Summer 2016

Clinical Update

Research Review 2015 – Part Two

In this issue of Clinical Update, we continue with our review of the literature published on chest drainage in 2015. The previous issue covered trauma, cardiac surgery, lung resection, and pleural effusion. You can read that issue here. In this issue, we will cover chest tube insertion, general chest tube management, and digital drains.

Chest Tube Insertion

A number of authors looked at chest tube insertion in 2015. While the procedure is generally safe in the hands of experienced practitioners, surveys and audits continue to reveal concerns related to lack of experience or knowledge about managing pleural conditions.[1] Physician groups in the UK are carefully examining how physicians are trained; one author notes true procedural competence is not only the technical proficiency but the clinical knowledge to determine when a procedure is and is not indicated.[1] Furthermore, what happens to skills over time? Once training is over, how are skills maintained? Should chest tube insertion be limited to a small group of expert practitioners, perhaps through a pleural consultation service, or should all hospital-based clinicians be required to maintain the competency?

One expert group conducted a survey of 66 internal medicine trainees, asking them to choose the location for safe tube insertion in a man with large symptomatic pneumothorax and mark it on a photograph. Two experts were also asked to mark the "triangle of safety" on the same picture. Forty of the 66 physicians marked a site within the safety triangle; 20/26 of the incorrect sites were too low.[2]

UK researchers identified chest tube placement locations on cadavers with a mean age of 84 years.[3] They compared the British Thoracic Society, Advanced Trauma Life Support and European Trauma Course guidelines for identifying the fifth intercostal space to avoid subdiaphragmatic tube placement. Guidelines were developed because the traditional palpation of the intercostal spaces is challenging in obese or muscular patients and those with trauma. The authors also considered avoiding damage to peripheral nerves of the chest wall. Experienced clinicians marked insertion sites, following guidelines. A senior anatomy professor evaluated anatomical accuracy following dissection of the chest wall.

The sixth intercostal space (ICS) was the one most commonly identified by all methods, with a range of the 3rd to 8th ICS. The 5th ICS or above was marked in only 16/96 attempts (17%) regardless of guideline followed. The trauma guidelines marks completely avoided the long thoracic nerve and 96% of the nerve branches.[3]

The same researchers then designed a study using 31 volunteers in their 20s (62 sides for tube placement) to compare locations following the same guidelines.[4] The original article provides detailed explanations of the different methods. The authors used ultrasound to confirm locations.

The site selected was significantly more likely to overlie the sixth intercostal space or below in women compared with male volunteers, as was noted in the cadaver study. Individual methods that relied on the nipple line also resulted in significantly lower marks in women volunteers. There was no difference between right and left sides of the chest. Of note, the degree of arm abduction changed the relationship of the skin marking to underlying rib margins. Ultrasonography can be used to confirm the site; however, results are affected by body habitus and operator experience.[4]

Kentucky researchers did a retrospective review to evaluate the location of the distal tip of the tube after insertion and whether that location affected tube function in 291 trauma patients who had CT scans after chest tube insertion in the emergency department.[5] The most common placement was in the 6th ICS (36%), with 26% in the 5th ICS; 39% were directed to a posterior location within the chest, and 34% were in a fissure. One tube was placed below the diaphragm, and two within the axillary soft tissue.

The detailed statistical analysis found the tubes "worked" regardless of how the clinician directed the distal end, even if it ended up in a fissure. Like direction, ICS was not associated with the need for secondary interventions (second tube, VATS, thoracotomy, or interventional radiology drainage) unless the tube was too low.

Canadian pediatric emergency specialists developed a day-long procedural training course with "task trainers" that simulated the pediatric chest for practice.[6] Learners were expected to complete Web-based mod-

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In the Literature

Sepsis: What's in a Name?

The current issue of *Critical Care Medicine* offers two must-read editorials about sepsis. The new definition, "*life-threatening organ dysfunction caused by a dysregulated host response to infection*" published in JAMA earlier this year. One author questions the requirement of infection as the trigger; what about pancreatitis, heat shock, ischemia-reperfusion injury and endotoxemia, that result in a similar clinical presentation through the same biologic pathways? He notes the advance in the focus on organ dysfunction and the more generic description of a dysregulated response rather than characterizing the response as pro-inflammatory, for example. His editorial is a valuable analysis of how we come to these definitions and how diagnostic criteria and therapeutic stratification flow from them. The other explores the long-term consequences faced by sepsis survivors who often face residual organ dysfunction that significantly reduces health-related quality of life. This author reminds critical care practitioners that surviving an ICU stay is only part of the equation – that the quality of life that follows is equally critical.

Sources: Marshall JC: Sepsis-3: What is the meaning of a definition? *Critical Care Medicine* 2016;44(8):1459-1460. PubMed Citation

Anderson-Shaw L: Surviving severe sepsis: is that enough? *Critical Care Medicine* 2016;44(8):1603-1604. PubMed Citation

You Can Go Home Again – Just Don't Come Back

Hospitals are now penalized if their readmission rate for Medicare patients does not meet performance standards. Nurse researchers from the University of North Florida analyzed the relationship between unplanned hospital readmissions and the Total Performance Score (TPS) assigned by CMS. In 2016, domains comprising the TPS include the clinical process of care, the patient experience of care, outcomes, and efficiency. The researchers found TPS significantly and inversely related to readmission rates for acute myocardial infarction, heart failure, and pneumonia. This article provides a detailed explanation of methodologies now used to determine hospital payments under Medicare and Medicaid.

Source: Haley DR, et al: Hospital value-based purchasing and 30-day readmissions: are hospital ready? *Nursing Economic$* 2016;34(3):110-116. PubMed Citation

Owls and Larks and the Effect on Shift Work Balance

A fascinating article in the *Journal of Nursing Scholarship* examines how a nurse's chronotype (his or her personal circadian rhythm), the shift schedule, and the nature of work on each shift affect both job-related and general well-being. Researchers looked at three settings: an acute care hospital, a maternity hospital, and an SNF and defined operational characteristics such as occupational hierarchy, autonomy, skill utilization, patient profile, health conditions, nature of common services, intrinsic rewards, and differences in work demand by shift in each of the practice areas. They then surveyed nurses on each shift in each practice area, looking at chronotype, negative affectivity, job satisfaction and general mental health. This research provides important data for nurse managers who want to enhance their staff's adaptability to shift work.

Source: Rodwell, J et al: Managing work across shifts: not all shifts are equal. *Journal of Nursing Scholarship* 2016;48(4):397-405. PubMed Citation

Does Organ Failure Include Skin Failure?

A wound care specialist discusses the concept of skin failure and notes that skin is not included in definitions of multiorgan dysfunction syndrome (MODS) and its sequelae. The few descriptions that do exist are inconsistent, limiting any clinical usefulness or practical application. This author suggests if the skin no longer performs its role maintaining vasomotor tone, body temperature, and water balance; and ceases protecting from infection and mechanical trauma, it can be considered failing. The author urges recognition of skin failure as a common clinical syndrome so that experts can develop common nomenclature and research priorities.

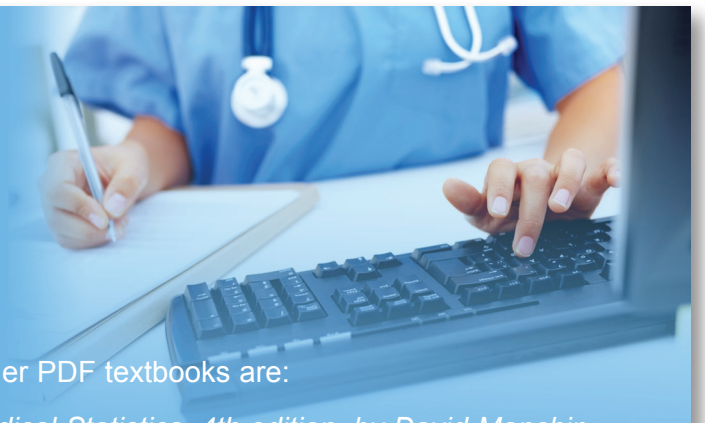
Source: Levine JM: Skin failure: an emerging concept. *JAMDA* 2016;17(7):666-669. PubMed Citation

Another Quality Measure?

Respiratory Care provides an interesting and comprehensive debate on whether ventilator-associated events (VAE, formerly ventilator-associated pneumonia or VAP) should become a quality indicator for ICUs. This lengthy article includes discussion from the Respiratory Care Controversies III conference at which it was presented.

Source: Klompas M., et al: Should ventilator-associated events become a quality indicator for ICUs? *Respiratory Care* 2016;61(6):723-736. PubMed Citation

On the World Wide Web



One of the challenges for nurses bringing research to practice is interpreting the statistics reported in many studies. While most recognize p values, concepts such as ANOVA, ANCOVA, hazard ratio and odds ratio can be more challenging.

Electronic Statistics Textbook

Dell Software provides free online access to this text as support for its Statistica software.

http://www.statsoft.com/textbook

OpenStax Free Textbooks

OpenStax, a non-profit located at Rice University, was created to improve student access to education. They published their first textbook in 2012 and have a variety of high-quality, peer-reviewed textbooks that can be downloaded as large PDFs for free, or purchased in book form at very low prices ($52 for an anatomy and physiology text). Their introductory statistics book is available here:
https://openstax.org/details/introductory-statistics

Other PDF textbooks are:

Medical Statistics, 4th edition, by David Manchin

http://bit.ly/2aIvS9F

Medical Statistics at a Glance, by Aviva Petrie

http://bit.ly/2aq7ntV

Little Handbook of Statistical Practice

A statistics professor at Tufts decided to put his teaching notes for his Statistical Methods for Nutrition Research course online. Since he started this project, Amazon made it possible for him to publish his Web pages as an eBook, but the content is still available here: http://www.jerrydallal.com/LHSP/LHSP.HTM

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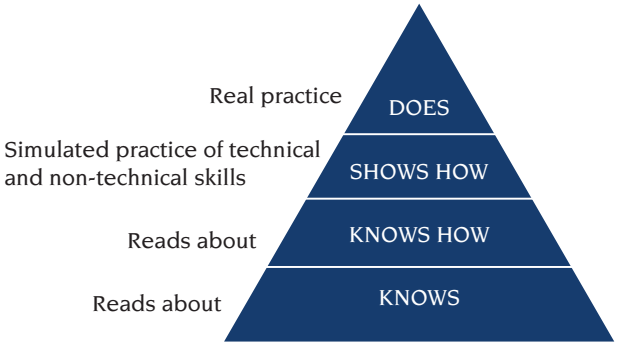
ules before the hands-on training. Three learners spent 45 minutes at each task station with an expert teacher to demonstrate the procedure and then provide feedback on learner performance.

The researchers evaluated homemade task trainers on three dimensions of realism: physical, conceptual, and emotional. Homemade models were judged to be more realistic for chest tube insertion (pork ribs, $20) and pericardiocentesis (gelatin and balloon mold, $70) while the commercial model was more realistic for cricothyrotomy. All post-course scores for comfort performing the procedure, willingness, and time to perform were significantly improved. The authors recommend further evaluation of how long clinicians retain skills, and whether the added realism contributed to increased learning.

Scotland physicians report on a project designed to teach high-risk clinical skills to remote and rural practitioners.[7] They based their training on Miller's pyramid: reading about a procedure, talking through it, theoretical teaching, and real practice. The actual technical procedure may not be the greatest challenge; knowing when



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to carry it out with situational awareness and leadership in an emergency situation often is.

Key leaders designed a mobile skill unit containing task trainers, medium-fidelity simulators, and AV technology. During the pilot, they trained 1700 practitioners. A needs assessment showed the training most wanted was chest tube insertion. This imperative was reinforced by a National Patient Safety Agency report identifying 12 deaths directly attributable to chest tubes. The workshop uses a blended learning approach for theoretical and practical elements with a focus on decision-making scenarios and technical skills.

Once practitioners are taught, how can their ability to carry out procedures be evaluated? Two groups of researchers, one in Canada and the other in Australia offer competency assessment tools.[8,9] The Canadian groups followed up on their homemade task trainers to then develop a competency assessment tool: the Tool for Assessing Chest Tube Insertion Competency (TACTIC). It rates 20 independent step-wise tasks required for successful chest tube insertion in four categories: preparation, tube insertion, securing the tube, and confirming placement.[8] Each task is rated from zero points for unacceptable performance to two for complete, correct performance. Designers chose the three-point scoring instead of a simple yes/no to add an element of quality assessment. To validate the tool, eleven physicians were videotaped twice: once before the chest tube insertion training and once after training. A significant increase in scores occurred after training. Statistical analysis determined the TACTIC is a reliable tool to assess chest tube insertion in a simulated model. An added advantage is that it identifies phases of the procedure that may need remediation. Future work will attempt to correlate scores to competent or expert practice.

The Australian researchers developed a 5-domain, 100-point assessment tool: the Chest Tube Insertion Competency Test (TUBE-iCOMPT) that they validated on both mannequins and live patients.[9] The domains are: (1) pre-procedure checks, (2) patient positioning and local anesthesia, (3) blunt dissection or (4) Seldinger skills, and (5) suturing, drain connection and dressing. The tool was evaluated by observing novice, intermediate, and advanced practitioners. Mean scores were significantly different when compared by experience. The authors urge the use of tools to assess competency rather than assuming competency because a certain number of procedures were done. Of note, neither research group has established a score that denotes "competent" performance.

General Chest Tube Management

The British Thoracic Society has been active developing standards and conducting audits of pleural procedures. The 2015 audit report presents data on chest tube insertions, pleural aspirations, and local anesthetic thoracoscopy.[10] Auditors review consent, location and timing, complications of these procedures, and statistics on drains for pneumothorax and those for pleural effusions. Of note, availability and training in bedside thoracic ultrasound has increased since the 2010 audit since ultrasonography improves safety and success rate.

In response to a safety alert in the UK, physicians examined care bundles in medicine and surgery to develop one for chest tube insertion on the medicine wards.[11] Initially, an audit tool was developed according to published guidelines to determine how documented practice correlated with guidelines and to identify areas where improvement was needed. A pilot bundle was developed and prospectively tried on several chest tube insertions. Feedback from the experience resulted in a revised draft, and the process was repeated with revisions and feedback two more times. It was tested 15 times over several months until all reviewers were satisfied with the tool's content and layout. Ultimately, there were nine cycles of development until the results of implementing the bundle were presented at a national meeting.

The authors note that this particular bundle focuses on documentation, not particular tasks performed. That said, the key to accurate audits and performance improvement is complete documentation from the start.

London researchers report on a study in which the fluid and air leak criteria for chest tube removal were liberalized to shorten chest tube duration and associated length of stay following lung resection.[12] Over four years, the fluid drainage criteria for tube removal increased from 5 mL/kg to 6 mL/kg to 7 mL/kg to no stated limit as long as the drained fluid is not blood or chyle. Air leak criteria started with no leak for at least 24 hours, and in the last year of the study, when digital chest drains were introduced, it changed to a leak of <20 mL/min as measured by the drain for at least 6 hours.

Chest tube duration dropped from 3 days to one (removal on POD 1), and hospital LOS from 6 days to 4 days. There was no increase in post-pull pneumothorax, effusion, or chest tube replacement.

Researchers from Iowa City and Baltimore examined the diagnostic value of pleural fluid obtained from a chest tube collection system.[13] They prospectively took samples of pleural fluid for diagnostic studies at the time of chest tube insertion. Then, drainage samples were removed from the collection chamber of the Atrium Oasis dry suction chest drain at 2, 6, and 24 hours after chest tube insertion and researchers compared those

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results to the initial sample. There was very little variation in total protein or albumin, but considerably more for measures of LDH and glucose. Repeat measures of total protein, albumin, cholesterol, and triglycerides showed high correlation at 2 hours and 6 hours; less so at 24 hours. More than 80% of all repeat measures were within 25% of baseline. LDH, on the other hand, was within 25% of baseline in 59% of measurements at 2 hours, 35% at 6 hours and 25% at 24 hours. The authors provide a detailed discussion of pleural fluid diagnostics. They concluded the fluid obtained from the chest drain provides useful diagnostic information as long as clinicians understand the metabolic factors affecting each test result.

Researchers from Poland compared the treatment of spontaneous pneumothorax with a small-bore pleural catheter (8 Fr, n=22) or large-bore chest tube drainage (20-24 Fr, n=27).[14] The small-bore catheter was connected to a three-way stopcock so air could be aspirated. If less than 2000 mL was aspirated, the tube was clamped. If there was still air present and 2000 mL was aspirated, the tube was connected to a Heimlich valve. The large-bore tube was connected to a chest drain.

The median duration of treatment was significantly shorter in the small-bore group (2.0 v. 6.0 days), resulting in a shorter hospital stay (4.0 v. 7.0 days). Otherwise, there was no significant difference in patient characteristics or treatment efficacy.

German anesthesiologists published a literature review to establish standardized procedures, recommend number and size of drainage tubes, ideal suction levels, and duration of chest tube drainage.[15] While their initial goal is appealing, many of their recommendations are based on personal preference and not on research. For example, they cite two studies that recommend a single chest tube postoperatively. They note, “In our experience, most surgeons rely on a single large-bore tube for most procedures…Personally, we still utilize two catheters for bilobectomy, left upper lobe resection…” without justification. The authors state “textbooks… advocate the use of two tubes, with one being placed apically and one directly over the diaphragm.” However, the citation for this statement is to a journal article, not a textbook. The only textbook in the list of references is from 1997, citing a chapter on pleural pressure and fluid dynamics. Since this is not the only instance in this review, this article is not recommended to guide practice.

Digital Chest Drains

Two studies looked at the role of digital chest drains in patient discharge. One, from the UK, described discharging 20 patients who had both persistent air leak and a confirmed air space within the pleural cavity on a radiograph.[16] They were sent home with a digital drain that provided suction in the home. Those with an air leak but fully inflated lung were connected to a Heimlich valve instead. An appendix to the study lists the 20 criteria that patients must meet by protocol before they can go home with a drain.

Six device failures occurred in the 20 patients at home. Three were filter blockage; one patient dropped the unit, cracking it; another knocked the device over, spilling fluid into the internal electronics. A patient with the device for more than 200 days experienced a failure to charge the device and was readmitted while a new device was ordered.

The discharge plan saved 772 bed-days, an average of 39 days per patient. Excluding two patients with 394 and 104 days of chest drainage, the average duration of home drainage was 15 days. Not only did this reduce expenditures, but it also increased throughput on the surgical service, increasing hospital revenue and reducing surgical wait times. It would be interesting to compare outcomes for these patients with similar patients discharged with less expensive non-electronic mobile drains.

The other discharge study described outpatient VATS wedge resections performed in Switzerland.[17] Preoperatively, carefully selected patients were told about three postop scenarios: discharge on the day of the procedure, admission for patient preference, or admission for medical or surgical reasons. No patient was discharged who did not want to go home the day of surgery.

The chest tube was placed on -20 cmH_20 suction postoperatively; it was removed when the air leak was 0-10 mL/min on a digital drain within two hours of surgery. Two hours later, a CXR was checked for pneumothorax or retained fluid. If there were no contraindications, patients were then offered the opportunity to go home. Of 66 wedge resection patients who were candidates for outpatient surgery, 55 were discharged and 11 admitted for patient preference, pleural air leak, or management of nausea or pain. There was no morbidity or mortality in the cohort. Four patients required readmission for pain (n=1), subcutaneous emphysema (n=1), and pneumothorax (n=2). Since hospitals in Switzerland make more money with longer stays, this study was driven by patient preference, not financial imperatives. The patients reported much less pain related to the short chest tube duration. All patients who went home the same day as surgery would want outpatient surgery again if they needed lung surgery in the future.

Three studies compare electronic chest drains with conventional chest drains.

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Spanish surgeons report on a study that correlates preop score for risk of prolonged air leak after lung resection to air leak measured with an Atrium Ocean chest drain's air leak meter.[18] The study was done with 100 consecutive patients having lung resection. Researchers standardized the air leak assessment three ways: 1. training on measuring air flow, 2. isolating air leak measurement from other variables relating to chest tube removal, and 3. measuring air flow after chest physiotherapy to minimize microatelectasis. There was 91% agreement on measurements made by two independent thoracic surgeons with a Kappa index of 0.81, meaning the measurements were reliable and reproducible. The authors suggest replicating the study with a larger, multi-institutional study to validate the findings, particularly since traditional drains are significantly less expensive than the digital counterparts.

The second study, from Canada, randomized lung resection patients to traditional drainage with a PleurEvac A6002 or digital drainage with Thopaz.[19] Randomization was done 24-48 hours after surgery when a true air leak was evident. There were 88 patients in the air leak group and the same number in the no air leak group. From there, 44 in each group were connected to a traditional drain or the digital drain. Patients without air leaks had a median tube duration of 2.9 (digital) and 3.0 (traditional) days, and hospital LOS was 4.0 days regardless of group. Patients with air leaks had a median tube duration of 4.9 (digital) and 5.6 (traditional) days, and LOS 6.0 days. None of the differences is significant. Ultimately, there was no advantage for the digital drain as has been previously suggested. The authors note that clinicians often assume clinical benefit from advanced technology, but there is a significant knowledge gap in the availability of data and its proven clinical significance.

The third study, from Denmark, is a prospective randomized trial designed to compare traditional and digital drains to inform this hospital's purchasing decision.[20] After lobectomy, patients were randomized to a Thora-Seal traditional drain (n=50) or a Thopaz digital drain (n=55). Patients with the digital drain received -15 cmH_2O suction because gravity drainage is not available with the electronic unit; those with the traditional drain received gravity drainage. There was no significant difference in chest tube duration (digital 1.9 v traditional 2.2 days) or hospital LOS (5 days). The authors note they use a strict algorithm to guide tube removal and did not see a financial advantage to the more expensive unit.

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