
Worker	18	34.6
Housewife	8	15.4
Employees	26	50
Education:		
Illiterate	5	9.6
Read and write	12	23.1
Secondary	15	28.8
University	20	38.5

Table (2) Size of chest drains inserted (n = 52).

Item	Total N=52	
	No	%
Tube size		
14F	5	9.6
16 F	15	28.8
18 F	20	38.5
20 F	10	19.2
22 F	2	3.8
x- ± SD	16.2 ±.83	
X^2- p value	20.50 &p value .000	

Table (3) Indications for chest drain insertion (n = 52).

Indication for Insertion	Total N=52	
	No	%
Primary pneumothorax	12	23.1
Secondary pneumothorax	9	17.3
Empyema	9	17.3
Heamothorax	15	28.8
Pleural effusion	7	13.5

Table (4) Relationship between Mean Tube size and Mean Tube duration/Days.

Indication for Insertion	Mean Tube size		Mean Tube duration/Days	
	$\bar{x}$	± SD	$\bar{x}$	± SD
Primary pneumothorax	16.08	± .90	4.3	± .65
Secondary pneumothorax	15.7	±.83	5.8	± .78
Empyema	15.28	±1.38	11	± 3.4
Heamothorax	16.2	±.45	6.8	± 1.5
Pleural effusion	16.2	±.44	5.5	± .53

Table (5) Complications as a Result of Chest Drain Insertion (n = 52)

Complications	Total N=52		test χ^2-p value
	No	%	
Insertional			
pneumothorax	2	3.8	
Pain	4	7.7	20.3-.009
Cough	4	7.7	df 8
Bleeding(minor)	4	7.7	
Surgical emphysema	5	9.6	
Infective			
Empyema	4	7.7	
mechanical			
Block	8	15.4	
Dislodged	6	11.5	
No Complications	15	28.8	

Table (6) Success of chest drain by indication for drain insertion

Complications And Successful Resolution	Indication for Insertion				
	Primary pneumothorax N=12	Secondary pneumothax N=9	Empyema N=9	Heamothorax N=15	Pleural effusion N=7
Pain	1	1	1	1	0
Pneumothorax	0	0	1	0	1
Cough	1	1	0	1	1
Emphysema	2	1	0	0	2
Bleeding	0	2	1	1	0
Empyema	0	0	0	2	2
Blocked tube	0	0	5	3	0
Dislodged tube	3	2	0	1	0
Successful Resolution, No. (%)	**5(41.7)**	**2(22.2)**	**1(11.1)**	**6(40)**	**1(14.3)**

Table (7) Grade of Nurses Responsible for Managing Patients with Chest Drain in Percentage Distribution

Nurse degree	Total N=56		Years Since Graduation	test χ^2-p value
	No	%		
Diploma	26	46.4	0–1	20.7&
Health technical institute	15	26.8	1–4	.000
Bachelor	13	23.2	> 3	
Post graduate(master)	2	3.6	> 8	

Table (8) Complications and Chest Drain Successful Rates According to Grade of Nurses Responsible for Managing Chest Drain

Complications And Successful Resolution	Nurse degree				
	Diploma N=26	Health technical institute N=15	Bachelor N=13	Post graduate(master) N=2	χ^2-p value
Pain	3	0	1	0	26.2
Pneumothorax	1	1	0	0	Linear by linear
Cough	3	0	1	0	8.75
Emphysema	3	2	0	0	.003
Bleeding	2	2	0	0	
Empyema	2	2	0	0	
Blocked tube	6	2	0	0	
Dislodged tube	4	2	0	0	
Successful Resolution, No. (%)	2(7.6)	4**(26.6)**	11**(84.6)**	2**(100)**	

It is observed that mean tube size for pneumothorax (16.08 ± .90) and mean tube duration/days (4.3 ± .65), but for empyema mean tube size (15.28 ± 1.38) was lesser than other conditions but the mean tube duration/days was longer than other conditions (11 ± 3.4). mean tube size for pneumothorax(16.08 ± .90) was more than mean tube size for empyema(15.28 ± 1.38) (table 4), this inappropriate tube size selection led to more mean tube duration/days for empyema which was longer than other conditions (11 ± 3.4). These results were in agreement with Fred *et al*. (2000) who reported that the development of empyema increases patient morbidity, mortality, hospital length of stay, and the cost of the cure.

Baumann (2003) and Laws *et al*. (2003) stated in their studies that fluid (compared with air) within the pleural space requires larger bore tubes (≥28 Fr), especially if the fluid is particularly viscous, as with blood or clotting blood. If the patient has an uncomplicated pneumothorax, a small bore tube (14F or smaller) will act as a vent, allow air to escape, and be less uncomfortable. On the other hand, if a patient has sustained a chest wound and is bleeding heavily, a large bore tube (28F or larger) will allow the blood to drain more quickly, allowing more accurate measure of blood loss. This can be useful for collecting the blood for autologous transfusion while preparing to go to the OR. However, if a patient has empyema with thick purulent drainage or an infected malignant effusion in which the fluid is thick and hard to remove, a larger tube may be necessary. In addition to considering viscosity of the material being removed, it is also important to think about how quickly fluids are being produced — higher volumes will need higher flow rates and thus larger tubes. The inner diameter of the thoracic catheter is a significant factor determining flow rate of air and/or fluid out of the chest. The smaller the diameter, the slower the flow. Not all tubes of the same outer diameter French size will have the same flow rates, due to differences in catheter wall thickness and the materials used in the catheter construction.

While Richard (2011) mentioned that in recent years, a higher and higher percentage of patients with pleural effusions or pneumothorax are being treated with small-bore (10-14 F) chest tubes rather than large-bore (>20 F). However, there are very few randomized controlled studies comparing the efficacy and complication rates with the small- and large-bore catheters. Moreover, the randomized trials that are available have flaws in their design. The advantages of the small-bore catheters are that they are easier to insert and there is less pain with their insertion while they are in place. The placement of the small-bore catheters is probably more optimal when placement is done with ultrasound guidance. Small-bore chest tubes are recommended when pleurodesis is performed. The success of the small-bore indwelling tunnelled catheters that are left in place for weeks documents that the small-bore tubes do not commonly become obstructed with fibrin. Patients with complicated parapneumonic effusions are probably best managed with small-bore catheters even when the pleural fluid is purulent. Patients with haemothorax are best managed with large-bore catheters because of blood clots and the high volume of pleural fluid. Most patients with pneumothorax can be managed with aspiration or small-bore chest tubes. If these fail, a large-bore chest tube may be necessary. Patients on mechanical ventilation with barotrauma induced pneumothoraces are best managed with large-bore chest tubes.

In relation to insertional complications (Table 5), the study findings revealed that (28.8%) of the sample had no complications, only (3.8%) of the sample had pneumothorax as secondary to chest drain insertion, while (7.7%), (7.7%), (7.7%), and (9.6%), developed pain, cough, bleeding (minor), surgical emphysema respectively. Published complications in literature include lacerations of lung, intercostals artery, esophagus, diaphragm, stomach, right atrium,

subclavian vein as well as pulmonary artery. (Ball *et al*., 2007, Spanjersberg *et al*., 2005 and Leone *et al*., 2008).

Most of these complications were the consequence of trocar insertion technique rather than blunt method. Hence, it is now a worldwide acceptance that trocar insertional technique is not safe and preference is being given to the blunt methods. A trocar, is a pointed metallic bar used to guide the tube through the chest wall. This method is less popular due to an increased risk of iatrogenic lung injury (Shalli *et al*., 2009).

In relation to infective complications(Table 5), the study findings revealed that 4 cases of empyema were recorded (7.7%), this occurred following chest drain insertion into heamothorax and pleural effusion (Table 6). This result is nearly consistent with study conducted by Aziz *et al*. (2010). Occurring of this infection may be due to contamination of blood in pleural space during tube thoracostomy insertion which is the key factor in developing post-traumatic empyema, as mentioned by Hoth *et al*. (2003).

Posttraumatic empyema is a significant problem in both blunt and penetrating chest injuries. Potential causes include iatrogenic infection of the pleural space as during chest tube placement, direct infection resulting from penetrating injuries of the thoracic cavity, secondary infection of the pleural cavity from associated intra-abdominal organ injuries with diaphragmatic disruption, secondary infection of undrained or inadequately drained hemothoraces, hematogenous or lymphatic spread of subdiaphragmatic infection to the pleural space, and parapneumonic empyema resulting from posttraumatic pneumonia, pulmonary contusion, or acute respiratory distress syndrome. Efforts to reduce the incidence of this complication will impact on morbidity and perhaps mortality. One possible interventional use of prophylactic antibiotics in patients requiring tube thoracostomy is for traumatic hemothorax or pneumothorax. Thus, antibiotic administration in the immediate postinjury period is more correctly considered presumptive therapy. Multiple factors contribute to the development of posttraumatic empyema. These factors include the conditions under which the tube is inserted (emergent or urgent), the mechanism of injury, retained hemothorax, and ventilator care. The incidence of empyema in placebo groups ranges between 0 and 18%. The administration of antibiotics for longer than 24 hours did not seem to significantly reduce this risk compared with a shorter duration, although the numbers in each series were small (Fred *et al*., 2000).

Concerning mechanical complications, these were recorded in a total of 14 cases because of drain dislodgement, and blockage (Table 5).

6 drains (11.5%) were dislodged through tube management which were draining primary, secondary pneumothorax, and heamothorax and 8 drains (15.4 %) were blocked which were draining empyema and heamothorax. (Table 6).

Aziz *et al*. (2010) reported in their study one (1.7%) case of accidental dislodgment and one (1.7%) with non-functioning tube as a result of clotted blood. Among these, dislodgment of drain was a cause of spontaneous pneumothorax, which was immediately replaced by another chest tube. Non-functioning tube due to clotted blood was also replaced. This was the consequence of using smaller tubes. We used 24-32 Fr sizes of drains in our patients. Horsley *et al*. (2006) described the blockage of tube related to small bore drains usage. Therefore, to overcome this complication large bore (36Fr or greater) chest drains should be employed.

Regarding successful resolution(Table 6), 5 drains (41.7%) were removed for successful resolution for patients with primary pneumothorax which had more successful resolution, but less successful resolution occurred with empyema 1(11.1%). As previously observed for empyema, (11 ± 3.4) mean tube duration/days, and the mean tube size was (14.28 ± 1.38) (table 4), so, most mechanical complications and longer mean tube duration/days occurred with empyema, and less mechanical complications and lesser mean tube duration/days occurred with other conditions, so, less successful resolution occurred with empyema.

It was observed that (46.4)% of total number of nurses managing patients with chest drain had diploma degree and only (3.6%) were having post graduate(master) degree, χ^2&p value of. 20.7 & .000 (Table 7). There were high significant differences between the different grades in the complications and drain successful rates. The more complications occurred with the more junior nurses (diploma) and less experienced but the more successful rate occurred with nurses with higher education and more experienced (post graduate)(master) (Table 8).

Kinjal *et al*. (2011) mentioned in their study that the vast majority of complications from chest drain in the emergency department were minor. The prevalence of complications was consistent with previous reports of chest drain placed by non-emergency-medicine-trained physicians outside the emergency department. The findings can be used to identify avoidable complications and improve residency training.

Aziz *et al*. (2010) reported in their study there were a relation between level of experience and positional complications as senior registrars had lesser complication rates as compared to junior ones. Hence postgraduate training level is an important

predictor of having these adverse outcomes in tube thoracostomy procedure. The percentage of occurring complications were as the following, with postgraduate residents was 13 (21.7), with junior resident (1-2 years) was 9 (15), with senior resident (3-4 years) was 4 (6.7), and with senior registrars was1 (1.7).

Conclusions:

Chest drain is an effective measure in managing patients with chest trauma but associated with significant morbidity. The development of complication increases patient morbidity, mortality, the duration of chest tube drainage, hospital length of stay, and the cost of the cure. Factors which can cause complications may be related to inappropriate tube size selection, trocar insertion technique rather than blunt method, contamination of blood in pleural space during chest tube insertion, furthermore, managing chest tube by junior nurses is predictor of complications.

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