Images in clinical medicine

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Pneumomediastinum diagnosed from a remote Tele-ICU center?

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Abstract

***Background*: The propagation of remote "telemedicine" has allowed intensivists (and other medical professions) to expand their ability to provide critical care medicine services to intensive care units (ICUs). The physical exam is a pertinent skill that all providers learn early in their medical careers. Key components of the physical exam can help a clinician narrow the differential diagnosis. Even with modern monitoring devices and high-powered imaging, it is hard to replicate the physical exam on a critical care patient from a tele-medicine center.**

***Case presentation*: An experienced intensivist working in a telemedicine (Tele-ICU) center reviewed the daily chest radiograph on a patient with a complex prolonged ICU course. The radiograph was immediately recognized as being concerning for an acute case of pneumomediastinum in a patient with recent tracheostomy manipulation. However, the intensivist was unable to corroborate his suspicions with a good physical exam as the differential diagnosis list was explored.**

***Conclusions*: Acute pneumomediastinum is a severe disease process arising from numerous etiologies that can be life threatening. This disease process can often times be diagnosed from plain chest radiography alone. However remote telemedicine patient care should never supersede a direct bedside physical exam. Every good clinician knows that the fundamental physical exam truly is fundamental.**

Key words: Pneumomediastinum, Tele-ICU, telemedicine, chest radiography, physical exam, critical care medicine.

Case presentation

An 87-year-old female with a past medical history significant for myocardial infarction, coronary artery disease with prior stenting, and atrial fibrillation presented to the emergency department with worsening dyspnea on exertion, shortness of breath, and dizziness. The patient was admitted for further inpatient evaluation. Significant inpatient findings on workup included a transthoracic echo demonstrating severe mitral stenosis and regurgitation. The patient subsequently underwent a bioprosthetic mitral valve replacement without operative complications. However, the patient was unable to wean from ventilatory support and required a bedside percutaneous tracheostomy on post-operative day four. On the evening of post-operative day seven the patient's chest radiography (**Figure 1**) was concerning for subcutaneous air in the soft tissue surround the neck and upper thorax. Physical exam by the bedside advance practice provider (APP) demonstrated no crepitus or obvious abnormalities, however the patient was noted to have increased work of breathing and respiratory distress. Initial concern for pneumomediastinum was explored including acute tracheostomy malposition. After an extensive discussion between the telemedicine intensivist and the APP regarding management, the APP remembered that fevers ear-

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lier in the evening lead nursing staff to place ice packs around the patient's neck and under the sheet covering the patient. The ice packs were immediately removed and a repeat chest radiography (**Figure 2**) demonstrated resolution of free air.

The initial imaging of our patient was concerning for free air in the upper thorax and neck (**Figure 3**). This image was initially reviewed remotely by an intensivist located in our telemedicine (Tele-ICU) center prompting an emergent call to the bedside team. A bedside APP provided an essential piece of information which included the fact that ice packs were placed on the patient's neck with the goal of temperature regulation. This case highlights several educational points including the radiographic findings, potential differential diagnoses and potential limits of Tele-ICU patient care.

Background

The radiographic finding in this case was concerning for acute pneumomediastinum. Pneumomediastinum is defined as the presence of gas in the mediastinum and can be categorized as either spontaneous or secondary. (1) Secondary pneumomediastinum can be further delineated into iatrogenic and non-iatrogenic causes. Iatrogenic causes include: chest/abdomen instrumentation, thoracic vascular access, airway procedures or any other inadvertently induced insult to the thoracic or abdominal cavity. Non-iatrogenic causes can be subsequently divided in traumatic and non-traumatic. Traumatic causes include blunt or penetrating trauma, where as non-traumatic causes encompass lung disease such as bronchiectasis, asthma, Chronic obstructive pulmonary disease (COPD) and interstitial lung disease, as well non-lung diseases including; physical activity, child birth, and toxic inhalations.

Given the recent tracheostomy, the clinical care team had prudent concern for pneumomediastinum and followed this concern with a history and physical exam looking for worrisome signs and symptoms. Typical signs and symptoms include: severe central chest pain (occurring in 60-100% of patients), dyspnea (75%), coughing spells (80%), neck pain (36%), and subcutaneous emphysema classically within the neck, anterior chest and face (70%). (1) The patient in this vignette was found to have no sign or symptoms consistent with pneumomediastinum. In the absence of signs and symptoms consistent with pneumomediastinum, providers must maintain a high index of suspicion and pursue diagnostic tests as deemed necessary to further validate their concern. A plain chest film can identify nearly 90% of cases with chest computed tomography scan being the definite imagining modality. (1) Once the diagnosis has been confirmed and in the absence of a pathologic cause, management is usually conservative as pneumomediastinum is generally considered a benign self-limiting process with air ultimately being resorbed into mediastinal tissue. However, if an esophageal or pulmonary trauma has been overlooked, a seemingly benign pneumomediastinum can develop into a life threatening entity. Complications can lead to tamponade and airway compression potentially requiring video-assisted thoracoscopic surgery (VATS) or thoracotomy for decompression management. (2) Other rare occurrences include: dissection of air into the retropharyngeal and retroperitoneal space or spinal canal (pneumorrhachis) resulting in respiratory compromise. The vast majority of cases however are uncomplicated, resolving with only supportive care and pain management once a pathologic primary etiology has been excluded. The prognosis for pneumomediastinum is generally excellent, although recurrence can occur, therefore follow-up with a health care provider upon discharge is typically indicated.

Discussion and conclusions

As identified in our vignette, an overnight coverage Tele-ICU or remote management critical care medicine system was involved in the management of this patient. Currently there is a national paucity of intensive care trained physicians staffing ICU's nationwide. (3) To fill this scarcity, a model of Tele-ICU care has been employed with the goal of leveraging limited physician resources. Telemedicine is defined as "the use of medical information exchanged from one site to another via electronic communications to improve patients' health status". (3) Tele-ICU has been utilized for several decades, however only recently has there been more extensive exploration into outcome data.

More recent literature has sought to clearly identify and describe outcomes by delimitation into three categories: 1) provider centered outcomes, 2) system centered outcomes, and 3) patient centered outcomes. Provider centered outcomes include factors such as burnout rate, resident education satisfaction, and staff acceptance. (3) System centered outcomes include the financial aspects of Tele-ICU care such as cost effectiveness and reimbursement. Perhaps one of the most important aspects of Tele-ICU intervention encompasses patient centered outcomes which includes: length of hospital stay, mortality, safe practices and error reduction, and time to intervention. Of the three outcome categorizes identified above, several major take home

points can be surmised. Regarding provider centered outcomes, it appears that both hospital-based physician and nursing staff are accepting of Tele-ICU care, with an unknown effect on physician satisfaction and/or burnout. Concerning system centered outcome, it can be definitively concluded that implementation of Tele-ICU incurs a significant financial commitment, however it appears that there is indeed cost-savings, especially when utilized in more complicated, critically ill patients. Finally, perhaps the most germane category is patient centered outcomes which has unfortunately provided less definitive answers. It has been identified that Tele-ICU enhances compliance with best care practices and care bundles, however variability of impact remains in both hospital length of stay as well as mortality, with currently no major studies demonstrating the ratio of preventative or treatable instability or complications. Earlier literature indirectly identified potential avoidance of patient harm. One such study was the 2014 multicenter retrospective work published in the Journal of Critical Care, which sought to identify the effect of Tele-ICU directed daily ventilator rounds on improving adherence to lung-protective ventilation (LPV), reducing ventilator duration ratio (VDR), and ICU mortality ratios. (4) The authors concluded that Tele-ICU involvement was associated with improved and durable adherence to LPV and significant reductions in both VDR and ICU mortality. From more recent data, it seems clear that Tele-ICU can positively influence provider, system and patient centered outcomes. However, as with most of newer more novel aspects of medical care, further studies are indicated to determine the most efficacious employment of this resource.

Certainly, as demonstrated in our vignette, remote patient care should never replace or supersede direct patient care and bedside physical exam. In the end, our case was cracked by sound fundamental physical exam skills and bedside awareness, both crucial aspects of providing excellent comprehensive care to critically ill patients.

Figure 1. Initial chest radiography concerning for subcutaneous air in the soft tissue surrounding the neck and upper thorax

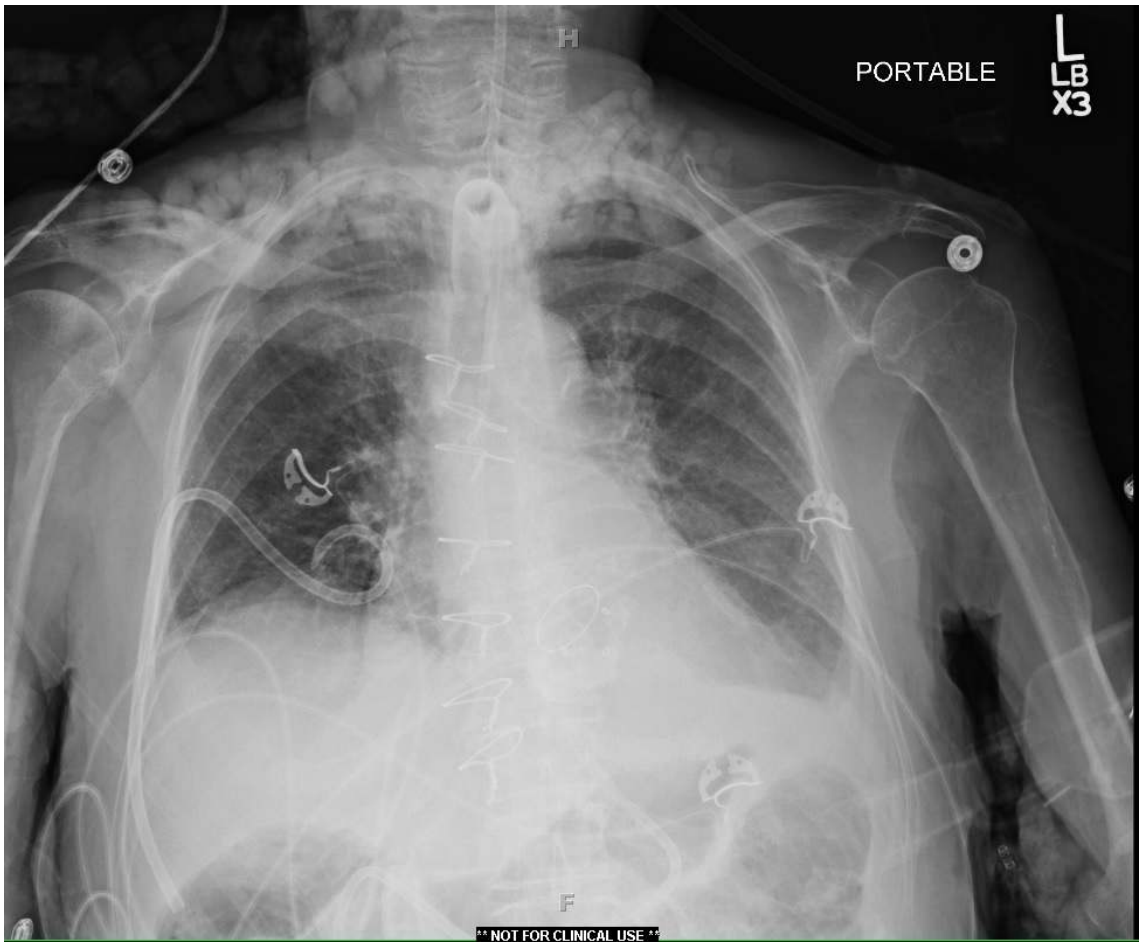


Figure 2. Repeat chest radiography immediately after removed of ice packs demonstrated resolution of presumed free air

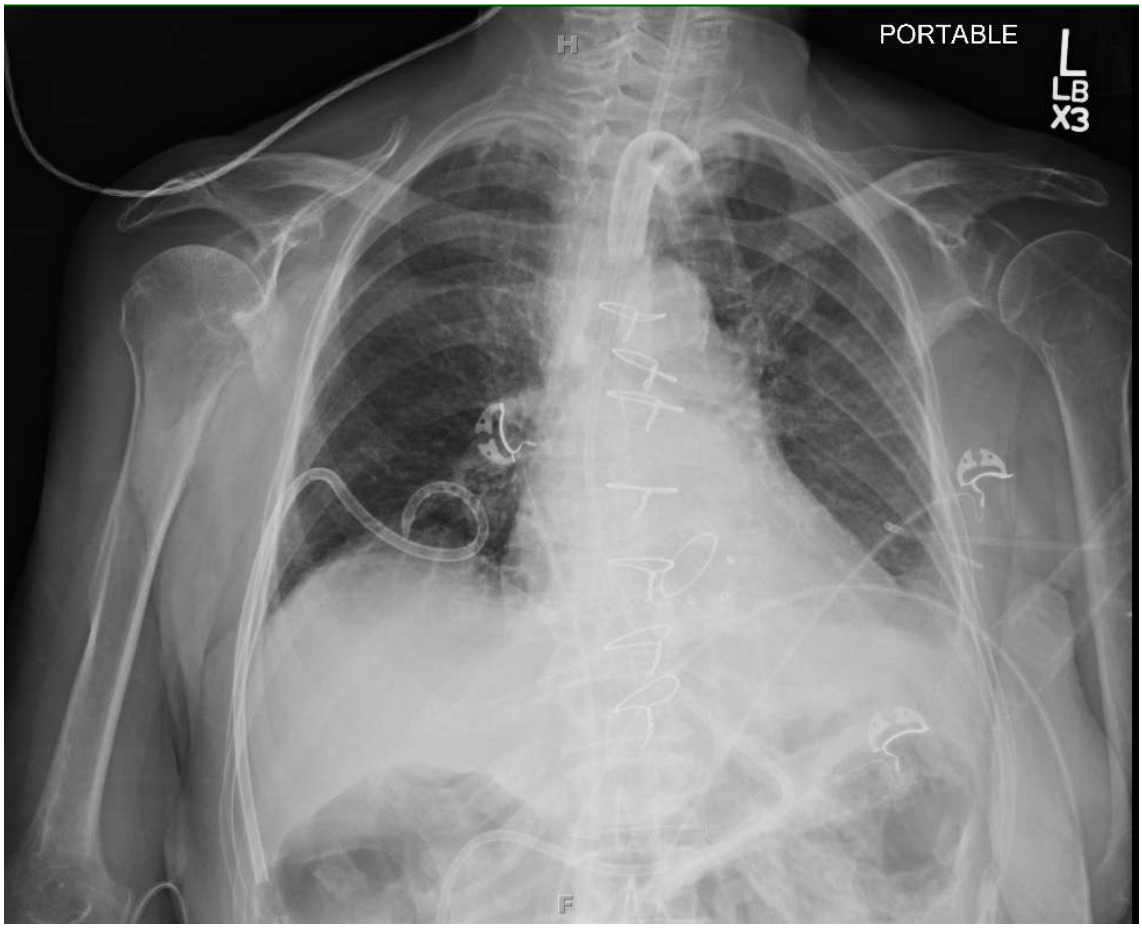
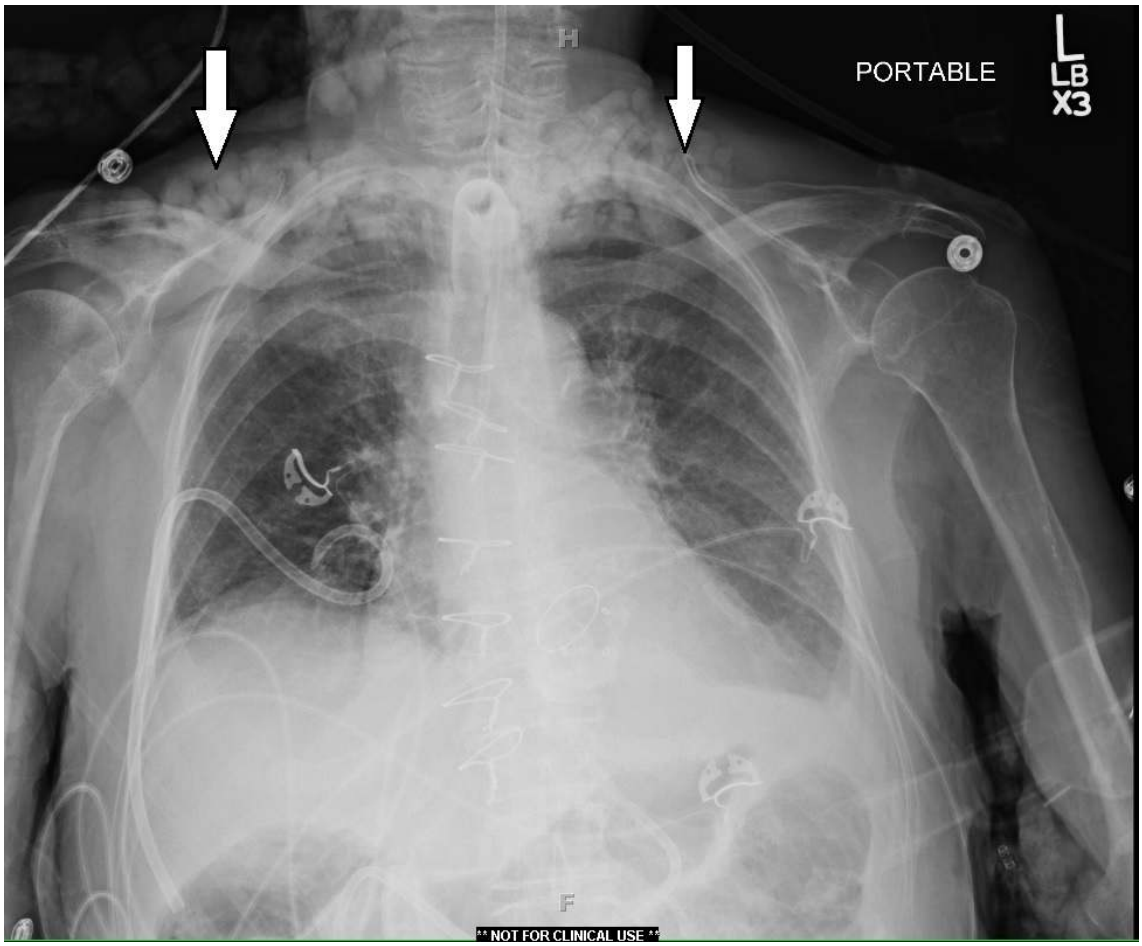


Figure 3. Arrows identifying the extensive locations of the appearance of subcutaneous air in the soft tissue of the neck and upper thorax



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