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How Much Negative Pressure Are We Generating During Thoracentesis?

To the Editor:

Handheld digital pleural manometers (DPMs) are used to measure pleural pressure during thoracentesis. Lee et al demonstrated concordance between pleural pressure measurements done with a DPM and with an electronic transducer manometer.[1]

Only static intrathoracic pressure can be measured with the DPM. Pleural pressure is usually measured at the beginning of the thoracentesis (opening pressure), after removal of 240 cc of fluid, and at the end of the thoracentesis (closing pressure). To our knowledge, no published studies document the negative pressure that occurs during the actual drainage. This letter focuses on the difference between the negative pressures generated with manual intermittent suction (MIS) vs the negative pressure bottle (NPB).

CASE REPORT

A 73-year-old male with a history of stage IV adenocarcinoma of the lung presented with progressive shortness of breath. Thoracic ultrasound examination demonstrated a large right pleural effusion. Ultrasound-assisted right-side thoracentesis was performed, and a DPM was used to measure pressures during the procedure. Three static pleural pressure measurements were assessed: the opening pressure, the pressure after the removal of 240 cc of pleural fluid, and the closing pressure. An NPB was used, and a total of 800 cc of pleural fluid was removed. No signs of lung entrapment were evident. Thoracic ultrasound confirmed the total removal of the fluid and the presence of pleural sliding at the conclusion of the procedure. The patient tolerated the procedure, confirmed improvement of his respiratory symptoms, and denied any chest pain or cough. A week later, the patient presented with dyspnea on exertion and reported the feeling of pleural fluid accumulation. Thoracic ultrasound confirmed reformation of the pleural fluid, and 760 cc of fluid was removed using a manual 60-cc suction syringe. As during the previous procedure, 3 pleural pressure measurements were performed and revealed the absence of lung entrapment. On both occasions, we measured the negative pressure generated by the suction device. The negative pressure generated by the NPB started at approximately –115 cm H_2O. Following the removal of 800 cc of fluid, the bottle pressure was approximately –75 cm H_2O (Figure 1). On the other hand, when MIS was performed with a 60-cc syringe, the negative pressure was approximately –250 cm H_2O each time with a fully pulled syringe (Figure 2). Despite the large difference between the negative pressures generated in each method, we saw no difference in the outcomes (Table).

DISCUSSION

The DPM is a new tool that can measure pleural pressure during thoracentesis.[1,2] The DPM is especially useful for patients with a high risk of expansion pulmonary edema or with lung entrapment.[3] Young patients with large pleural effusion (>3 L) and more than 7 days' duration of lung collapse are at risk for developing expansion pulmonary edema.[4,5] Obtaining static measurements of the pleural pressure while performing thoracentesis can provide information about the intrathoracic pressure. The measurements identify any sudden drop in the intrathoracic pressure and provide an early sign of lung entrapment. Our patient did not have any signs of lung entrapment during either procedure.

The amount of negative pressure generated by the NPB and MIS during the fluid removal process is significantly different. Although we saw no difference in the outcomes at the end of each procedure, the amount of negative pressure generated with MIS exceeded the negative pressure generated by the NPB by approximately 100 cm H_2O with each syringe filling. On the other hand, the negative pressure generated by the NPB is a continuous negative pressure throughout fluid drainage that is inversely reduced by the volume removed. One of the factors that can contribute to the development of expansion pulmonary edema is the speed of the fluid removal. Considering both methods, the negative pressure generated by MIS can reach approximately –250 cm H_2O with full syringe expansion and can cause more rapid fluid removal. Also, MIS can cause intermittent fluctuations in the intrathoracic pressure. To avoid the rapid removal of fluid and pressure fluctuations while using MIS, a gentle manual negative pressure can be applied.

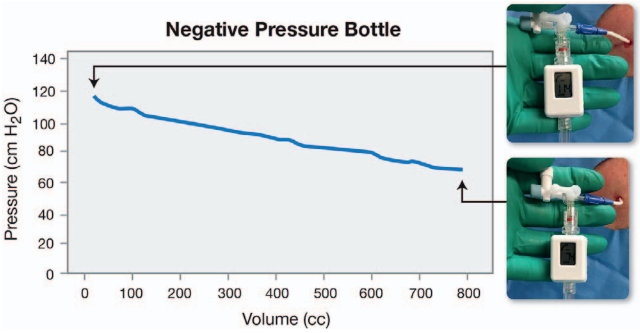

Figure 1. Graph demonstrates the difference in negative pressure generated by a negative pressure bottle in relation to the volume of fluid removed while performing thoracentesis. On the right, a digital pleural manometer shows the negative pressure measurement at the start and at the end of the procedure.

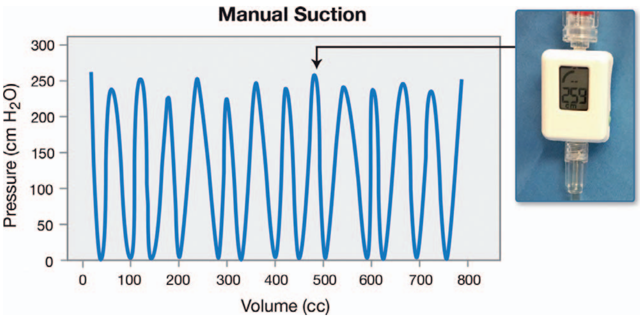

Figure 2. Graph demonstrates the difference in negative pressure generated by manual intermittent suction with a 60-cc syringe (13 full 60-cc syringe suctions) in relation to the volume of fluid removed while performing thoracentesis. On the right, a digital pleural manometer shows the measurement of negative pressure at each full syringe suction.

The outcomes of both procedures did not show that one method was superior to the other. However, the NPB method is less cost effective than MIS because of the price of the bottles.

	Opening Pressure	240 cc Fluid Removal	Closing Pressure
Negative Pressure Bottle	+9 cm H_2O	+7 cm H_2O	+2 cm H_2O
Manual Intermittent Suction	+10 cm H_2O	+8 cm H_2O	+1 cm H_2O

Our findings are an eye-opener about the amount of pressure generated with manual fluid removal.[6] However, the real negative pressure generated by each method cannot be confirmed by static intermittent measurement of the pleural pressure. Intrathoracic pressure should be continuously measured to obtain the real correlation between the negative pressure generated and the pleural pressure.

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Heat Stroke: A Public Health Crisis: Reflections from Pakistan

To the Editor:

Heat stroke is a life-threatening emergency, defined as a body temperature of >40°C (>104°F), that can result in a systemic inflammatory response leading to multiorgan dysfunction in which encephalopathy tends to predominate.[1] The mechanism of heat stroke includes direct tissue injury and cell death resulting from cytotoxicity and delayed organ dysfunction because of the activation of inflammatory and coagulation pathways.[2]

Heat exhaustion with nonspecific symptoms such as malaise, nausea, and headache precedes heat stroke. If heat exhaustion persists, it develops into heat stroke[3] and principally affects the central nervous system, causing delirium and coma. Eventually, multiorgan failure ensues, giving rise to rhabdomyolysis, liver failure, cardiac arrhythmia, disseminated intravascular coagulation, and subsequent death. Heat stroke that is not induced by exercise has a high mortality rate (62.6%) even if the patient is managed in a timely way.[4] People at high risk include the elderly (>75 years); young children (<4 years); individuals with limited mobility; alcoholics; and patients taking antipsychotics, sedative-hypnotics, anticholinergics, anti-Parkinson medications, and cardiovascular medications (beta blockers, calcium channel blockers, and vasodilators).[5]

Pakistan is located in South Asia where residents are highly dependent on agriculture and water resources for survival. The country is inadequately prepared for emergencies or calamities such as floods or high temperatures that can cause heat stroke.[6] Pakistan ranks 135th in global greenhouse gas emissions per capita but ranks 16th in its vulnerability to climate change.[7]

In June 2015, Karachi, Pakistan, experienced an intense and prolonged heat wave that claimed 1,200 lives even though heat stroke relief centers were established. The Edhi Foundation, the largest charity organization in Pakistan, reported that 2 of their city morgues received more than 500 corpses as a result of death from the heat wave.[2] A significant factor contributing to the death toll was that Muslims were observing the Islamic month of Ramadan, during which strict fasting is observed from sunrise to sunset. Fasting can result in significant dehydration, particularly during harsh weather.[2]

Heat-related mortality is an important public health concern, particularly in the context of climate change.[8] The principal predictors of outcome in heat stroke are the duration and degree of hyperthermia.[9] Treatment of mild heat exhaustion involves observing the patient in a cool, sheltered environment and ensuring the patient is sufficiently hydrated.[3] For heat stroke, various methods are used to reduce the core body temperature. One of the most effective methods is to immerse the individual in ice water.[9] Other methods include immediate cooling through evaporation, a variety of invasive techniques, and the use of chemical agents such as dantrolene.[9] In addition, doctors must monitor electrolyte abnormalities and replace fluids in patients in a timely manner. The goal of the treatment process is to reduce the core body temperature to 39°C (102.2°F) and then to halt the reduction in the body temperature to avoid hypothermia.[10]

Experts believe that doctors and public health officials should focus on preventing the incidence of heat stroke. Identifying susceptible individuals, raising awareness through print and electronic media, and establishing heat shelters may help prevent heat-related illness. These preventive measures, when paired with wise recognition of the early signs of heat-related illness, can allow physicians in the ambulatory setting to prevent significant morbidity and mortality associated with heat exhaustion and heat stroke.[3]

Malik et al have suggested that the government needs to direct its efforts to the socioeconomic uplift of resource-poor areas to reduce their populations' vulnerability to the adverse effects of climate change.[6] Emergency mass causality drills should be practiced in the country's major hospitals to ensure staff are prepared for natural disasters. Bed capacity should be monitored through a central government communication center that can facilitate efficient contact and transfers between hospitals, giving prime importance to high quality patient care.

Finally, the population needs to be educated regarding first aid strategies to use during a heat wave, such as applying cold water to the skin, placing ice packs on the groin and axilla, and immersing the overheated individual in cool water. Encouraging oral consumption of fluids and seeking proper medical attention are equally important. The general public should also be made aware of the concept of emergency triage and how the overuse of hospital resources can result in delays in delivering proper medical attention to deserving patients.[11]

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