Assessing Competence in Chest Tube Insertion with the ACTION-tool: a Delphi study

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Abstract

Intro: Chest Tube Insertion (CTI) should be trained in simulated settings prior to patient contact. Feedback and certification is based on valid assessments, especially in simulation-based training. This study aimed to develop a novel assessment tool for CTI and to ensure content validity based on expert opinion collected through a structured Delphi study.

Methods: A diverse European expert panel was invited to participate. In round 1, the experts provided at least five procedural steps and three errors involved in CTI. Round 2 evaluated the level of agreement with the inclusion of each item in the assessment tool on a five-point Likert scale. In round 3, experts rated their agreement on inclusion of the procedural step with its descriptive anchors. Consensus was reached when ≥80% of participants agreed on an item's inclusion.

Results: Thirty-six of 105 (34%) invited surgeons (26/75, 35%), pulmonologists (8/23, 35%) and emergency physicians (2/7, 29%) participated. The overall response rate was 81% (29/36): 100% (36/36) in round 1, 83% (30/36) in round 2, and 97% (29/30) in round 3. Round 1 resulted in 23 steps and 44 errors after condensation and removal of duplicates. In round 2 consensus was achieved for 15 steps (65%) and 14 errors (32%). Nineteen steps were adapted into a rating scale with descriptive anchors and a list of 16 errors was presented to the panel. In round 3, experts reached consensus on the inclusion of 17 procedural steps (89%) with descriptive anchors and on all 16 errors.

Conclusion: A multidisciplinary expert panel achieved consensus in the development of the ACTION (Assessment of Competence in Chest Tube Insertion) tool. This procedure-specific rating scale of 17 steps, supplemented with a checklist of 16 errors, requires further research to collect validity evidence.

Introduction

Chest tube insertion (CTI) is a commonly performed procedure in surgical and emergency care, mainly to treat pneumo- and haemothorax [1,2]. Despite its importance and its frequent execution, blunt dissection CTI still carries a high risk for complications [3]. Most of these complications can be linked to a lack of relevant anatomical knowledge, or the use of unsafe practices [4–6]. Consequently, CTI has been identified as one of the thoracic procedures that should be integrated in a simulation-based curriculum [7].

Modern medical education utilizes an updated curricular model, where the Halsted method 'see one, do one, teach one' is replaced by the 'see one, simulate several deliberately, do one, simulate several, do one,…' model [8]. Here, learners can train and perform procedures in a safe environment, where procedural errors can be observed and corrected, until a predefined level of skill is obtained [9]. Only then can learners progress to the next level in their education. This is supported by the Cognitive Load Theory (CLT), which recommends the use of basic instructions and scenarios for novice learners, prior to progression to more complex scenarios [10]. Likewise, in the skill acquisition model, as proposed by Fitts and Posner, novice learners first pass through a cognitive phase where they acquire the knowledge associated with the procedure. Only later do they progress to higher phases where they are able to learn strategies to counter unexpected findings [11]. These proficiency-based curricula increase clinical skill and have a positive impact on patient care [12]. They, however, need valid assessment tools to evaluate trainees' skills in order to provide specific feedback and to make decisions on remediation or certification [13,14].

Validity refers to the steps taken to ensure assessment tools are objective and reliable in their results [14]. Although several assessment tools for CTI have been developed[15–19], few have had their validity evaluated by using contemporary frameworks [20]. The American Educational Research Association (AERA) advocates the use of Messick's framework, where validity evidence for an assessment in each of its intended uses is collected from five sources: content, response process, internal structure, relation to other variables, and consequences [21].

Content evidence, the first source, evaluates if the construct the assessment tool intends to measure is reflected in the assessment itself [14]. In other words, it evaluates how the assessment tool was developed, and how decisions were made on what items to be included in the assessment tool.

The aim of this study was to develop an evidence-based assessment tool to evaluate residents' technical skills in CTI through a multinational and multidisciplinary Delphi consensus study; the Assessment of Competence in Chest Tube Insertion (ACTION) tool.

Methods

This research was approved by the Ethics Committee of Ghent University Hospital (BC-09710). This study was reported in line with the SQUIRE guidelines [22].

The Delphi method

A Delphi methodology was employed to achieve expert consensus on the included items in a novel CTI assessment tool. This method is based on the idea that 'pooled intelligence' will provide an answer closer to the 'truth', or at least pools the opinion of experts [23,24]. The Delphi process has been used to guide decision making regarding curriculum content, and to develop several assessment tools [7,24–29]. Panelists are characterized as being 'informed individuals' or experts in their field.

The process acts as a multi-stage repetition of surveys that are presented to the panel in consecutive rounds. Some Delphi studies have a first round in which panelist are asked to provide initial statements, others build on preparation of the researchers [30]. In each following round, panelists are asked to provide their opinions on these statements. Responses are collected anonymously, and each opinion has the same weight. Following completion of a round, responses are analyzed by the research team and presented in the next round [30,31]. Each round offers information regarding the panel's opinions, thus promoting critical thinking. The anonymous nature of the survey also ensures participants have equal possibilities to give or change their opinions [32]. The process ends when a predefined level of consensus is reached.

Expert panel recruitment

A heterogeneous sample of surgeons, pulmonologists, and emergency medicine physicians was identified through purposive sampling by three authors (L.D., L.K., and W.W.) and invited. Experts were required to have five years post-residency experience and have performed a minimum of 50 CTIs. To counter expert dropout, sampling was large, aiming to have at least 5-10 experts per discipline, which has been suggested as a minimum when working with heterogeneous populations [30]. All experts provided written consent prior to participation.

Delphi process

The Delphi process was carried out using Research Electronic Data Capture (REDCap) hosted at Ghent University Hospital. REDCap is a secure, web-based software platform designed to support data capture for research studies [33]. An invitation email with a unique survey link was sent to experts' professional email addresses. They had six weeks to complete each round and reminders were sent to non-responders every two weeks. Those who did not respond during this period were excluded but their data from previous rounds were used in the analysis.

A steering group constructed the surveys and reviewed all responses. This steering group includes a PhD student (L.D.M.), one emergency physician (P.V.d.V.), one thoracic surgeon (L.K), two thoracic and vascular surgeons (L.D., I.V.H.), and a gastro-intestinal surgeon (W.W.). All members, excluding L.D.M., had experience with resident education in their respective fields and Delphi studies. The steering group and the panel were blinded to the identity of panel members.

Panel consensus was a priori defined as at least 80% of participants scoring 4 or 5 on an item. Items that did not reach consensus were removed but were still presented for review in the following round.

The flow of the Delphi process is illustrated in Figure 1.

<u>Round 1</u>

Demographic information of experts was collected. Only those who met the inclusion criteria had access to the first round. Next, participants were informed about the aim and setup of the study. They were

asked to provide at least five procedural steps involved in blunt dissection CTI, and at least three errors that may occur during the procedure. The number of entries was not limited.

A standardized patient scenario guided the participants: a 20-year old patient with no relevant clinical history was admitted with a spontaneous pneumothorax and required a blunt dissection CTI. The patient was awake, had stable clinical parameters, and had not been in contact with the physician. There was no ultrasound machine available, but a surgical nurse was present.

The steering group reviewed all entries and deleted duplicates. Remaining items were grouped based on their procedural phase; items with similar or nearly similar content were merged.

Round 2

The list of procedural steps and errors, including the number and percentage of experts who suggested each item, had to be rated on its inclusion in the assessment tool, using a five-point Likert scale ranging from 'strongly disagree (1)' over 'neutral (3)' to 'strongly agree (5)'.

All panel members were encouraged to comment on an item if they did not agree with its content or wording, or if they wanted to merge items. They were also invited to suggest new items.

The steering group processed all responses and the steps that reached consensus were adapted into a rating scale with descriptive anchors at scores 1, 3, and 5. To promote critical thinking of the panel, the steps that received a score of 4 or 5 from at least 50% of the panel were also adapted into a rating scale. Errors that reached consensus but were nominated for merging, or those that received comments to change the wording, were updated and passed on to the third round.

Round 3

The panel members were asked if they agreed upon inclusion of each step with its descriptive anchors as it was presented in the CTI assessment tool, using the same five-point Likert scale as in round 2. They were encouraged to comment on each item, especially if they thought the anchors needed to be altered. The list of errors was presented to the panel for a final review.

Statistical analysis

All analysis was performed with R statistics version 4.0.3 (R Foundation, Vienna, Austria), and Excel version 2112 (Microsoft, Redmond, WA, USA). Descriptive data analysis was performed to obtain median, mean, and standard deviation for each item in the individual rounds. The frequency of scores was also calculated as a percentage score, in order to evaluate consensus on each item.

Results

Expert panel

A total of seven emergency physicians, 23 pulmonologists, and 75 surgeons (n=105) were invited, of whom 36 (34%) responded and met the inclusion criteria. Participants included surgeons (n=26), pulmonologists (n=8), and emergency medicine specialists (n=2). Experts were active in five European countries; Belgium (n=20), United Kingdom (n=7), the Netherlands (n=5), Denmark (n=3), and France (n=1). Participant demographics are summarized in Table 1.

Delphi results

The study was performed between March 30th and September 28st 2021. The overall response rate was 81% (29/36): 100% (36/36) for the first round, 83% (30/36) for the second round and 97% (29/30) for the third round. Table 2 illustrates the response rates per round and specialty.

Round 1

The first round took place between March 30th and May 11th 2021. The experts proposed a total of 344 steps and 174 errors, which were condensed by the steering group into a chronologically ordered list of 23 procedural steps and 44 errors.

Round 2

The second round took place between June 1st and July 13th 2021. Consensus was achieved for 15 of 23 steps (65%). Based on the panel's input, 'skin closure', which received 70% agreement was merged with 'tube fixation' (97% agreement) into one step. At least half of the panel (strongly) agreed on including four additional steps ('ensuring patient monitoring', 'administration of analgesia', 'finger sweep', and 'clamping of tube'). The steering group adapted these 19 steps into a rating scale with

descriptive anchors which was evaluated during the third round. Additionally, a symbol (i.e. *) indicated in the assessment tool that these steps may be performed in a different order. Consensus was achieved for 14 of 44 errors (32%). Additionally, seven errors (16%) with ≥50% agreement, received feedback concerning their definitions. This resulted in 21 errors, of which the steering group, based on the panel's input, combined nine errors into four errors (Table 3). The definitions of two other errors were also altered. This resulted in a final list of 16 errors. No extra items were suggested by the panel.

Round 3

The third round took place between August 17th and September 28th 2021. Nineteen steps with descriptive anchors were presented to the panel, of which 17 (89%) achieved consensus and were included in the final CTI assessment tool. Experts provided no comments on the wording of the descriptive anchors. All 16 errors reached consensus and were included in the assessment tool.

Assessment tool

The three-round Delphi process resulted in a novel assessment tool for CTI: the ACTION tool (Table 4). It has a procedure-specific rating scale with 17 procedural steps, and an error checklist with 16 errors. Procedural steps are ordered chronologically but leave room for learner-specific preferences. Errors are broadly defined and may be observed during different stages in the procedure.

Discussion

An assessment tool for blunt dissection CTI has been developed through an international and multidisciplinary Delphi consensus study. Experts suggested, reviewed, and approved procedural steps and errors for inclusion.

The assessment of technical skills remains an important aspect in traditional and simulation-based training of junior physicians. Simulation-based mastery learning builds on formative feedback that is based on valid assessments, as it will stimulate learners to reach predefined performance standards [13]. The aim was to develop a useful assessment tool for simulated environments and in real practice. As

such, additional validity evidence for the assessment tool will need to be collected for direct and indirect (i.e. based on video-recordings) observation of performances. This validity evidence will evaluate if differences between various levels of expertise are measurable and will establish a pass/fail score. This will allow trainees to train deliberately until they reach the predefined goal as evaluated by valid assessments, a prerequisite for mastery learning [9,13,21].

To our knowledge, this is the only rating scale for blunt dissection CTI that has been developed solely on the input of an expert panel [15–19]. Some of the existing assessment tools for CTI are constructed as checklists [15,18,19]. Others use arbitrary weighing of items [16,17]. In cases where a Delphi methodology was used to develop the assessment tool, the steering group performed a literature search prior to the study, thus limiting the initial input of the expert panel [17].

The Delphi method is well established to help experts achieve a consensus [24]. Several assessment tools for various procedures have been developed with this technique, and validity evidence has been established [25–27,34–36]. The electronic Delphi survey has some major advantages; panel anonymity ensures that participants can provide honest opinions without feeling pressured or vulnerable, and the electronic interface facilitates data collection and analysis. We started the process by asking open-ended questions in round 1, avoiding influence in the initial responses [24].

Note that we chose to develop the assessment tool as a rating scale rather than a checklist. Rating scales may be more suitable to capture nuances in expertise. Checklists only mention the observation of an action rather than assessing the quality of the performance [37,38]. Furthermore, high scores on checklists do not rule out incompetence. For seven bedside procedures, global rating scales demonstrated a higher internal reliability than checklists [39,40]. Lastly, experienced physicians might score lower on checklists than on rating scales, which is a high threat to validity [13,41].

The inclusion of an error checklist in the ACTION tool is unique. There are several reasons for this implementation. Errors may be more easily observed and quantified than procedural steps, where rater bias may play a role. There is also evidence that error checklists may be more sensitive in discriminating different experience levels than rating scales or checklists for procedural steps [42]. Finally, errors are

a major source of concern in medical education; preventable harm occurs frequently in high tech health care settings, but seems to be more frequent in surgical environments [43,44].

Error training may play an important role in resident education. Residents are sometimes not aware that an error was made, nor did they adjust their behavior after its occurrence [45]. The detection of errors and error recovery are thus essential parts of the educational process in simulated procedural training, and can be seen as an 'error encouragement training' [45,46]. Residents have the possibility to train CTI in a simulated safe environment. By pointing out the committed errors to residents and engaging them in a conversation to decide on the best error recovery methods, they are encouraged to improve their performance in the following training sessions. The feedback provided in this manner, is a combination of 'how to do it' and 'how to avoid it', thus establishing a firm basis for formative assessment [47,48]. As our aim was to develop an assessment tool useful in simulated circumstances, the observation and discussion of procedural errors is a valuable addition in the assessment of performances.

Certainly, some errors in the ACTION tool are difficult to observe in simulated environments; items like 'damages the intercostal nerve' may even be difficult to observe in real-life performance. These items reflect the need for accurate patient follow-up.

Interestingly, the expert panel included several non-technical procedural steps such as 'patient identification' and 'informed consent', which may be explained by a more demanding patient population that is increasingly critical about the quality of care they receive [49,50]. These type of non-technical skills are also reflected in assessment tools measuring teamwork (e.g. Non-Technical Skills for Surgeons or Observational Teamwork Assessment for Surgery), which include skills such as 'Situational awareness' and 'Collaboration' [51]. Furthermore, 'ensuring patient monitoring' and 'administration of analgesia' do not reflect CTI-specific technical skills but are generic and focus on the patient's comfort and safety. These observations were to be expected since non-technical skills have been included in other assessment tools [28,52,53].

Surprisingly, our panel did not include the finger sweep in the ACTION tool, as only 55% of the panel scored it ≥4 in round 3. This step, whereby a finger is inserted in the pleural cavity to verify pleural

adhesions prior to tube insertion, has been advocated by the Advanced Trauma Life Support (ATLS) program, and in recent guidelines[1,54,55]. Some participants stated that an ultrasound should be performed to identify adhesions before the procedure. Others were hesitant to perform finger sweep in a relatively small incision or may have thought that it would be challenging to observe a difference in this specific skill, which is the aim of an assessment tool. Indeed, making a 360° finger sweep may be easy to master but how the information gained from this action is being used, may vary. While this step is not included in the rating scale, some errors reflect the purpose of the finger sweep, e.g. 'Injures the lung parenchyma due to blind introduction of the tube', 'Omits intrathoracic palpation to make sure no adhesions are present', and 'Places the tube extra-thoracic (including subcutaneous - chest wall - abdominal)'. This does reflect the fact that physicians must be aware of the depth and eventual destination of their dissection tract, which is most logically done by a finger sweep. As a result, the authors believe finger sweeps allow to verify the pleural cavity is entered, to check for adhesions, and make sure the dissection tract is sufficiently large[56,57]. Although finger sweeping is not scored in the rating scale of the ACTION tool, the authors recommend to inform novice physicians about its execution.

This study has several limitations. By specifying the diagnosis in our simulated patient as a spontaneous pneumothorax and noting the absence of an ultrasound machine, the responses given by the expert panel may differ compared to other scenarios. For example, several experts mentioned their preference for the Seldinger technique in our scenario. The diagnosis of a spontaneous pneumothorax was chosen to avoid complicating factors in trauma care such as fractured ribs, extensive bleeding and unresponsive patients. This decision was further informed by the Cognitive Load Theory (CLT), which advocates adjusting the complexity of instructions based on the prerequisites of the learner. As a result, basic elective procedures are those that should be initially trained before progression to more difficult tasks and scenarios[10]. Likewise, ultrasound is frequently used in clinical practice, but may not be universally available.

The results of this Delphi process are influenced by the type of participants involved. A large number of participants with various backgrounds was invited but most participating experts were surgeons, since CTI is mostly performed by surgeons. However, the response rates of the three specialties during the

study were similar. A volunteer bias in the participants cannot be completely excluded. Experts who feel strongly about resident education, CTI and its complications, or assessment in general, might have been more interested in participating. Also noteworthy is the time needed to participate in a Delphi process; some individuals might have been interested, but did not have time to join[24]. All these factors may have influenced the disciplinary distribution of the participants, as only a minority of the panel are emergency physicians.

All of our participants were based in Europe, due to our purposeful sampling. Therefore, differences may exist between these results and studies with a different geographical background. However, the blunt dissection CTI is widely known, and most steps included in this assessment tool can be found in international publications about CTI, such as the British Thoracic Society Guidelines, and the ATLS course material[54,55,58].

Finally, the potential influence of the steering group during the Delphi process is also important to consider[23]. This influence was countered by asking two open-ended questions in round 1, by clearly communicating all decisions made by the steering group, and by presenting all deleted and altered items in the following rounds, allowing the expert panel to have control over all decisions. In this study, none of the decisions made by the steering group resulted in negative responses.

Classification of panelists' demographic information was straightforward, albeit without nuance. Some surgeons specified their subspecialty while others did not, resulting in a panel of surgeons, pulmonologists, and emergency physicians, without differentiating between thoracic surgeons, trauma surgeons or other specialties. Thus, the authors believe participants' procedural and supervisory experience may be a more informative source when evaluating the value of this study.

It must be emphasized that the Delphi process does not produce a right or wrong answer but it produces 'valid expert opinion'[24]. The fact that some items are more or less emphasized by our panel, does not interfere with the scientific evidence that advocates other best practices. This is clearly the case in the exclusion of the finger sweep, as discussed above.

In conclusion, this study succeeded in collecting expert opinion to develop a novel assessment tool for CTI. The ACTION tool contains a procedure-specific rating scale, and an error checklist. Additional validity evidence to demonstrate that it is suitable for its intended uses (i.e. collection of validity evidence for each simulated or clinical setting) is needed[14]. This evidence will focus on the response process, internal structure, relation to other variables and consequences of the assessment, all of which are important sources of validity evidence [13,14]. However, the tool holds great promise for the objective evaluation of CTI and structured education of physicians in both clinical and simulated environments.

Acknowledgements

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Figures and tables

Figure 1: Flow of the Delphi process. The asterisk was added as a result of panel input.

Table 1: Participant demographics (n=36).

Type of hospital, n (%)	
Academic	22 (61%)
Non-Academic	14 (39%)
Post-residency experience in years, n (%)	
5-9	13 (36%)
10-14	12 (33%)
15-19	6 (17%)
>20	5 (14%)
CTIs performed in total career, n (%)	
50-100	7 (19%)
100-300	7 (19%)
>300	22 (62%)
CTIs supervised in the last year, n (%)	
<10	9 (25%)
10-24	15 (42%)
24-50	5 (14%)

>50	7 (19%)

Table 2: Response rates per specialty

	Surgeons	Pulmonologists	Emergency physicians	Total
Invited	75	23	7	105
Responses round 1 n (% of invited)	26/75 (35%)	8/23 (35%)	2/7 (29%)	36
Responses round 2 n (% of participating)	22/26 (85%)	6/8 (75%)	2/2 (100%)	30
Responses round 3 n (% of participating)	21/22 (95%)	6/6 (100%)	2/2 (100%)	29

Table 3: Combination of errors between round 2 and round 3.

Error definition round 2	Percentage agreement round 2	Error definition round 3
Site error	90 %	Chooses incision site outside of triangle of safety
Dissection too close to the axilla	50 %	
Damage to the nerve due to dissection	80%	Damages the intercostal nerve by dissecting along the lower edge of the rib
Dissection along the lower edge of the rib	90%	
Extra-thoracic tube placement (subcutaneous – chest wall)	100%	Places the tube extra-thoracic (including subcutaneous - chest wall - abdominal wall)
Extra-thoracic tube placement (abdominal)	97%	
Dissection outside the thoracic cavity	60%	
Tube insertion into visceral thoracic structure	93%	Inserts tube into a mediastinal and/or visceral structure
Tube insertion into visceral abdominal structure	93%	

Table 4: The ACTION tool

Procedural steps						
	1	**2**	**3**	**4**	**5**	**Score**
1* Patient ID	Does not verify patient ID and pre-procedural checklist not done		Verifies patient ID, but carries out an incomplete pre-procedural check		Verifies patient ID and carries out pre-procedural check correctly	
2* Obtaining informed consent	Does not inform or consent the patient		Informs the patient but risks associated with CTI have not been discussed		Obtains informed consent after explaining indication, CTI, and its risks	
3 Ensuring patient monitoring	Does not verify patient monitoring		Requests patient monitoring, but does not verify its correct use		Verifies patient monitoring is in place, e.g. pulse oximeter, ECG, respiratory rate, etc	
4 Administration of analgesia	Does not verify patient's comfort		Informs about the patient's comfort, but does not provide additional analgesia when indicated		Identifies the need for additional analgesia and asks for administration	
5 Patient positioning and determining the insertion site	Incorrect patient positioning – does not identify the safety triangle		Correct positioning but ipsilateral arm not secured - predetermined site deviates slightly from the safety triangle		Correct positioning with elevated ipsilateral arm Identifies and marks the triangle of safety and the 4th or the 5th intercostal space	
6 Sterile prepping and draping	Does not disinfect, or does not wear sterile clothing		Disinfects the field without draping - Wears sterile gloves without sterile gown		Disinfects hands and wears sterile clothing, ensures a thorough disinfection and draping of the surgical field	
7* Equipment preparation	Starts procedure without checking the equipment or orders wrong tube size		Starts procedure while equipment is lacking or does not place a clamp at the tip of the tube		Ensures that all necessary equipment is available, removes the trocar if present, and places a clamp at the tip of the tube	
8* Local anesthesia	Does not provide adequate anesthesia - does not assess the result of the anesthesia		Anaesthetizes the insertion area widely, but does not infiltrate all layers, and does not assess adequate anesthesia		Anaesthetizes the insertion area widely and infiltrates all layers; aspirates content of the thoracic cavity to confirm correct location and	

					assesses adequate anesthesia	
9 Incision	Makes an incision outside of the triangle of safety or not parallel to the ribs		Makes an incision within the boundaries of the triangle of safety, but deviates from the midaxillary line		Makes a smooth incision on the midaxillary line in the triangle of safety, superior and parallel to the 5th or 6th rib	
10 Blunt dissection	Dissects the intercostal tissues inferior to the rib, or not parallel to the rib, or using sharp instruments		Insecure dissection superior to the 5th or 6th rib by spreading forceps, but uses sharp instruments for subcutaneous dissection		Fluent blunt dissection superior to the rib by spreading forceps, avoiding the intercostal neurovascular bundle. And if needed, additional local anesthesia is administered	
11 Pleural perforation	Punctures the pleura without consideration, e.g. using sharp instruments and without bracing the instrument		Punctures the pleura with a blunt dissector while bracing in a minimal manner		Safely punctures the pleura with a blunt dissector while bracing the instrument	
12 Tube insertion	Roughly inserts the tube, without guidance and tube placed in any direction other than cephalad and posterior/head		Gently inserts the tube using the clamp under guidance but does not pay attention to the orientation of the tube		Fluently inserts the tube using the clamp cephalad and posterior/directed to the head; verifies depth of insertion and intrathoracic positioning of drainage holes	
13 Skin closure and tube fixation	Does not secure the tube to the chest wall or does not close the skin		Secures the tube loosely to the chest wall with a suture but suturing is done clumsy, or skin not well closed		Fluently secures the tube to the chest wall with a suture, the skin is closed with approximation	
14 Attachment to drainage system	Does not connect the tube to the drainage system		Awkward connection of the tube to the drainage system, with no additional attachments (e.g. tape)		Attaches the tube to the prepared drainage system and ensures secure connection	
15 Check functionality of drainage system	Does not perform a function check before or after the connection to the drainage system		Asks the surgical team to perform the function check, but does not actively verify its result		Ensures the drainage system is functional. Traditional systems: bubbling of the water seal and oscillation of the water column when the patient is asked to cough. Digital systems: digital functional check is performed.	
16 Dressing	Does not apply a surgical dressing or does not instruct the surgical team to do so		Applies a surgical dressing without concern for patient comfort or tube positioning		Places an airtight sterile dressing around the surgical site, ensuring the patient is comfortable and mobile	

17 Postoperative instructions	Does not request X-ray, does not provide postoperative instructions. Sharp waste products are left in place.		Requests X-ray but does not provide concise postoperative instructions for care		Reassesses the patient, requests X-ray, provides postoperative instructions, verifies removal of sharp instruments and documents the procedure.	

Steps indicated with an * can be performed interchangeable, depending on the preference of the learner.

Errors	Observed?
Performs procedure on the wrong side	
Performs procedure on the wrong patient	
Does not provide oral or intravenous analgesia	
Chooses insertion site outside triangle of safety	
Violates sterility	
Administers local anesthesia in an inadequate manner	
Injures the lung parenchyma due to blind introduction of the tube	
Damages the intercostal nerve due to dissection along the lower edge of the rib	
Omits intrathoracic palpation to make sure no adhesions are present	
Introduces the trocar in the thoracic cavity	
Places the tube extra-thoracic (including subcutaneous - chest wall - abdominal)	
Inserts tube into a mediastinal and/or visceral structure	
Does not insert tube deep enough (holes outside thoracic cavity)	
Does not adequately fix tube to chest wall	
Forgets to unclamp tube	
Does not connect the tube to a drainage system	

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