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ORIGINAL CASE REPORT

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THE EFFECT OF INTRAPLEURAL ANALGESIA IN PATIENTS OPERATED FOR FLAIL CHEST

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ABSTRACT

Objective: Chest wall injury is an extremely common following blunt trauma. It varies in severity from minor bruising or an isolated rib fracture to server crush injuries. About 10% of adult patients in high-energy trauma sustain multiple rib fractures. Some of these patients suffer from flail chest leading to respiratory insufficiency. IPA administration is one of the different methods for providing perioperative analgesia in various upper abdominal surgeries like cholecystectomy, renal surgery and breast surgery. As well as providing analgesia for non-surgical conditions like fractured ribs, cancer pain, herpes pain and pancreatic pain.

Methods: Patients and Methods: In a prospective manner, we randomized all patients admitted between September 2010 and July 2014, with flail chest requiring surgery in this trial. We found 36 patients.
Group A consist of 5 women and 13 man and Group B 6 woman and 12man
With an age between 19-86 years (mean 59). The mean Injury Severity Score (ISS) was 21.7 (SD +─10.8) in 36 patients. 11women and 25 of 36 patients with IPA catheters,
Almost all of our patients also received EDA by anesthesiologists before thoracotomy. Tab-1&2 Intrapleural infiltration started in the trauma bayaccording to the written routine.
They received intrapleural 40 mL of 0.25% bupivacaine, Postoperative pain was evaluated using a visual analog scale (VAS). Pulse oximetry for saturation, heart rate, and systemic arterial pressures were monitored. All observations were recorded, 30,60, 120 and 360 minutes after the injection, and thereafter every 3 hours, intervals through the postoperative 36 hours. Tab-3&4

Results: Intrapleural bupivacaine does not increase the respiratory depression risk that is often associated with opioids, comparing of groups A and B, our patients in group B got more complication in form of arrhythmia, Headache, Nausea, Urinary, retention, Hypotension than group A.

Conclusions: Intrapleural bupivacaine can be a suitable pain management option for thoracic surgeries (flail chest surgery) without EDA Complications. IPA is an easy technique; somatic and visceral anesthesia may be achieved by injecting local anesthetics in the intrapleural space. The easy placement of an intrapleural catheter and better pain relief observed in the present study suggest that intermittent pleural infusion of 0.25% bupivacaine has proven to be a safe and effective method for relief of post-thoracotomy pain.

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INTRODUCTION

Post-thoracotomy pain is the most severe types of post-operative pain and occurs in more than 70% of patients. Pain control and restoration of proper lung function is of primary objective in postoperative Fig-1&2. By creating a vicious circle of hypoventilation, discharge accumulation and atelectasis the pain causes hypoxia, hypercapnia and, consequently, progressive intrapulmonary shunt, and ultimately exacerbates the patient's problems (Tan *et al.*, 2004). In addition, the failure to properly improve pain leads to stressful postoperative responses and endocrine and metabolic disorders (Furrer *et al.*, 1997). Chest wall injury is very painful and makes breathing difficult. Chest wall injury is an

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extremely common following blunt trauma. It varies in severity from minor bruising or an isolated rib fracture to server crush injuries of both hemithoraces. Fig-3 Multiple rib fractures will often be associated with an underlying pulmonary contusion, which may not be immediately apparent on an initial chest X-ray. Injuries to upper ribs are less commonly associated with injuries to adjacent great vessels.

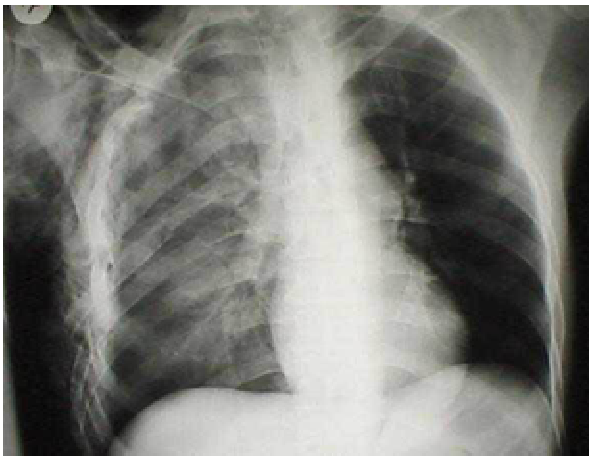


Fig. 1. AP lung contusion

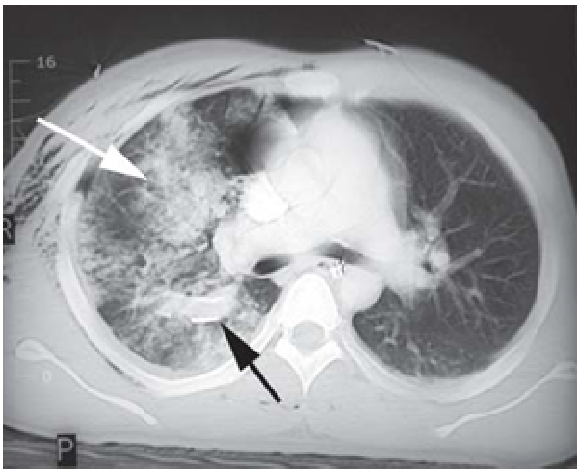


Fig. 2. CTlung contusion

Fig. 3. 3D reconstruction

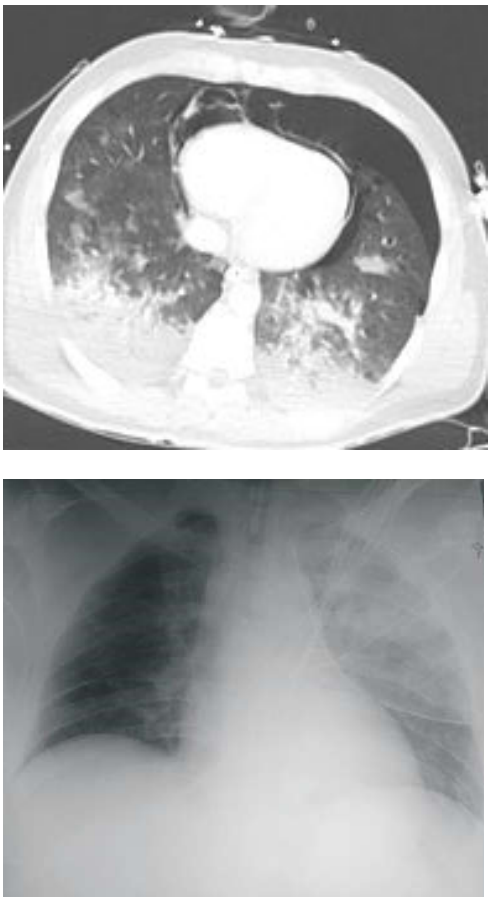
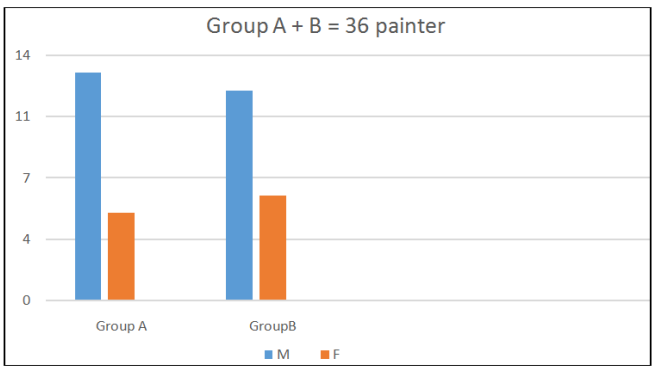


Fig. 4. Pulmonary contusion with pneumothorax post trauma

The main significance of a flail chest however is that it indicates the presence of an underlying pulmonary contusion. Fig 1, 2 and 3 Postoperative pain after flail chest is a significant complication in patients operated for flail chest. Intrapleural analgesia (IPA) is suggested to ameliorate this complication, therefore, we performed this trial to find out the effect of IPA.

MATERIALS AND METHODS

Between September 2010 and July 2014, we randomized 36 patients with flail chest or multiple rib-fractures resulting in unstable thoracic cage were operated. With an age between 19-86 years (mean 59). 2 patients in group A and one patient in group B had significant COPD and all three patients had emphysema at the time of injury.



All patients were intubated with a double lumen tube Most patients were operated in the side position with an antero-lateral thoracotomy incision, but often curved around the

scapula. An intrapleural catheter was inserted under direct vision during surgery. Thoracotomy was performed and lung lacerations were debrided. Leakage of blood and air was fixed by sutures but if the lung tissue was lacerated, small non-anatomic resection was also performed, with staples. We used modern fracture techniques with plates and intramedullary splint. Prophylactic antibiotics were given to all patients until the drains were extracted on day three or four. The affected lung was emptied during at least part of the surgery depending on the patient's ability to saturate on one lung. The surgery was performed in all cases by experienced trauma surgeons with a special interest in thoracic or fracture surgery HG/DP. They received intrapleural 40 mL of 0.25% bupivacaine, Postoperative pain was evaluated using a visual analog scale (VAS). Visual Analog Scale for Pain (VAS Pain)

RESULTS

Surgical stabilization of a flail chest was performed under general anesthesia with a double lumen endotracheal tube in order to obtain a selective pulmonary exclusion that allows exploration of the pleural cavity and lung parenchyma. Uncontrolled postoperative pain may aggravate some of the related complications and increase patients' morbidity and mortality. Post-operative pain management, especially with certain types of analgesic regimens, may decrease related morbidity and mortality. (Liu *et al*., 1995) Intrapleural anesthesia (IPA) is an easy technique; somatic and visceral anesthesia may be achieved by injecting local anesthetics in the intrapleural space. Open thoracotomy surgeries constitute very painful procedures (Conacher, 1990; Hazelrigg *et al*., 2002). While thoracic epidural analgesia may help control the incisional component of the pain, an excruciating post thoracotomy Ipsilateral Shoulder Pain (ISP) could undermine pain management in the post thoracotomy patient (Burgess *et al*., 1993).

Table 1. Other injuries and surgery of 36 Patients Group A + B = 36 painter

Group A	5 women	13 men
Group B	6 women	12 men

Table 2. Thoracotomy and Intrapleuralanesthesia Number n: 36

Thoracotomy	36
Intrapleural anesthesia (IPA)	36
EDA	36
Fractured ribs	162
Plates	162

Table 3. Thoracotomy and Intrapleuralanesthesia in 32 patients in Group A and B

Number total nr: 32 nr: 10 womannr: 22 Man

Thoracotomy	32
Intrapleural anesthesia (IPA)	32
Fractured ribs	148
Fixated ribs	148
Plates	136 (12 patients with Cordell suture)

Shoulder pain is also common in abdominal surgery with some similarities, but its management seems somewhat different. Very little specific data exists about ISP in the literature (MacDougall, 2008). Furthermore, the majority of studies about IPA are not well designed clinical trials.

Table 4. Effects and complications in Group A or IPA group 17 patients

Arrhythmia	0	%
Headache	0	
Nausea	3	0,51%
Urinary retention	0	
Hypoxia	0	
Pneumothorax	0	
Hypotension	0	
Empyema	0	
Thoracic wall hematoma	0	
Pneumonia		

Table 5. Effects and complications Group B or EDA group 6 woman and 9 man = 15 patients with EDA

Arrhythmia	1
Headache	3
Nausea	3
Urinary retention	3
Hypoxia	0
Pneumothorax	0
Hypotension	2
Empyema	0
Thoracic wall hematoma	0
Pleural effusion	0
Pneumonia	0

Table 6. Group A or IPA group (4 woman and 13 man) = 17 patients in Visual Analogue Scale (VAS)

1-No pain	10 patients
2-Barely Perceptible pain	1 patient
3-Mild Pain	0
4-Moderate Pain	2 patients
5Barely Strong Pain	0
6-Strong/Severe Pain	0
7-Intense Pain	0
8-Very Intense Pain	0
9-Horrible (most uncomfortable) Pain	0
10-Worst (Excruciating) Pain	0

In group A according to VAS we had 10 patients with No pain, 4 patients with Barely Perceptible pain, 1 patient with Mild Pain and 2 patients with Barely Strong Pain

Table 7. Group B or EDA group (6 woman and 9man) = 15 patients with

1-No pain	7 patients
2-Barely Perceptible pain	2 patients
3-Mild Pain	1 patient
4-Moderate Pain	2 patients
5Barely Strong Pain	2patients
6-Strong/Severe Pain	0
7-Intense Pain	1patient
8-Very Intense Pain	0
9-Horrible (most uncomfortable) Pain	0
10-Worst (Excruciating) Pain	0

In group B or EDA group according to VAS we had 7patients with No pain, 2 patients with Barely Perceptible pain, 1 patient with Mild Pain,2 patients with Moderate Pain, 2 patients with Barely Strong Pain and one patient with Intense Pain .

Background: Interpleural local anesthetic administration is one of the different methods for providing perioperative analgesia in various upper abdominal surgeries like cholecystectomy, renal surgery, breast surgery, as well as providing analgesia for non-surgical conditions like fractured ribs, cancer pain, herpes pain and pancreatic pain. (Brockmeier *et al*., 1993) In the original abstract, Kvalheim and Reistad suggested a mechanism of reverse diffusion of local

anaesthetic through the parietal pleura into the subpleural space. From there, as shown in 1980 by Nunn and Slavin, the fluid could pass between the flimsy fascicles of the intercostalisintimus muscle to the intercostal space(s) and nerve(s). This mechanism seems to be supported by the observation of Miserocchi and colleagues, using gamma camera imaging that a major distribution of fluid injected into the pleural cavity of anaesthetized dogs is in the paravertebral area, where the intercostal nerves are covered only by parietal pleura. Further support has come from studies on intrapleural local anesthetic in dogs, using somatosensory evoked potentials, and in patients using computed tomography. (Brockmeier *et al*., 1993)

Inspiration. (In flail chest) As intrapleural pressure becomes increasingly negative, the flail segment and its underlying lung tissue are sucked inward, collapsing the lung on the affected side and shifting the mediastinum toward the unaffected side Fig-4.

Expiration. As intrapleural pressure becomes less negative, the flail segment and underlying tissue are pushed outward, and the mediastinum shifts to the affected side. Some air moves between the lungs instead of passing through the upper airways. Kitt *et al*., 1995 Fig-4.

Interpleural local anesthetic administration technique produces multiple unilateral intercostal nerve blockade by gravity-dependent retrograde diffusion of the local anesthetic to reach the intercostal nerve. Rocco *et al*. (1987) were the first to describe the use of this method in patients with MFRs, and various other investigators have also successfully used this method to control pain in patients with blunt chest trauma. (Graziotti and Smith, 1988; Shinohara *et al*., 1994; Knottenbelt *et al*., 1991; Hudes, 1990) Drugs and dosage commonly used for IPA in patients with MFRs are outlined in Tab- 2. When comparing IPA to EA for pain relief in chest wall trauma, Shinohara *et al*. (1994) found IPA to be comparable to EA, whereas Luchette *et al*. (?) concluded that EA is superior. More recently, in a well-controlled study, Short *et al*. found IPA to be comparable to conventional opioids in controlling pain in patients with blunt chest trauma. This variable efficacy of IPA in patients with blunt chest trauma may be because the success of IPA can be affected by a number of factors, including catheter position, patient position, presence of hemothorax, location of fractured ribs, characteristics of the local anesthetic agent, and the use of epinephrine. Moreover, significant amounts of local anesthetic agent can be lost through the intercostal drain. (Rocco *et al*., 1987; Ferrante *et al*., 1991) To improve analgesic efficacy after intrapleural injection of local anesthetic, patients are often nursed in the supine position for 20 minutes to facilitate diffusion of local anesthetic through the parietal pleura into the intercostal nerves (Stromskag *et al*., 1990).

Nursing a blunt chest trauma patient with decreased FRC and often-compromised respiration in the supine position is not optimal. Although an upright position may be considered advantageous, this may result in a gravity-dependent accumulation of local anesthetic in relation to the diaphragm. Because the diaphragm takes up bupivacaine after intrapleural administration, (Stromskag *et al*., 1991) this may adversely affect diaphragmatic function. (Seltzer *et al*., 1987) with a thoracostomy tube in situ, clamping it for 20 to 30 minutes to prevent siphoning away of the local anesthetic agent is often recommended. This maneuver has raised concerns (Squier *et al*., 1990) because it can result in a dangerous situation of tension pneumothorax in the event that a significant air leak is present. Interpleural catheter placement can be technically difficult68 and can result in symptomatic pneumothorax, (Murphy, 1993; Gomez *et al*., 1988) intrapulmonary catheter placements, 70 misplacements into the chest wall, (Gomez *et al*., 1988) or an extra pleural plane. Local anesthetic agents are rapidly absorbed from the intrapleural space, resulting in high plasma.One of the great advantages of this technique is that analgesia can be extended beyond the operative period. Some important complications following this procedure are getting pneumothorax Horner's syndrome, chest wall hematoma, L.A. toxicity and rarely LA spreading to epidural space, in patients without thoracotomy. About 10% of adult patients in high-energy trauma sustain multiple rib fractures. Some of these patients suffer from flail chest leading to respiratory insufficiency. Granhed and Pazooki Journal of Trauma Management & Outcomes (2014) 8:20. During last year's interest and results for operative treatment has improved. The literature today all show positive results for surgical versus conservative treatment, specifically regarding time spent in mechanical ventilator, complication rates and length of hospital stay. Granhed and Pazooki Journal of Trauma Management & Outcomes (2014) 8:20. Interpleural block can provide analgesia over the chest wall and upper abdomen and a single injection of local anesthetics spreads to several intercostal nerves. Interpleural analgesia is an established technique for providing hemi thoracic analgesia and sympathetic block and offers some advantage in the management of widespread chest wall pain by minimizing the number of injections required compared with intercostal block.

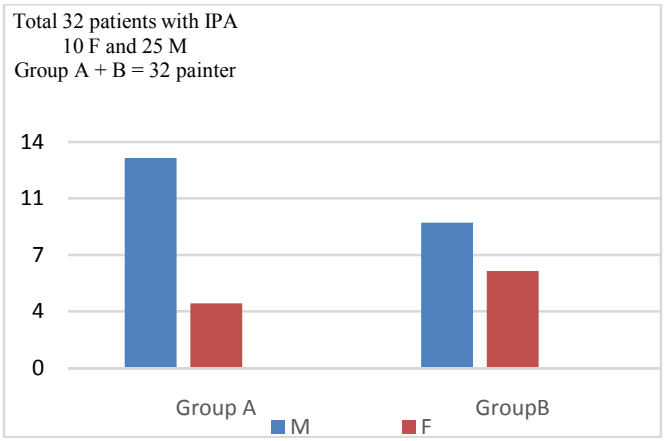
The technique appears to have a few recognized complications in addition to pneumothorax, including intravascular injection, chest wall hematomas and pleural effusion. (Gomez *et al*., 1988; Murrell, 1988; Llivener and Rosenthal, 1992) Intrapleural and intrapleural techniques have been used interchangeably but the Latter is more appropriate. A single epidural catheter is most commonly inserted through a Tuohy needle at a level between T6 and T8, a point anywhere between 8 cm lateral to the posterior midline and posterior axillary line. A loss of resistance can be used to find the intrapleural space. The catheter is placed 3-6 cm deep to the space and fixed. 20-25 ml of local anesthetic (usually 0.25% bupivacaine) is then injected. The reported mean duration of analgesia is 2 to 18 hours (mean 7 hours). Continuous infusion dose is at a rate of 0.125 ml/kg/hour (Seltzer *et al*., 1987). The mean Injury Severity Score (ISS) was 21.7 (SD +−10.8) in 36 patients.

They received intrapleural 40 mL of 0.25% bupivacaine, Postoperative pain was evaluated using a visual analog scale (VAS) Pulse oximetry for saturation, heart rate, and systemic arterial pressures were monitored. All observations were recorded, 30, 60, 120 and 360 minutes after the injection, and thereafter every 3 hours, intervals through the postoperative 24 hours. All patients also received EDA by anesthesiologists before thoracotomy, and IPA with the end of operation. Intrapleural infiltration started in the trauma bye according to the written routine. HG/DP SPSS version 20 (IBM Corporation, Somers, NY) was used for statistical analyses. Pearson's correlation was used between ISS and ventilated days.

Diagnose	Number	Surgery
Pelvis fracture	3	3
Diaphragmatic rupture	3	3
Lung contusion	32	7 Lung resections
Liver injury	6	0
Spleen rupture	3	2
Uncontrolled bleeding	1	Emergency thoracotomy
Lumbar spine FX	3	3
Thoracic spine FX.	4	4
Sternum FX.	3	0
Cardiac contusion	3	0
Commotiocerebri	6	0
Fracture to the skull	3	Icp.1
Subdural bleeding	2	1
Face fracture	5	1
Upper extremity FX.	3	7Ex fix op + reop
Lower extremity FX.	2	1

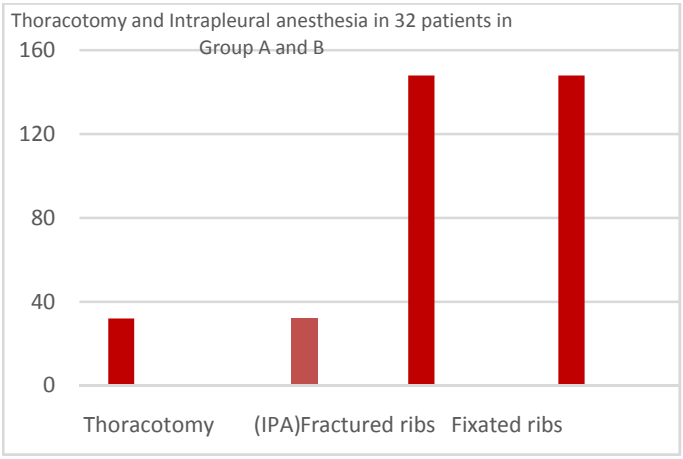
We show other injuries and surgery of 36 Patients in Table 1

11 women and 25 of 36 patients with IPA catheters, 4 of them due to technical failure did not work (3 in B group of man) and 1 of them had been withdrawn from the patient in (Group A in woman) by mistake. This five (4 man and1woman) patients removed from study, and four of them had EDA already, one patients received new EDA from anesthesiologist later due to postoperative pains because of EDA dysfunction.



Total 32 patients with IPA
10 women and 25
Group A + B = 32 painter

Group A	4 women	13 men	17 patients with IPA
	6 women	9 men	15 patients with EDA



DISCUSSION

EDA is technically demanding, especially in patients distressed with pain. In patients with multiple injuries, it can mask intraabdominal injuries, (Ward and Gillatt, 1989) is associated with hypotension 38 during the early phase of treatment, and can result in cardiovascular collapse and cardiac arrest in the inadequately resuscitated patient. (Worthley, 1985) Another serious complication of note is epidural infection. (Worthley, 1985; Rankin and Comber, 1984) Since the introduction of IPA in 1984 by Kvalheim and Reiestad, there have been numerous reports on the use and complications of the technique in the management of different types of pain. However, there have been few investigations into the mechanism of action, which remains conjectural. Many study showed that the VAS method of pain rating is *reliable* and *Valid* for Clinical use. So, we used VAS method of pain rating of all patients.

Verbal Rating Scale.0 . . . . 5 10

No pain Worst Pain Possible

1-No pain
2-Barely Perceptible pain
3-Mild Pain
4-Moderate Pain
5Barely Strong Pain
6-Strong/Severe Pain
7-Intense Pain
8-Very Intense Pain
9-Horrible (most uncomfortable) Pain
10-Worst (Excruciating) Pain

Intrapleural bupivacaine does not increase the respiratory depression risk that is often associated with opioids, it can be a suitable pain management option for thoracic surgeries (flail chest surgery) without EDA Complications. Our patients in this study had multiple trauma with multiple lesions in abdomen and skeletal fractures as well as neuro trauma and not just flail chest, perhaps it is best for patients with multi trauma and flail chest to use both EDA and IPA.

Conclusion

Intrapleural anesthesia (IPA) is an easy technique; somatic and visceral anesthesia may be achieved by injecting local anesthetics in the intrapleural space. The easy placement of an intrapleural catheter and better pain relief observed in the present study suggest that intermittent pleural infusion of 0.25% bupivacaine has proven to be a safe and effective method for relief of post-thoracotomy pain. Perhaps it is best for patients with multi trauma and flail chest to use both EDA and IPA. Without adequate analgesia, deep breathing, coughing, and chest physiotherapy are compromised and respiratory failure may ensue.

Disclosure

The authors declare no conflicts of interest.

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