Editorial

Does daily chest ultrasound in the postoperative period contribute to an enhanced recovery after surgery pathway for patients undergoing general thoracic surgery?

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Thoracic surgery is one of the most common surgical procedures around the world due to the conspicuous prevalence of pulmonary disorders, especially lung cancer (1). This surgery brings with it certain benefits and risks. Although the related surgical technologies are constantly developing, postoperative complications are still inevitable. In thoracic surgery, some of the most common complications are pneumothorax (PTX), pleural effusion (PE), lung consolidation (LC), diaphragm abnormality, subcutaneous emphysema, and lung torsion—all which can often lead to unnecessary increases in length of stay, hospital costs or mortality (2).

Enhanced recovery after surgery (ERAS) is an evidence-based paradigm shift in perioperative care, which has been effective in lowering postoperative complication rates and recovery time. ERAS is a protocol that relies on a well-trained and experienced multidisciplinary team, who are capable of using multi-modes, integrated and comprehensive methods, and a series of evidence-based medical measures to relieve psychological and physical trauma stress in patients, thereby reducing the complications, shortening the hospitalization time, and decreasing the risk of readmission and mortality, and lowering the associated costs. The key measures of ERAS are preoperative, intraoperative and postoperative management which can include preoperative education, water fasting, prophylactic use of antibiotics and antithrombotics, optimization of anesthesia, postoperative pain care, complications care, tube and incision care, nutritional support, mobilization care and so on (3). Thus, complication management is closely related to ERAS.

Detecting and managing complications after thoracic surgery in a timely manner is important for decision-making and health outcomes, which in turn may contribute to ERAS. Judging complications by clinical signs is not enough, thus imaging modalities which provide the necessary information have a critical role in the postoperative follow-up and diagnosis of the complications that may occur after surgery.

Postoperative follow-up chest X-ray (CXR) or computed tomography (CT) are conventional methods for identifying complications. Even though CT remains the gold standard for the diagnosis of complications such as PTX, PE, LC, etc., this approach is costly and requires optimal patient positioning and transportation when compared with a portable CXR. On the other hand, portable CXR is insufficient for the evaluation of apical and small-sized PTX due to poor sensitivity to PTX when patients are placed

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in a supine position and may miss consolidation because of suboptimal films in difficult positions (4,5). In addition, routine CXR may increase the risk of radiation injuries and radiation-related illnesses. Considering the radiation and diagnostic deficiency of CXR, physicians are still uncertain whether it should be used as a routine postoperative monitoring method for ERAS.

Chest ultrasound (CU), which was proposed for the first time by Ziskin *et al.* in 1982 (6) is currently used to diagnose several pathological conditions, provide qualitative and quantitative information, and to guide clinical decisions. CU has been currently applied in emergency departments, neonatology, and intensive care units (ICU) by emergency medicine physicians, pediatricians, pulmonologists and thoracic surgeons respectively (7). Unlike CXR, CU does not require optimal patient positioning and therefore does not cause discomfort. Compared to CT, CU is easily transportable which can shorten the hospitalization time. These characteristics are exactly what postoperative patients need for recovery.

So far, CU has been implemented to assess pleural diseases (i.e., PTX, PE, and pleural masses), parenchymal diseases (i.e., atelectasis, pneumonia, neoplasms, and infarct), chest wall abnormalities (i.e., chest wall tumor), and the diaphragm (i.e., function and mass) (8-10). Some scanning protocols are made and used in-patient management, like the Blue, FALLS and C.A.U.S.E. protocols, to improve diagnostic accuracy. Nevertheless, it remains unclear whether postoperative CU is effective and sufficiently exhaustive for complications evaluation compared to CXR. Chiappetta and colleagues have recently found that the CU allowed further discrimination of lung abnormalities, and could discriminate between atelectasis, infections and hematoma, concluding that CU can be useful in post-thoracic surgery management and decrease any unnecessary X-ray exposure through this improved diagnostic accuracy (11).

A number of studies have shown that postoperative CU has high accuracy in detecting PTX based on three criteria (12-15): disappearance of pleural sliding, the presence of B lines, and lung point to rule out PTX. Sonography is thought to outperform radiography in detecting small-localized PTX (16). In the ICU and trauma setting, ultrasound is clearly superior to CXR for the diagnosis of PTX due to greater sensitivity and specificity (17-20). Yet, the accuracy of ultrasound for spontaneous PTX remains unclear and requires further investigation (4). Chiappetta *et al.* have proven that the limit of postoperative CU for the diagnosis of PTX is the presence of massive subcutaneous emphysema or the absence of lung point (11). Furthermore, Hew *et al.* have recommended that conventional CXR or CT can be applied to diagnose spontaneous PTX until more evidence is accrued in this area (4).

With reference to PE diagnosis, systematic reviews have shown that CU is more sensitive than CXR (21,22). Furthermore, CU can characterize PE. Lesser *et al.* and Yang *et al.* have reported that ultrasound may distinguish simple PE from complicated PE by the presence or absence of septum, and differentiate transudates and exudates through observing the internal echogenicity (23,24). Ultrasound can quantify PE, but measurements and formulae are only valid for free-flowing effusions (25).

LC is the increase in lung density. Important CU performances of consolidation are the absence of the pleural line; small, peripheral or large areas of the same density as liver tissue; air-bronchograms; and hypoechoic vascular structures. Many possible etiologies include infectious pneumonia, acute respiratory distress syndrome, pulmonary infarction, or other similar causes, and may lead to the same LC. Nonetheless, CU may be able to distinguish the possible cause to make a clinical diagnosis when some additional ultrasound features and clinical data are integrated (4,26,27). Furthermore, some studies have found that diaphragm function can be evaluated through measuring excursion and thickness of diaphragm by ultrasound (28,29).

In addition, it has been proven that postoperative CU can be easily and rapidly performed at the bedside to assist clinical decisions, especially for interventional procedures. Lavingia *et al.* have asserted that sonography is able to successfully predict the safe tube thoracostomy removal and to reduce the patient exposure to radiation and costs during hospitalization (2). On the basis of a decision-tree analysis, ultrasound-guided pleural puncture is economical and effective, mainly due to the reduction of PTX rates (30,31). Given the evidence derived from patient outcomes, it seems likely that CU can play a potential role in the precise prediction of PE requiring pleural drainage, and can also contribute to the earlier diagnosis of PE occurrence (32).

Although many studies have confirmed that CU has many advantages including its speed, real-time functionality, low-cost, lack of radiation, sensibility, specificity and bedside patient-performance, it is still necessary to point out that CU is inadequate in PTX with the presence of massive subcutaneous emphysema, spontaneous PTX, and mediastinum evaluation.

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Even though this may rend CU results somewhat controversial, previous studies have shown that good consistency and repetition can be achieved through standardized ultrasound training (33). Moreover, in this era of optimal resource use, CU can be used to rapidly evaluate complications, and thereby contribute to reduced costs.

In conclusion, postoperative CU implementation may rapidly detect complications, shorten hospital stay, decrease cost and reduce ionizing radiation, thus ultimately aiding in ERAS.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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