

Use of pigtail catheter and urosac: Numero uno for ambulatory chest drainage!

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ABSTRACT

Background: Intercostal chest drainage is required for varied lung diseases with the pleural involvement. While the conventional method of intercostal drainage (ICD) insertion with the bulky underwater drain (UWD) was the gold standard for management, it had numerous disadvantages. It was time and again challenged with better ambulatory methods, although the documentation and continued use of the same are rare in practice. We studied the efficacy of ambulatory chest drainage (ACD) with pigtail and urosac against the conventional drainage methods (ICD-UWD) at a tertiary care center. **Materials and Methods:** This prospective, observational study included the patients requiring chest drainage grouping them as per the intervention they underwent, i.e., (1) Pigtail-Urosac (ACD group) and (2) ICD-UWD (Non-ACD group). The clinical data were recorded and analyzed for the difference in the hospital stay, the total duration of drainage, successful outcome, residual disease, and pain in both groups using unpaired *t*-test and Chi-square test. **Results:** Of the 85 patients included in the study; 45 had pigtail-urosaac and 40 had ICD-UWD, consisting of 34 pleural effusions and 51 pneumothoraces. The ACD and non-ACD groups were similar in etiology. Of the 85 patients, 50 had complete lung expansion, 18 pleural thickening, 15 loculated residual disease, and two pleurocutaneous fistulae. In the ACD group, the hospital stay was less as compared to the non-ACD group, i.e., 4.06 (4.42) versus 19.68 (31.39) days ($P = 0.0008$). The duration of chest drainage showed a similar trend, i.e., 19.29 (66.91) versus 52.18 (46.38) days ($P = 0.006$). Pain ($P < 0.0001$) recorded was significantly less with better expansion ($P < 0.0001$), less pleural thickening ($P = 0.0067$), and residual disease ($P = 0.0087$) in the ACD group. **Conclusion:** The use of pigtail-urosaac is a safe, effective, and preferred method for ACD.

KEY WORDS: Hydropneumothorax, intercostal chest drainage, pleural effusion, pneumothorax

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INTRODUCTION

Intercostal chest drainage is required for varied lung diseases such as pneumothorax, hydropneumothorax, pyopneumothorax, and pleural effusion. Chest drainage is usually performed using the intercostal tube (ICD) [Figure 1] attached to the underwater drain (UWD) consisting of reusable glass units (empyema bottles) [Figure 2].^{1,2} Ambulatory chest drainage (ACD) devices that use a mechanical one-way valve are an

alternative to the traditional UWD. The ambulatory devices consist of the flutter valve, flutter bags, chest seals, and stoma bags.^{1,2} Indigenous adaptations were described in 1987³ and 1996⁴ by Indian researchers. They used the ready and cheap available urosac bag as a pneumosac successfully. The commonly used indigenous ambulatory method involves use of a wide bore catheter such as pigtail [Figure 3] for drainage which is attached to an urosac [Figure 4]. The insertion of a pigtail catheter is easy

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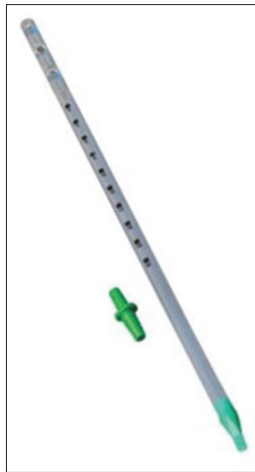


Figure 1: Intercostal drain tube



Figure 2: Glass drain (empyema bottle)

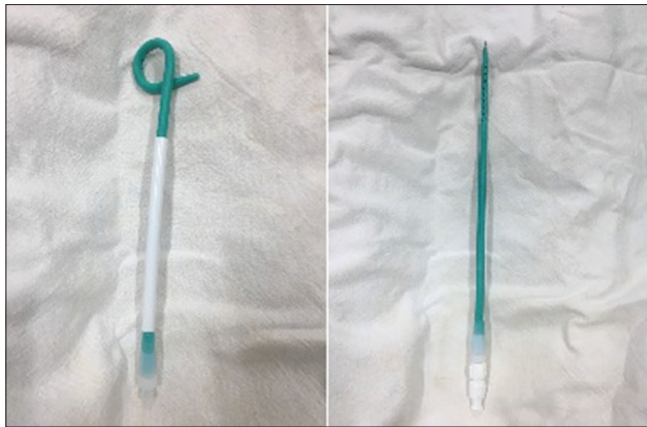


Figure 3: Pigtail catheter

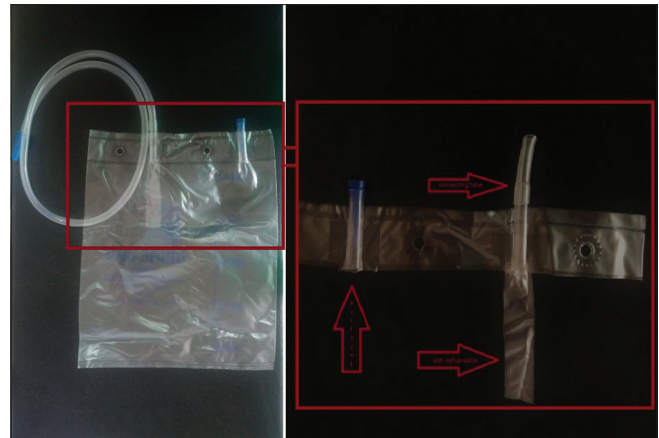


Figure 4: Urosac with enlarged image of nonreturn valve. Up arrow denotes the Exit valve. Lower right arrow denotes the Anti-reflux valve. Upper right arrow denotes the Connecting tube

and associated with less pain. The urosac is lightweight, portable, and less bulky drain. The assembly [Figure 5] thus allows the patient to be ambulatory, thus reducing the risk of complications from immobilization. Therefore, we studied the efficacy, safety, and outcome of ACD (consisting of pigtail and urosac) with conventional intercostal drainage (ICD) (consisting of ICD and UWD) in our patients with pleural diseases of various etiologies.

MATERIALS AND METHODS

A prospective, observational study was conducted with institutional ethics committee permission. The patients with diseases such as pneumothorax, hydropneumothorax, empyema, and pleural effusion referred to the department of pulmonary medicine of a tertiary care center were included in the study. Being a tertiary care center, our department receives patients through the secondary care centers/hospitals and directly. There were two categories of patients: (1) newly diagnosed patients attending our outpatient department (OPD), requiring chest drainage. These patients, directly referred to our department, were intervened with a wide-bore catheter (pigtail size 16 French) insertion attached to an urosac. Thus, the pigtail-urosac patients

comprised the “ACD” group. (2) The patients attending our OPD for further management of ICD with persistent air/fluid leak. These patients, referred from other centers/hospitals, were already intervened with a conventional portex ICD size 28/24 French with portex UWD. Thus, ICD-UWD patients comprised the “non-ACD” group. The patients <18 years of age and unwilling to give consent were excluded from the study. The study included 85 adult patients requiring chest tube drainage for pleural diseases of various etiologies over 2 year duration. Pediatrics patients and patients unwilling to give consent were excluded from the study.

All patients were assessed with detailed clinical history, examination, and etiology. The patients were evaluated for hospital stay and ambulation following insertion of the ICD. Pain associated with each procedure was assessed on the visual analog scale (VAS) on a scale ranging from 0 mm (no pain) to 100 mm (unbearable pain).^[5] The patients were discharged when stable and ambulatory after teaching ICD/pigtail care. ICD/pigtail was removed when lung expanded fully and did not collapse on clamping for 24 h, fluid drainage became serious, and < 50 ml or no further lung

expansion occurred despite continued ICD; however, the lung did not collapse on clamping. The average duration of ambulatory drainage with its efficacy and safety assessed the outcome. Statistical analysis involved calculation of mean and standard deviation. Quantitative data comparing the ACD and non-ACD groups were analyzed using the unpaired *t*-test and the Chi-square test.

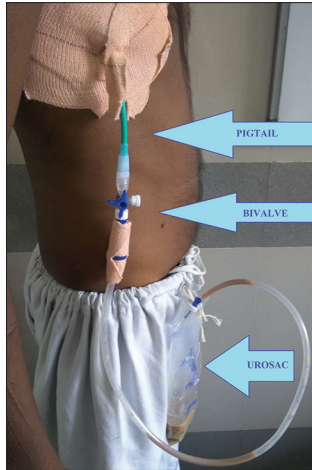


Figure 5: Pigtail with Urosac assembly applied to a patient

RESULTS

A total of 85 adult patients were included in the study. They ranged from 18 to 80 years of age. The mean age was 40.29 (15.82) years. There were 59 men and 26 women. Of the 85 patients, 45 had a pigtail-urosac, the ACD group and 40 had an ICD with UWD, the non-ACD group. The 85 patients consisted of 34 cases of pleural effusion and 51 cases of pneumothorax. The 34 cases of pleural effusion were classified as follow: nine pyogenic, three amoebic, eight tuberculosis, six malignancy, 4 due to trauma, one each due to chronic kidney disease, rheumatic heart disease, postabdominal surgery, and pulmonary thromboembolism, respectively, as per etiology. The details are given in Table 1. The difference in the distribution of patients from the ACD and non-ACD group across the various etiologies was statistically insignificant ($P = 0.3$). Thus, the two groups were similar in nature with respect to etiologies. The 51 cases of pneumothorax were classified as per etiology into: five primary spontaneous pneumothorax, nine chronic obstructive pulmonary diseases, one interstitial lung disease, 21 tuberculosis, three pyogenic, nine iatrogenic, one pulmonary Langerhans cell histiocytosis, one Marfan's syndrome, and one postlung hydatid resection surgery. The details are given in Table 2.

Table 1: Pleural effusion: Clinical data and drainage

Etiology	n=34	Complications	Non-ACD group (n)*	ACD group (n)*	Male	Female	Mean (SD)	
							Hospital stay	Duration of chest drainage
Pyogenic	9	No	4	5	6	3	37.2 (57.9)	52.9 (65.2)
Amoebic	3	No	0	3	3	0	4.7 (2.5)	10 (10.7)
Tuberculosis	8	1 iatrogenic	5	3	6	2	3.1 (0.8)	9.8 (9.8)
		hydropneumo-thorax						
Malignancy	6	No	2	4	4	2	12.2 (8.8)	20.2 (17.5)
Trauma	4	No	3	1	3	1	17.3 (20.1)	33 (26)
Chronic kidney disease	1	No	0	1	0	1	5	5
Rheumatic heart disease	1	1 iatrogenic	0	1	1	0	5	5
		hydropneumo-thorax						
Postabdominal surgery	1	1 iatrogenic	0	1	0	1	4	4
		hydropneumo-thorax						
Pulmonary thromboembolism	1	1 iatrogenic	1	0	1	0	24	30
		hydropneumo-thorax						

*The two groups are similar as the difference between the two groups is statistically insignificant ($P=0.3$). SD: Standard deviation, ACD: Ambulatory chest drainage

Table 2: Pneumothorax: Clinical data and drainage

Etiology	n=51	Complications	Non-ACD group (n)*	ACD group (n)*	Male	Female	Mean (SD)	
							Hospital stay	Duration of drainage
Primary spontaneous pneumothorax	5	No	2	3	3	2	6 (6)	9.6 (7)
Chronic obstructive pulmonary disease	9	1HPT	5	4	8	1	9.6 (8.4)	27.7 (28.4)
Interstitial lung disease	1	No	1	0	1	0	11	11
Tuberculosis	21	8HPT, 8PPT (4 + 4 with BPF)	15	6	12	9	9.8 (13.4)	76.8 (96)
Pyogenic	3	1HPT, 1PPT	0	3	2	1	2.7 (0.5)	3.7 (0.9)
Pulmonary langerhans cell histiocytosis	1	1BPF	1	0	1	0	29	60
Marfan's syndrome	1	No	0	1	1	0	3	3
Iatrogenic	9	No	2	7	7	2	3.2 (1.8)	5.6 (3.1)
Posthydatid surgery	1	1PPT	1	0	0	1	14	66

*The two groups are similar as the difference between the two groups is statistically insignificant ($P=0.43$). HPT: Hydropneumothorax, PPT: Pyopneumothorax, BPF: Bronchopleural fistula, SD: Standard deviation, ACD: Ambulatory chest drainage

The difference in the distribution of patients from the ACD and non-ACD group across the various etiologies was statistically insignificant ($P = 0.43$). Thus, the two groups were similar in nature with respect to etiologies.

Mean hospital stay in ACD group was 4.06 (4.42) days. Mean hospital stay in non-ACD group was 19.68 (31.39) days. The difference in hospital stay was statistically significant (unpaired t -test $P = 0.0008$). Mean duration of drainage required in the ACD group was 19.29 (66.91) days. Mean duration of drainage required in the non-ACD group was 52.18 (46.38) days. The difference in the duration of drainage was statistically significant (unpaired t -test $P = 0.006$). Regarding outcome, 50 patients had complete lung expansion, 18 had pleural thickening, 15 had loculated residual disease, and two developed pleurocutaneous fistula [Table 3]. Of the 48/50 patients with a successful outcome in the form of expansion of the lung, 37 had pigtail-urovac, and 11 had ICD-UWD. The difference was statistically significant ($P < 0.0001$). The remaining 2/50 patients with complete expansion, one each with pigtail-urovac, and ICD-UWD had clinically significant subcutaneous emphysema as complication. Of the 18 patients with pleural thickening, 4 and 14 were from the ACD and non-ACD group, respectively. The difference was statistically significant ($P = 0.0067$). A total of 15 patients with loculated residual disease consisted of 3 with pigtail-urovac and 12 with ICD-UWD. The difference was statistically significant ($P = 0.0087$). Two patients both from the non-ACD group developed pleurocutaneous fistula as a complication which were managed by application of stoma bag. The pain recorded on VAS in the ACD group was 47 (7) mm versus 64 (5) mm in the non-ACD group. The difference was statistically significant ($P < 0.0001$).

DISCUSSION

Chest tube drainage or tube thoracostomy is a common procedure to drain fluid, blood, pus, and air collected in the pleural cavity. It is required for diseases that involve the pleura such as pneumothorax/hydropneumothorax and pleural effusions. Indications of chest tube drainage in pneumothorax/hydropneumothorax include the clinical scenario suggesting respiratory distress, presence of BPF/hypoxemia.^[1] As against the indications for chest tube drainage in pleural effusions include recurrent pleural effusions, empyema, massive pleural effusions,

hemothorax, and respiratory distress inspite of therapeutic thoracocentesis.^[1] Chest drainage was first described by Hippocrates for empyema in his old texts; the other context was battlefield-related thoracic trauma.^[6] The debate on open thoracostomy versus closed drainage persisted over the two world wars. Only, during the world war II, McNamara documented and propagated closed tube drainage versus an open thoracostomy.^[7] In 1968, Hemlich described the flutter valve, a first of the ACD devices.^[8] The original chest drains consisted of an assembly of self-retaining India rubber ICD/Malecot's catheter ranging from size 40 French attached to the glass containing UWD which mandated hospitalization and patient nonambulatory. The chest tubes or catheters were classified on the basis of make, size, and method of drainage.^[1] The material consisted of India rubber, polyvinyl chloride, silicone, and polythene. The shape would be straight, angled, or coiled at end. They had numerous holes on the side and the tip to ensure adequate drainage and had a single or double lumen. The chest tubes are classified on the basis of their size into small-bore chest tubes, medium bore chest tubes, and large bore chest tubes having the outer diameter of <14 French, 14–24 French and more than 24 French, respectively. The small/medium bore tubes are placed using the Seldinger technique, while the large bore tubes are inserted by blunt dissection.^[1] The optimal size of the chest tube has been debatable though the BTS guidelines recommend the use of small/medium bore chest tubes in various diseases.^[9-11] As the size of tube and drainage method became less bulky, the ambulation of a patient with chest drainage was possible. The ACD were flutter valve, flutter bags, flutter seals, and stoma bags.^[1,2] While they were of optimal use in the patients with pneumothorax, in the absence of a drainage bag, they had severe limitations with diseases associated with large collection of fluid. Hence, the use of urovac was further illustrated which served as an ambulatory collecting bag with a nonreturn valve. ACD was discussed by pulmonologist in medical cases of pleural diseases first.^[3,4,12] The subsequent controlled clinical trials studied ACD mainly in postsurgical/posttrauma cases. Our remains a robust case study done after the initial few describing the recently available ACD against the conventional drainage system. The urovac is an alternative to the flutter bag. The flutter bag consists of a flutter valve with a drainage bag which can be attached to any size chest tube without the need to add water. The anti-reflux valve prevents air/fluid from reentering the chest. The urovac functions on the same principle as the flutter bags. It has been documented to be a safe, efficacious, cheap, and easily available substitute in several studies.^[2-4,12,13] It is lightweight, presterilized, disposable and allow ambulation of the patient undergoing chest drainage. It can be used for drainage of both pneumothorax and pleural effusion. It has an anti-reflux valve and exit vent that drains out the fluid/air [Figure 4]. The vent may be kept open to allow continuous escape of air versus may be temporarily opened to empty the bag intermittently depending upon the rate of air leak. Literature has elephantine documentation of

Table 3: Outcome in ambulatory chest drainage and nonambulatory chest drainage group

Outcome	ACD	Non-ACD
Lung expansion**	38	12
Pleural thickening**	4	14
Residual loculated disease**	3	12
Pleurocutaneous fistula**	0	2
Total	45	40

**Difference is statistically significant, i.e., $P < 0.05$. ACD: Ambulatory chest drainage

the spectrum of pleural diseases. Hence, the focus of this discussion is mainly the efficacy, safety, and outcome of ACD.

ACD has been described in the Western literature with reference to postthoracotomy persistent air leaks and thoracic trauma. Ours is the first robust study describing the indigenous pigtail-urosac as the numero uno/preferred ACD method in pleural diseases in comparison with the ICD-UWD. We reported statistically significant efficacy of chest drainage in our ACD group as compared to the non-ACD group. This was assessed in terms of successful outcome of lung expansion, less pleural thickening, less residual disease with reduced need for hospitalization, and reduction in the total duration of chest drainage. Our reported successful outcome of ACD is consistent with studies from 1976 to 2017 describing various types of ACD devices. Mercier *et al.* described chest drainage with flutter valve in 169 patients of pneumothorax with reexpansion in 72% of cases with the duration of drainage ranging from 1 to 18 days (average 5.1 days).^[14] Sharma *et al.* describe use of urosac in 20 patients of pneumothorax with reexpansion in 90% of cases with the duration of drainage ranging from 4 h to 30 days (average 4.7 days).^[3] Graham *et al.* described the efficacy, safety, and early mobility of the patients postthoracotomy treated with a chest drainage bag incorporating a one-way flutter valve against the conventional underwater seal drains in a randomized control clinical trial of chest drainage systems.^[15] Joshi *et al.* discuss successful use of urosac for chest drainage in 29 patients of pneumothorax and 13 cases of pleural effusion.^[4] Ponn *et al.* enlist the efficacious use of outpatient tube management in pneumothorax (176 cases), prolonged postresection air leak (45 cases), and outpatient thoracoscopy pulmonary wedge excision (19 cases).^[16] Kim *et al.* describe use of an ACD, thoracic vent, in the patients of pneumothorax, with reduced mean duration of drainage of 4.7 days.^[17] However, in contrast, the study by Cooper *et al.* described the use of an ACD, Xpand drain, in penetrating thoracic trauma though without significant difference against UWD.^[18] Our study demonstrated a significant reduction in the hospital stay in the ACD group. This is consistent with studies by Hussein *et al.* who observed shorter duration of hospital stay using pigtail catheter.^[19] Somolinos *et al.* also enumerated the efficacious use of portable chest drainage system in reducing the hospital stay in the management of persistent air leak postthoracotomy.^[20] Our study revealed a decreased duration for drainage in the ACD group as compared to the ICD-UWD, consistent with study by Hussein *et al.* who observed a shorter duration of drainage.^[19] In view the heterogeneity of the data and the diverse distribution of cases as per various etiologies, the exact number of days required for drainage and hospitalization is not comparable with these various studies. The ACD was a safe method of drainage and the pain recorded on VAS was significantly less as compared with nonambulatory method. This may have also lead to greater patient satisfaction and earlier mobilization

of patients, thus reducing the stay in hospital. This is consistent with study by Cafarotti *et al.* wherein small bore drainage was used successfully in various pleural diseases with very mild pain recorded on VAS 46 mm.^[21] Both the drainage methods were readily available free of cost to the patients of our tertiary care hospital. These pigtail-urosac and ICD-UWD are readily available in India. The pigtail catheter costs 800–1000 rupees and the urosac costs 100–200 rupees; hence, the total cost of the ACD assembly is 900–1200 rupees. Whereas, the cost of an ICD is only 100–200 rupees, the portex UWD costs 700–800 rupees commercially; hence, the total cost of the ICD-UWD assembly is 800–1000 rupees. Thus, there is no significant difference in the cost of both the drainage systems.

Our study had limitations. Our patient referrals included majorly chest symptomatic medical cases and had very few posttrauma or postlung surgery cases which were referred in case of rare, difficult scenarios by respected surgical specialties. Our method of classifying the two groups may have led an unintentional referral bias.

CONCLUSION

Chest drainage system has evolved from reusable glass units to plastic waterless, disposable ACD devices. However, drainage decisions are often made on individual preferences without sound evidence. The pigtail-urosac can be used as a simple, cheap, and effective way of ACD in various clinical situations. The ACD thus avoids prolonged and expensive hospitalization without compromising patient's condition and clinical outcomes.

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Conflicts of interest

There are no conflicts of interest.

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