Annotated Literature on Chest Drainage

Literature about caring for patients with chest drainage with quick summaries of reports

Evidence-based practice requires a review of the literature, reflecting relevant scientific evidence; the clinician's clinical judgement; and patients' values and preferences.

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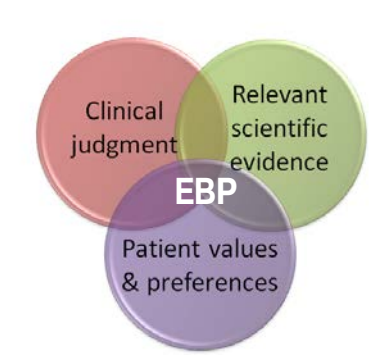
Chest Drain Literature

When caring for patients who have chest tubes and require chest drainage, tradition (the way we've always done it) is being replaced by evidence (published literature in peer-reviewed journals).

While evidence-based practice (EBP) is multifactoral, the literature review is the most challenging for most professional nurses. This document provides an extensive list of articles published in the nursing and medical literature. A short summary of the contents is provided where appropriate to help nurses decide which resources would be most helpful for answering questions, developing policies and procedures, writing lesson plans, or other clinical applications.

Evidence-Based Practice



Evidence-based practice is often focused exclusively on literature reviews. It is important to remember that the clinician's informed experience and the patients' values and preferences play an important role.

For example, research may show that patients do not need a dry sterile dressing over a median sternotomy incision, but if the patient has a tracheostomy and purulent sputum, the clinician's judgement is essential to safeguard the patient.

Nursing Literature

Briggs D: Nursing care and management of patients with intrapleural drains. *Nurs Stand* 2010;24(21):47-55.

Comprehensive, referenced review of care of patients with chest tubes from indications, to tube insertion, types of drains, tube, and drain management, patient assessment, and tube removal.

Charnock Y, Evans D: Nursing management of chest drains: a systematic review. *Aust Crit Care* 2001;14(4):156-160.

Systematic review of the literature relating to chest drain care, specifically: dressings, tube manipulation and positioning, and tube removal.

Crawford D: Care and nursing management of a child with a chest drain. *Nursing Children and Young People* 2011;23(10):27-34.

Comprehensive review of care of children with chest tubes including indications (with a focus on pneumothorax), patient assessment, chest tube insertion, tube, and drain management and removal with special attention to particular needs of children; includes questions with activities to apply content to practice

Danitsch D: Benefits of digital thoracic drainage systems. *Nurs Times* 2012;108(11):16-17.

Descriptive trial of digital drain use in thoracic surgery

Duncan C, R Erickson: Pressures associated with chest tube stripping. *Heart & Lung* 1982;11:166-171.

The classic reference that first identified very high negative pressures with chest tube stripping demonstrated pressures between -145 cmH2O and -370 cmH2O depending on length of tube compressed and -145 cmH2O -408 cmH2O when roller was compared to manual technique; pleural pressures were higher than mediastinal pressures. Study measurements were done on 20 men who had postoperative pleural or mediastinal chest tubes; measurements were taken at the juncture of the chest tube and the drainage tubing; suction to the drain was -20 cmH2O

Duncan CR, RS Erickson, RM Weigel: Effect of chest tube management on drainage after cardiac surgery. *Heart & Lung* 1987;16(1):1-9.

This study compared standard care with venting and sump drainage; all chest tubing was stripped with a roller. Chest drains today automatically vent excess negative pressure in the system. This study did not compare tube manipulation techniques.

Durai R, Hoque H, Davies TW: Managing a chest tube and drainage system. *AORN Journal* 2010;91(2):275-280.

Review of nursing care for patients with chest tubes: tube insertion, managing the chest drain, complications, and tube removal

Fox V, Gould D, Davies N, Owen S: Patients' experiences of having an underwater seal chest drain: a replication study. *J Clin Nurs* 1999;8(6):684-692.

Study of 15 thoracic surgery patients; patients were not well prepared preop and had significant pain directly related to chest tube

Gordon PA, Norton JM, Guerra JM, Perdue ST: Positioning of chest tubes: effects on pressure and drainage. *Am J Crit Care* 1997;6(1):33-38.

Bench test of pressure and drainage through chest drain tubing in various configurations; demonstrates hazards of dependent loops

Gordon PA, Norton JM, Merrell R: Refining chest tube management: analysis of the state of practice. *Dimens Crit Care Nurs* 1995;14(1):6-12.

Compares traditional practices with evidence-based practices relating to suction levels, manipulating chest drain tubing, positioning tubing

Gross SB: Current challenges, concepts, and controversies in chest tube management. *AACN Clin Issues Crit Care Nurs* 1993;4(2):260-275.

This comprehensive, extensively referenced review examines the state of the art of nursing care in 1993, including indications; tube placement; drainage systems; principles relating to chest drainage; controversies including mediastinal bleeding, tube clearance, clamping, tube site care, antibiotics; chest tube removal complications; and autotransfusion

Halm MA: To strip or not to strip? Physiological effects of chest tube manipulation. *Am J Crit Care.* 2007;16(6):609-612.

This clinical evidence review examines the literature relating to drainage tube manipulation and finds no research supporting the practice

Isaacson JJ, Brewer MJ: The effect of chest tube manipulation on mediastinal drainage. *Heart & Lung.* 1986;15:601-605.

Milking compared with stripping showed no difference in drainage in cardiac surgery patients; statistical analysis also showed no difference in drainage between suction pressures of -5 cmH2O and -20 cmH2O

Jeffries M, C Gryglik, D Davies, S Knoll. Chest tube dressings: outcomes of taking petroleum-based dressings out of the equation on air leak and infection rates. National Teaching Institute Pub ahead of print. Boston, MA: American Association of Critical Care Nurses; 2013.

First research done on use of petroleum-based dressings for chest tubes; authors conclude no need for petroleum-based dressings; use dry sterile dressing instead

Kirkwood P: Are chest tubes routinely milked, stripped, or suctioned to maintain patency? *Crit Care Nurse* 2002;22(4):70-72.

"Ask the Expert" recommends against routine tube manipulation

Kol E, Erdogan A, Karsli B, Erbil N: Evaluation of the outcomes of ice application for the control of pain associated with chest tube irritation. *Pain Manag Nurs* 2013;14(1):29-35.

This randomized study compared an intervention of local application of ice to chest tube insertion site to usual care and found reduced pain with ice when coughing and during mobility exercises and less analgesic use in study patients.

Lehwaldt D, Timmins F: Nurses' knowledge of chest drain care: an exploratory descriptive survey. *Nurs Crit Care* 2005;10(4):192-200.

Survey of practicing nurses identified significant gaps in knowledge relating to care of patients with chest tubes and makes recommendations for educational interventions.

Lehwaldt D, Timmins F: The need for nurses to have in service education to provide the best care for clients with chest drains. *J Nurs Manag* 2007;15(2):142-148.

This study, in followup to the previous, checked knowledge deficit, and then examined how nurses gained knowledge as practicing professionals.

Lim-Levy F, Babler SA, De Groot-Kosolcharoen J, Kosolcharoen P, Kroncke GM: Is milking and stripping chest tubes really necessary? *Annals of Thoracic Surgery* 1986;42:77-80.

This classic study is one of the first to compare milking, stripping and no manipulation to CABG patients and determined there was no benefit to tube manipulation and recommended avoiding any dependent loops in the drainage tubing.

Nesbitt JC, Deppen S, Corcoran R, et al: Postoperative ambulation in thoracic surgery patients: standard versus modern ambulation methods. *Nurs Crit Care* 2012;17(3):130-137.

A study comparing two methods of ambulation: the standard practice in which IV pole, oxygen tank, Foley catheter, chest tube and drain were handled by assistive personnel OR use of a device designed to hold the equipment and incorporate a walker if needed. The integrated system was preferred by the patients and the nurses noted it was safer for ambulation compared to traditional methods. A comprehensive review of literature relating to postoperative ambulation is included.

Oldfield MM, El-Masri MM, Fox-Wasylyshyn SM: Examining the association between chest tube-related factors and the risk of developing healthcare-associated infections in the ICU of a community hospital: a retrospective case-control study. *Intensive & Critical Care Nursing* 2009;25(1):38-44.

This retrospective correlational study determined that the risk of any hospital acquired infection increased in patients with chest tubes as chest tube days rose.

Owen S, Gould D: Underwater seal chest drains: the patient's experience. *J Clin Nurs* 1997;6(3):215-225.

This pilot study (upon which Fox [above] relied) found patients were ill prepared for their experience with chest tubes; pain was intense but short-lasting with tube removal.

Pierce JD, Piazza D, Naftel DC: Effects of two chest tube clearance protocols on drainage in patients after myocardial revascularization surgery. *Heart & Lung* 1991;20(2):125- 130.

Randomized trial compared milking (any compression with twisting or squeezing) with stripping (continuous compression with a roller) when a clot was visible in the drainage tubing. 78/200 patients had no clots; tube manipulation did not improve outcomes and is not recommended

Saucier S, Motyka C, Killu K: Ultrasonography versus chest radiography after chest tube removal for the detection of pneumothorax. *AACN Advanced Critical Care* 2010;21(1):34-38.

Prospective observational study compared bedside thoracic ultrasound by APRN with portable chest radiography to detect pneumothorax in cardiothoracic surgery patients immediately after pleural chest tube removal; each method found 3 pneumothoraces with ultrasound results in 4.24 minutes and radiography results in 79.2 minutes at a cost of $200.

Schmelz JO, Johnson D, Norton JM, Andrews M, Gordon PA: Effects of position of chest drainage tube on volume drained and pressure. *Am J Crit Care* 1999;8(5):319-323.

This animal study was designed to expand on Gordon's research and compared tubing positions: straight, coiled, dependent loop, and loop that was lifted and drained in the setting of pleural pressure changes with breathing. Dependent loop had significantly less fluid drainage; dependent loop and lift and drain had significantly higher pressure measured in the lumen at the chest tube / drainage tube connector (- 6 cmH2O) than other positions (-20 cmH2O)

Sullivan B: Nursing management of patients with a chest drain. *Br J Nurs* 2008;17(6):388- 393.

Review of nursing care for patients with chest tubes: types of drains, nursing role, drain position, insertion complications, infection control, monitoring, tube manipulation, suction, pain management, and drain removal

Teplitz L: Update: are milking and stripping chest tubes necessary? *Focus on Critical Care* 1991;18(6):506-511.

This literature review found no research in support of stripping or milking chest tube draining tubing to maintain patency.

Verma P: Impact of self-instructional module for the nurses on nursing management of the patients having chest tube drainage. *The Nursing Journal of India* 2003;94(2):33-34.

A study of 100 randomly-selected nurses staff nurses; after using a self-instruction module, 76% of nurses achieved a "most-satisfactory" score on the knowledge post-test versus 6% on the pre-test. The greatest gain was in knowledge of indications for chest tube removal.

Weber BB, M Speer, D Swartz, S Rupp, W O'Linn, KS Stone: Irritation and stripping effects of adhesive tapes on skin layers of coronary artery bypass graft patients. *Heart & Lung* 1987;16(5):567-572.

This randomized trial compared use of Micropore and Transpore tape for dressings on median sternotomy beginning with the first postop dressing change by assessing irritation and stripping of skin. Irritation with Micropore was significantly lower than Transpore and skin stripping scores were also significantly worse with Transpore with Transpore worsening each POD and Micropore improving.

Wikblad K, B Anderson: A comparison of three wound dressings in patients undergoing heart surgery. *Nursing Research* 1995;44(5):312-316.

Randomized study comparing semiocclusive, occlusive hydrocolloid, and standard absorbent dressings on median sternotomy; wounds were evaluated during 4 weeks postop. Conventional dressing more effective in wound healing, less painful to remove, and more cost effective despite the need for more frequent dressing changes.

Wynne R: Effect of three wound dressings on infection, healing comfort, and cost in patients with sternotomy wounds: a randomized trial. *Chest* 2004;125(1):43-49.

Randomized study comparing dry absorbent dressing, hydrocolloid dressing, and hydroactive dressing applied in the OR at skin closure. No differences in wound healing or rate of infection; dry absorbent was most comfortable and most cost- effective; hydrocolloid increased wound exudate and required more frequent changes due to poor integrity; more discomfort with removal and increased cost.

Wynne R, Botti M, Copley D, Bailey M: The normative distribution of chest tube drainage volume after coronary artery bypass grafting. *Heart & Lung* 2007;36(1):35-42.

Retrospective descriptive study to determine drainage volume after CABG; mean duration of tube was 45.2 hours with total drainage 1300mL with plateau of 31mL/hr at hour 8, suggesting tubes could safely be removed earlier after surgery

Literature Reviews by Author

Carroll P. A guide to mobile chest drains. *RN* 2002;65(5):56-60.

Carroll P. Chest tubes made easy. *RN* 1995;58(12):46-48, 50, 52-45.

Carroll P. Exploring chest drain options. *RN* 2000;63(10):50-54.

Carroll P. Keeping up with mobile chest drains. *RN* 2005;68(10):26-31.

Carroll P. Mobile chest drainage: coming soon to a home near you. *Home Healthcare Nurse* 2002;20(7):434-441.

Carroll P. Pneumothorax in the newborn. *Neonatal Network* 1991;10(2):27-34.

Carroll P. Salvaging blood from the chest. *RN* 1996;59(9):32-38.

Carroll P. What circumstances warrant a chest drain suction pressure greater than -20cmH_2O? *Crit Care Nurse* 2003;23(4):73-74.

Carroll P. What's new in chest tube management. *RN* 1991;54(5):34-38, 40.

Additional Annotated References

Abramov D, M Yeshaaiahu, V Tsodikov, et al.: Timing of chest tube removal after coronary artery bypass surgery. *J Card Surg* 2005;20(2):142-146.

Randomized trial that compared tube removal at 24 hours with tube removal at 48 hours as long as drainage was not >100mL in prior 8 hours; early removal improved outcomes and reduced resource use without increase in effusions

Anand RJ, JF Whelan, P Ferrada, et al.: Thin chest wall is an independent risk factor for the development of pneumothorax after chest tube removal. *Am Surg* 2012;78(4):478- 480.

Retrospective review of trauma patients; CT measurements used to determine chest wall thickness at nipple line. Post-removal pneumothorax was diagnosed with CXR, occurring in 30% of patients. Significant risk factors were younger age, penetrating mechanism of injury, and thin chest wall; logistic regression showed only chest wall thickness as independent risk factor.

Antanavicius G, J Lamb, P Papasavas, P Caushaj: Initial chest tube management after pulmonary resection. *Am Surg* 2005;71(5):416-419.

Retrospective review of lung resection patients comparing those whose chest tubes were at -20 cmH2O with those who were at gravity drainage; all patients had CXR in PACU, 72% had no air leak after surgery; tube removal criteria <200mL/24h, no air leak. Patients with suction were converted to gravity at mean of POD 2.65. Without air leak: chest tube duration suction 4.5d, gravity 3.19d; LOS suction 6.74d, gravity 5.13d Air leak: chest tube duration suction 6.35d, gravity 5d; LOS suction 8.96d, gravity 6.57d; all differences $p<0.05$; there were no complications attributable to difference in chest drain management.

Ball CG, AW Kirkpatrick, DV Feliciano: The occult pneumothorax: what have we learned? *Can J Surg* 2009;52(5):E173-179.

Comprehensive literature review that discusses imaging with CT, radiograph and ultrasound to detect pneumothorax; "occult" is considered not seen on CXR, approx 2-17% in trauma; provides algorithm, and examines the question "do all patients with pneumothorax of any size require a chest tube if they receive mechanical ventilation?" If fewer chest tubes, reduce 22% risk for associated complications

Ball CG, J Lord, KB Laupland, et al.: Chest tube complications: how well are we training our residents? *Can J Surg* 2007;50(6):450-458.

Increased complication rate when residents inserted tubes, but less than half of malpositioning were detected by CXR, requiring CT to detect these

Bertholet JW, JJ Joosten, ME Keemers-Gels, FJ van den Wildenberg, WB Barendregt: Chest tube management following pulmonary lobectomy: change of protocol results in fewer air leaks. *Interact Cardiovasc Thorac Surg* 2011;12(1):28-31.

Compared a new protocol of single postop chest tube; suction -10 cmH2O until pneumothorax <25% or absent, then to gravity drainage; removed when air leak resolved and drainage <400mL/day. When compared with usual care of multiple tubes and suction, there was statistically significant shorter duration of air leak and chest tube and decreased LOS without increase in morbidity or mortality

Brunelli A, M Salati, M Refai, L Di Nunzio, F Xiume, A Sabbatini: Evaluation of a new chest tube removal protocol using digital air leak monitoring after lobectomy: a prospective randomised trial. *Eur J Cardiothorac Surg* 2010;37(1):56-60.

Randomized trial that compared tube removal based on digital measurements of air leak: if zero for at least past 6 hours, CXR -> tube removed OR instantaneous observation for bubbling: if no bubbling, CXR -> tube removed. Digital measurement resulted in fewer chest tube days, LOS, and reduced costs overall.

Brunelli A, A Sabbatini, F Xiume, MA Refai, M Salati, R Marasco: Alternate suction reduces prolonged air leak after pulmonary lobectomy: a randomized comparison versus water seal. *Ann Thorac Surg* 2005;80(3):1052-1055.

Randomized trial that compared gravity drainage OR gravity drainage during the day with suction applied at night in patients with visible air leak the morning after surgery; -10 cmH2O applied until morning after surgery, same level at night in suction group. Night suction group had less prolonged air leak, less chest tube time, and shorter LOS.

Cerfolio RJ, AS Bryant: Results of a prospective algorithm to remove chest tubes after pulmonary resection with high output. *J Thorac Cardiovasc Surg* 2008;135(2):269- 273.

Retrospective study over 10 years with 8,608 procedures discovered chest tubes could be removed with drainage < 450mL/day without risk of recurrent effusion

Coughlin SM, HM Emmerton-Coughlin, R Malthaner: Management of chest tubes after pulmonary resection: a systematic review and meta-analysis. *Can J Surg* 2012;55(4):264-270.

Systematic review and meta-analysis comparing suction with water seal found no difference in duration of air leak, duration of chest tubes, or LOS; suction associated with reduced incidence of pneumothorax, but clinical significance is not known

Day TG, RR Perring, K Gofton: Is manipulation of mediastinal chest drains useful or harmful after cardiac surgery? *Interact Cardiovasc Thorac Surg* 2008;7(5):888-890.

"Best evidence review" examined the literature and only considered Issacson, Lim- Levy and Pierce to meet inclusion criteria; insufficient evidence to support tube manipulation; given risks illustrated by Duncan, tube manipulation is not recommended

Dango S, W Sienel, B Passlick, C Stremmel: Impact of chest tube clearance on postoperative morbidity after thoracotomy: results of a prospective, randomised trial. *Eur J Cardiothorac Surg* 2010;37(1):51-55.

Randomized trial compared milking (1 min Q 2 hr x 48 hr) with observation and all patients had -20 cmH2O. Milking significantly increased drainage, but thought to be resulting from stimulation of pleura, not because tube was more patent; no clots were observed in tubes of any patients; advise against routine tube manipulation

Deng B, Q Tan, Y Zhao, R Wang, Y Jiang: Suction or non-suction to the underwater seal drains following pulmonary operation: meta-analysis of randomised controlled trials. *European Journal of Cardio-Thoracic Surgery* 2010;38:210-215.

This systematic review and meta-analysis examined RCT comparing suction with gravity drainage. Suction reduces postoperative pneumothorax (but not clinically significant), no difference on length of air leak, data favored reduced chest tube time and length of stay in gravity group, but studies not standardized enough for meta- analysis on this point.

Eisenberg RL, KR Khabbaz: Are chest radiographs routinely indicated after chest tube removal following cardiac surgery? *AJR Am J Roentgenol* 2011;197(1):122-124.

Prospective study that examined 400 cardiac surgery patients' CXR after pleural tube removal found residual asymptomatic inconsequential pneumothorax in 9.3% of patients; 2 patients whose pneumothorax required reinsertion of chest tube were symptomatic. No indication for routine films without specific clinical changes.

Galbois A, H Ait-Oufella, JL Baudel, et al.: Pleural ultrasound compared with chest radiographic detection of pneumothorax resolution after drainage. *Chest* 2010;138(3):648-655.

Patients hospitalized with pneumothorax and chest drainage and not on mechanical ventilation had CXR and ultrasound 24 hours after bubbling in the drain ceased, 6 hr after clamping, and 6 hr after tube removal. All residual pneumothorax seen on CXR were also seen on ultrasound; 13 (39%) pneumothorax seen on ultrasound were missed and confirmed with either CT scan or aspirating air through the pleural catheter. Time to obtain ultrasound results was 35 min (mean) for CXR, 71 min.

Gercekoglu H, NB Aydin, B Dagdeviren, et al.: Effect of timing of chest tube removal on development of pericardial effusion following cardiac surgery. *J Card Surg* 2003;18(3):217-224.

Compared tube removal when appearance of drainage turned to serosanguineous with removal when < 50mL x 5hr; no difference in post-removal pericardial effusion; safe to remove tubes when appearance changes because it indicates cessation of active bleeding

Gottgens KW, J Siebenga, EH Belgers, PJ van Huijstee, EC Bollen: Early removal of the chest tube after complete video-assisted thoracoscopic lobectomies. *Eur J Cardiothorac Surg* 2011;39(4):575-578.

Single chest tube after VATS to gravity drainage, removed when drainage < 400mL/24 hr; 59% removed within 24 hr and 83% within 48hr without increase in complications

Goudie E, I Bah, M Khereba, et al.: Prospective trial evaluating sonography after thoracic surgery in postoperative care and decision making. Eur J Cardiothorac Surg 2012;41(5):1025-1030.

Whenever a postoperative CXR was ordered, ultrasound was performed to compare results. Mean CXR to results was 166 min, ultrasound 11 min; compared with CXR, ultrasound had sensitivity of 83% and specificity of 59%; for pneumothorax, sensitivity of 21% and specificity of 95%. May be able to reduce number of CXR, but not replace.

Grodzki T: Prospective algorithm to remove chest tubes after pulmonary resection with high output--is it valid everywhere? *J Thorac Cardiovasc Surg* 2008;136(2):536; author reply 536-537.
Letter in response to Cerfolio 2008

Hessami MA, F Najafi, S Hatami: Volume threshold for chest tube removal: a randomized controlled trial. *Journal of Injury & Violence Research* 2009;1(1):33-36.
Chest trauma patients randomized for tube removal when drainage 150mL/day (standard) or 200mL/day (trial); trial patients had shorter LOS despite no significant difference in tube duration

Irwin JP, O-Yurvati A, Peska D: Rapid ambulation post-thoracotomy with the Atrium Express Mini-500 system. Available online at: http://www.atriummed.com/PDF/RapidAmbulation.pdf

Jiwnani S, M Mehta, G Karimundackal, CS Pramesh: Early removal of chest tubes after lung resection---VATS the reason? *Eur J Cardiothorac Surg* 2012;41(2):464.
Letter in response to Gottgens 2011

Khan T, G Chawla, R Daniel, M Swamy, WR Dimitri: Is routine chest X-ray following mediastinal drain removal after cardiac surgery useful? *Eur J Cardiothorac Surg* 2008;34(3):542- 544.
Nurses removed chest tubes when drainage < 20mL/2hr and no air leak. 98% of CXR showed no pneumothorax; in 2 patients, clinical changes would have required CXR. Routine CXR not indicated after chest tube removal.

Mahmood K, MM Wahidi: Straightening out chest tubes: what size, what type, and when. *Clin Chest Med* 2013;34(1):63-71.
Comprehensive review of the literature and current state of practice regarding thoracic catheters in pleural conditions. Covers tube type; insertion techniques; size and configuration; comparing size for various clinical indications including pneumothorax, pleural effusion, hemothorax, and postoperative treatment.

McCormick JT, MS O'Mara, PK Papasavas, PF Caushaj: The use of routine chest x-ray films after chest tube removal in postoperative cardiac patients. *Annals of Thoracic Surgery* 2002;74:2161-2164.
Patients who had routine CXR after chest tube removal (usual) were compared with those who only had CXR if symptomatic after tube removal. 8/703 routine patients had chest tubes replaced for symptomatic pleural effusion or pneumothorax; 14/297 in the study group had CXR for symptoms; three were completely normal, and 2 required chest tubes. 283 had no symptoms and no CXR.

Moore FO, PW Goslar, R Coimbra, et al.: Blunt traumatic occult pneumothorax: is observation safe?--results of a prospective, AAST multicenter study. *J Trauma* 2011;70(5):1019-1023; discussion 1023-1015.
Observational multicenter study identified 588 occult pneumothorax in blunt trauma patients. 79% were observed; of these, 6% required chest tube for clinical deterioration; most patients in group who died had TBI. Most blunt trauma patients with occult pneumothorax can be carefully monitored without chest tube.

Muffly TM, B Couri, A Edwards, N Kow, AJ Bonham, MF Paraiso: Effect of petroleum gauze packing on the mechanical properties of suture materials. *Journal of Surgical Education* 2012;69(1):37-40.
285 knots of 4 types of suture material were split into two groups; half were exposed to petroleum for 12 hr, the others exposed to saline. Tensile strength was then tested to assess knot failure; knots exposed to petroleum failed at a lower tensile strength, many by untying.

Okamoto J, T Okamoto, Y Fukuyama, C Ushijima, M Yamaguchi, Y Ichinose: The use of a water seal to manage air leaks after a pulmonary lobectomy: a retrospective study. *Annals of Thoracic and Cardiovascular Surgery* 2006;12(4):242-244.

Compared patients with -10 cmH2O suction with those on gravity drainage. Tube removal when no air leak and < 200mL/24 h. No hazards with gravity drainage, but not able to statistically power duration of air leak or chest tube; did note statistically significant increase in fluid drainage in suction patients.

Oveland NP, HM Lossius, K Wemmelund, PJ Stokkeland, L Knudsen, E Sloth: Using thoracic ultrasonography to accurately assess pneumothorax progression during positive pressure ventilation: A comparison with CT scanning. *Chest* 2013;143(2):415-422.

Animal study that compared ultrasound with CT scan in detecting pneumothorax during positive pressure ventilation; 10 different volumes were assessed. Accuracy in detecting pneumothorax was comparable with ultrasound and CT.

Prokakis C, EN Koletsis, E Apostolakis, et al.: Routine suction of intercostal drains is not necessary after lobectomy: a prospective randomized trial. *World J Surg* 2008;32(11):2336-2342.

Randomized trial compared suction -15 to – 20 cmH2O to gravity drainage; there was no statistically significant difference in any measure between the groups, including time of chest tube, persistent air leak, complications, or hospital LOS. Raises the question whether "pneumothorax" on CXR is actually dead space or the result of atelectasis from sputum retention, in which case suction will not resolve the condition. Suction is not necessary after lobectomy, may contribute to maintenance of air leak.

Sanni A, A Critchley, J Dunning: Should chest drains be put on suction or not following pulmonary lobectomy? *Interact Cardiovasc Thorac Surg* 2006;5(3):275-278.

"Best evidence review" examined the literature finding 6 studies that met review criteria; no studies in favor of suction, 2 found no difference, and 4 favored gravity; 5 of the 6 initially used suction for a "short period"

Sepehripour AH, S Farid, R Shah: Is routine chest radiography indicated following chest drain removal after cardiothoracic surgery? *Interact Cardiovasc Thorac Surg* 2012;14(6):834-838.

"Best evidence review" examined the literature finding 6 studies that met review criteria; conclusion is that routine CXR after tube removal offers no diagnostic or therapeutic advantage over those performed when there is a clinical indication with a change in patient assessment; this is the determining factor for replacing tubes in patients with positive findings on routine CXR

Shalli S, D Saeed, K Fukamachi, et al.: Chest tube selection in cardiac and thoracic surgery: a survey of chest tube-related complications and their management. *J Card Surg* 2009;24(5):503-509.

Survey of North American cardiothoracic surgeons and nurses to identify problems with chest tube management; tube clogging was the leading concern; surgeons tend to choose larger tubes to reduce this risk; 74% of surgeons allow stripping, 23% discourage it and 4% forbid it; 28% of nurses' facilities allow stripping, while 72% do not allow; 75% of nurses agreed that managing chest tube clogging took them away from other important tasks.

Tang AT, TJ Velissaris, DF Weeden: An evidence-based approach to drainage of the pleural cavity: evaluation of best practice. *J Eval Clin Pract* 2002;8(3):333-340.

This evidence review was done after earlier research by the author that discovered wide variations in care that were not based on research. Addresses indications; tube insertion; complications; management: avoid dependent loops, clamp only to change

drain or assess tolerance of tube removal, most patients do well with gravity, but suction may be used if lung is not re-expanded; assessment should include volume and nature of fluid drainage, bubbling in water seal relative to respiratory cycle or coughing, radiograph for tube position, and lung expansion, seek specialist if air leak >2d, check for alternative source of air leak, subcutaneous air; remove when air leak zero x24hr, fluid < 200mL and lung expanded

Tawil I, JM Gonda, RD King, JL Marinaro, CS Crandall: Impact of positive pressure ventilation on thoracostomy tube removal. *J Trauma* 2010;68(4):818-821.

Retrospective cohort review of chest tube removal while patients were receiving positive pressure ventilation. 136/234 removals were in ventilated patients; 11% (15) developed recurrent pneumothorax, 6 (4%) required tube reinsertion. In spontaneously breathing patients, pneumothorax recurred in 16/98 (16%) with 3 requiring reinsertion.

van den Boom J, M Battin: Chest radiographs after removal of chest drains in neonates: clinical benefit or common practice? *Archives of Disease in Childhood Fetal and Neonatal Edition* 2007;92(1):F46-48.

Retrospective review of routine CXR findings in infants after chest tube removal; no chest tubes were reinserted in asymptomatic infants regardless of CXR findings, tubes were reinserted in 5 of 12 infants (one with reaccumulation of pleural effusion, 4 for air) with respiratory distress; 7 of 12 had no abnormalities on CXR. Routine CXR is not recommended.

Wallen M, A Morrison, D Gillies, E O'Riordan, C Bridge, F Stoddart: Mediastinal chest drain clearance for cardiac surgery. *Cochrane Database Syst Rev* 2004;CD003042 [pii] 10.1002/14651858.CD003042 [doi](2):CD003042.

Cochrane Review found 3 studies that met criteria but could not be combined in meta-analysis; no data to support tube manipulation (milking or stripping) to prevent cardiac tamponade; no evidence to support or reject tube manipulation

Whitehouse MR, A Patel, JA Morgan: The necessity of routine post-thoracostomy tube chest radiographs in post-operative thoracic surgery patients. *Surgeon* 2009;7(2):79-81.

Prospective study compared patient management in patients who had routine CXR with those who did not, both postoperatively, and post tube removal. Management changed in 3 patients based on postop CXR; intervention in 1 patient post tube removal was based on clinical presentation, not CXR; there were no adverse events in those who did not have routine CXR.

Yarmus L, D Feller-Kopman: Pneumothorax in the critically ill patient. *Chest* 2012;141(4):1098-1105.

Review of the literature and state of the art in assessing for and managing pneumothorax in critically ill patients. CT is the gold standard, but may be impractical; pneumothorax can be missed on portable CXR; ultrasound is emerging as standard of care and can detect >90% of pneumothorax missed by CXR; wide range of “occult” pneumothorax: those missed on CXR and detected on CT.

Younes RN, JL Gross, S Aguiar, FJ Haddad, D Deheinzelin: When to remove a chest tube? A randomized study with subsequent prospective consecutive validation. *J Am Coll Surg* 2002;195(5):658-662.

Randomized study assigned patients with pleural tubes to removal when no air leak and fluid ≤ 100mL/d, ≤ 150mL/d ≤ 200mL/d; drainage time and LOS not significantly different among groups; no significant differences in thoracentesis for reaccumulation of fluid. All patients -20 cmH2O suction.

Notes