



Instilling Saline When Suctioning: A Weapon of Mass Infection?

by Jeff Whitnack, RRT, RPFT

As RTs, we are no strangers to the normal saline instillation debate. But in my opinion there seems to be a “rush to judgment” - a growing pervasive perception that this issue has been scientifically proven and resolved. Largely ignored in this often one-sided discussion are studies on targeted patient populations - patients with tenacious secretions or with collapsed lungs. These patients do appear to receive benefit from the practice.

The abstracts presented here (excerpted due to space restrictions) shed some much needed light on the issue.

Studies showing benefit from the instillation of normal saline:

When targeted patient populations are studied and saline instillation is combined with other adjuncts to open up collapsed lungs, benefits may be realized.

Postoperative head and neck cancer patients with artificial airways: the effect of saline lavage on tracheal mucus evacuation and oxygen saturation

Hudak M, Bond-Domb A, ORL Head Neck Nurs 1996 Winter;14(1):17-21

“Twenty postoperative nonventilated head and neck cancer patients with a tracheostomy were studied...The mean sputum weight with normal saline was 7.75 g, and 4.53 g without saline. Findings concerning S_{aO_2} showed that no saturation levels dropped below 95%...using normal saline instillation as part of the suctioning procedure does significantly enhance mobilizing bloody mucus tracheal secretions common in postoperative head and neck cancer patients and does not cause oxygen desaturation.”

Transtracheal long-term oxygen therapy in respiratory failure

Wurtemberger G, Matthys H, Abteilung Pneumologie Medizinische Universitätsklinik Freiburg.

“Dealing with side effects due to high oxygen flow rates for sufficient oxygenation we treated four patients via a transtracheal oxygen catheter...Refractory hypoxaemia was successfully treated requiring 50% less oxygen. There were no complications related to the insertion procedure. Increased mucous plugging, while acute bacterial infection was observed, required frequent instillation of 0.5 cc normal saline. All patients experienced an improvement in their quality of life with transtracheal oxygen.”

Bedside management of lung collapse in children on mechanical ventilation: saline lavage-simulated cough technique proves simple, effective

Galvis AG, Reyes G, Nelson WB, Pediatr Pulmonol 1994 May;17(5):326-30

“We report a simple, four-step procedure for bedside treatment of infants on mechanical ventilation who have various degree of lung collapse unresponsive to conventional instillation of saline followed by chest percussion with endotracheal suctioning... (the procedure) resulted in notably improved lung expansion in 48 of 57 infants, documented by chest radiographs.”

Treatment for collapsed lung in critically ill patients: Selective intrabronchial air insufflation using the fiberoptic bronchoscope

Tsao TC, Tsai YH, Lan RS, Shieh WB, Lee CH, Chest 1990 Feb;97(2):435-8

“A new, simpler method to re-expand collapsed lungs was introduced in 14 procedures in 12 critically ill patients...Room air was then insufflated into the atelectatic alveoli after repetitive sputum suctioning and bronchial washing with normal saline solution...Complete re-expansion was achieved in 12 of the 14 procedures and partial in two. The average alveolar-arterial oxygen pressure difference ($P_{[A-a]O_2}$) declined from 217.5 before the procedure to 200.3, 150.0 and 152.2, respectively at 30 minutes, 12 hours and 24 hours after. There were no complications.”

It is often alleged that normal saline and sputum don't mix. If this were the only criterion then one would not expect that saline lavage of impacted sinuses would have any benefit. However:

Effect of irrigation of the nose with isotonic salt solution on adult patients with chronic paranasal sinus disease

Bachmann G, Hommel G, Michel O, Eur Arch Otorhinolaryngol. 2000 Dec;257(10):537-41

“We compared the effectiveness of endonasal irrigations with Ems salt solution to that with sodium chloride solution in the treatment of adult patients with chronic paranasal sinus disease...Nasal air flow was not improved significantly. Subjective complaints, endonasal endoscopy, and radiography results revealed a significant improvement in both groups ($p = 0.0001$). In comparison, the two groups were not significantly different in outcome. Endonasal irrigations with salt solutions are effective in the treatment of chronic sinusitis, and a significant difference between Ems salt and sodium chloride was not observed.”

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Studies showing how the practice may be improved upon

Rather than just abandoning the practice of instilling normal saline, perhaps the practice (where indicated and on selected patients) may be improved. Warming the normal saline to body temperature, pre-treating or mixing with anticholinergics, using special dual lumen catheters, and paying attention to potential sources of infection may all help.

Endotracheal suctioning of the newborn piglet

Gunderson LP, Stoeckle ML, West J Nurs Res 1995 Feb;17(1):20-31

“Eleven newborn Yorkshire piglets less than 24 hours of age were randomly exposed to both the room temperature (RT) and body temperature (BT) normal saline suctioning protocols. The analysis and interpretation of the results revealed that the RT normal saline injectate caused a greater decline in heart rate and greater alterations in arterial blood gas parameters than did the BT normal saline injectate.”

Effectiveness of bronchial lavage with a new double-lumen catheter

Schmidt C, Schon R, Russ J, Anaesthetist 1988 Jun;37(6):392-5

“(A new double lumen catheter) was compared with a common suction catheter in 16 patients...Using the dual lumen probe, the suctioned volume was 3.8 times higher. In a short time the arterial oxygen pressure rose from 100% to 123%. An obvious improvement in ventilation could be seen even after 1 h. There was a positive correlation between the suctioned volume and the rise in oxygen pressure. Only suctioning of more than 3.7 mL was accompanied by a rise in the arterial oxygen pressure. Because of continuous artificial respiration, the arterial carbon dioxide pressure was kept constant. Therefore, there is a catheter available that makes it possible to perform a much more effective endobronchial lavage in a shorter period of time.”

Prevention of bradycardic responses to endotracheal suctioning by prior administration of nebulized atropine

Winston SJ, Gravelyn TR, Sitrin RG, Crit Care Med 1987 Nov;15(11):1009-11

“Six mechanically ventilated patients who reproducibly experienced a 20% or greater fall in resting heart rate exclusively with endotracheal suctioning were given three trials: a) inhaled atropine sulfate (0.05 mg/kg); b) inhaled saline aerosol (0.05 ml/kg); and c) atropine sulfate (1 mg, given im or iv). Mean heart rate fell from 114 ± 10 to 45 ± 5 beat/min with suctioning after the saline aerosol ($p < 0.001$). Both nebulized and parenteral atropine sulfate prevented the bradycardic response in all six subjects ($p < 0.001$). After nebulized saline, three patients also experienced a greater than or equal to 10 mm Hg fall in systolic BP. Both nebulized and parenteral atropine prevented the hypotensive response. Tachycardia occurred after parenteral atropine in all six patients, while only one episode of tachycardia was seen after nebulized atropine. Both parenteral and nebulized atropine can prevent bradycardia and hypotension elicited by endotracheal suctioning, but nebulized atropine may have a wider margin of safety at the doses used in this study.”

A potential infection hazard associated with the use of disposable saline vials

Rutala WA, Stiegel MM, Sarubbi FA Jr, Infect Control 1984 Apr;5(4):170-2

“Cultures of nurses’ hands and squeeze vial contents were obtained in the ICU where 24 nurses opened 92 vials (with ungloved hands). Twenty-three percent of vial contents were contaminated and cultures revealed *S. epidermidis*, *S. aureus*, *Streptococcus viridans* and *enterococcus*. On six occasions, organisms recovered from vial contents were believed to be identical to organisms isolated from the hands of the nurse who opened the vial. When nurses used care in removing the saline vial cap, cultures of vial contents were sterile.”

Infant responses to saline instillations and endotracheal suctioning.

Shorten DR, Byrne PJ, Jones RL, J Obstet Gynecol Neonatal Nurs 1991 Nov Dec;20(6):464-9

“The study examined the effects of endotracheal suction with and without saline instillation on neonates with respiratory distress...27 intubated neonates were randomly assigned to two orders of presentation of treatment conditions. Heart rate and blood pressure were continuously recorded throughout both treatment conditions. The ratio of arterial oxygen tension to alveolar oxygen tension was used to assess oxygenation. Results indicated that clinically stable newborns tolerated instillations of 0.25-0.5 mL. The suctioning protocol used in this study minimized changes in infants’ heart rates and blood pressures.”

Studies purporting to show harm via short-term worsening of oxygenation indices (S_{pO_2} or S_{vO_2})

Endotracheal Suctioning With or Without Instillation of Isotonic Sodium Chloride Solution in Critically Ill Children

Ridling DA, Martin LD, Bratton SL, Am J Crit Care. 2003 May;12(3):212-9

“A convenience sample of 24 critically ill patients were enrolled before having suctioning...Patients who had isotonic sodium chloride solution instilled experienced significantly greater oxygen desaturation 1 and 2 minutes after suctioning than did patients who did not. No occlusions of endotracheal tubes and no cases of nosocomial pneumonia occurred in either group...Results of this study support a growing body of evidence that instillation of isotonic sodium chloride solution during endotracheal tube suctioning may not be beneficial and actually may be harmful.”

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Instillation of Normal Saline During Endotracheal Suctioning: Effects on Mixed Venous Oxygen Saturation

Kinloch D, Am J Crit Care. 1999 Jul;8(4):231-40; quiz 241-2

“35 patients were assigned to either of 2 groups after coronary artery bypass grafting. One group had 5 mL of normal saline instilled at the start of endotracheal tube suctioning; the other group had the same endotracheal tube suctioning procedure without the use of saline...The time required for mixed venous oxygen saturation to return to baseline values after suctioning was an average of 3.78 minutes longer when saline was used...Instillation of normal saline before endotracheal suctioning has an adverse effect on oxygenation as indicated by mixed venous oxygen saturation. This finding contradicts the assumption that instillation of normal saline improves oxygenation status.”

I wrote a letter to the *AJCC* editor about this study that was published in the January 2000 issue. Part of the original letter reads:

“In my opinion, using a transient fall in S_{vO_2} as a standard to judge the practice of normal saline instillation during endotracheal suctioning is inherently flawed. Oxygenation, per the S_{vO_2} value, is more a measure of cardiac function or stress than it is of lung function. To perhaps overly simplify, the S_{aO_2} tells you how well the lungs are working; the S_{vO_2} tells you how well the heart is working. Had the instilled saline done its detrimental work via a direct pulmonary mechanism, one should have seen both a profound and a sustained drop in S_{aO_2}/S_{pO_2} .

The study had no discussion or speculation as to the actual mechanism whereby the instillation of saline caused a greater and more sustained drop in S_{vO_2} . Did the instillation of saline, all 5 ccs of it, pool in the cardiac fossa and cause a tamponade? Did the Na^+ and Cl^- of the instilled saline somehow tip the ionic scales in the plasma milieu such that cardiac contractility or rate were affected? Of course not.

Somehow the instillation of saline must have caused an even greater increase in systemic oxygen consumption which was greater than that able to be supplied by the cardiopulmonary system.

The only possible mechanism to explain the greater and more sustained drop in S_{vO_2} for the saline instilled group that I can possibly imagine is simply that saline instillation caused an increased and more vigorous cough effort. Now this cough effort, along with possibly loosening up tenacious secretions, may be worth the price of the transient drop in S_{vO_2} . Or perhaps even the suction event itself, without saline, wasn't worth the risk for some marginal patients without tenacious secretions.

In any event, the use of the S_{vO_2} value as a determinant for the practice is to mix cardiac apples with pulmonary oranges.

Much of what we do in clinical practice - suction, CPT, ambulation, turning, weighing, coughing, etc., all may cause a (hopefully!) transient drop in S_{vO_2} below that which would have occurred had we just let the patient lie in bed.”

The effect of saline lavage prior to suctioning.

Ackerman MH, Am J Crit Care 1993 Jul;2(4):326-30

“Subjects... in need of intensive care nursing and mechanical ventilation (were) suctioned as needed for 24 hours. A 5-mL saline bolus was instilled every other time the subject was suctioned...The instillation of a saline bolus was found to have an adverse effect on oxygen saturation that worsened over time. Significant changes in oxygen saturation as a result of saline bolus instillation were found at 2, 3, 4 and 5 minutes after instillation...These results indicate that instilling saline prior to suctioning has an adverse effect on oxygen saturation (and) support the recommendation that the practice of instilling saline prior to suctioning should be abandoned as a routine procedure. More study is needed to investigate whether a specific group of patients may actually benefit from this procedure.

In this study the patients were not necessarily those with thick secretions. It is highly unlikely that the transient drops in oxygen saturation were of any real significance. By way of analogy, the low V_T wing of the ARDSnet study also had lower initial oxygenation indices.

Endotracheal saline and suction catheters: sources of lower airway contamination

Hagler DA, Traver GA, Am J Crit Care. 1994 Nov;3(6):444-7

“Endotracheal tubes from 10 critical care patients intubated for at least 48 hours were obtained immediately after extubation. Each tube was used in random order for both saline instillation and suction catheter insertion. Dislodged material was cultured for quantitative analysis...Suction catheter insertion dislodged up to 60,000 viable bacterial colonies. A 5-mL saline instillation dislodged up to 310,000 viable bacterial colonies...The potential for infection caused by dislodging bacteria into the lower airway is additional evidence that routine use of saline during suctioning procedures should be abandoned.

While certainly relevant to discussion of this issue, this study hardly proves that saline instillation is in any way associated with an increased rate of nosocomial infection. Indeed, routine suction without any saline also dislodges a significant amount of bacteria. Does this mean that instilling saline increases the rate of infection? Or does instilling saline help to curtail the buildup of a Biofilm on the inside wall of the ET tube?

Review articles which urge that the practice not be performed routinely, or altogether abandoned:

A review of normal saline instillation: implications for practice.

Ackerman MH, Ecklund MM, Abu-Jumah M, Dimens, Crit Care Nurs. 1996 Jan-Feb;15(1):31

Normal saline instillation with endotracheal suctioning: primum non nocere (first do no harm).

Blackwood B, Adv Nurs 1999 Apr;29(4):928-34

Re-examining the practice of normal saline instillation prior to suctioning.

Druding MC, Medsurg Nurs 1997 Aug;6(4):209-12

Normal saline instillation before suctioning: helpful or harmful? A review of the literature.

Raymond SJ, Am J Crit Care 1995 Jul;4(4):267-71

Again, a bit of a rush to judgment seems to be evident in the review articles. For every two or three studies looking at oxygenation indices, or potentially irrelevant benchmark studies, there seems to be a review article decrying the practice.

Studies pointing out that respiratory therapists are much more likely to instill saline than nurses:

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INSTILLING SALINE WHEN SUCTIONING: A WEAPON OF MASS INFECTION?

A survey of endotracheal suctioning with instillation of normal saline

Schwenker D, Ferrin M, Gift AG, Am J Crit Care 1998 Jul;7(4):255-60

“A survey of nurses and respiratory therapists working in adult ICUs was conducted ...Most nurses (64%) rarely use saline before suctioning, whereas most respiratory therapists (71%) frequently use saline. Respiratory therapists (57%) were more aware than were nurses (37%) of the benefit of using normal saline to stimulate a cough. Nurses indicated more adverse effects of instillation of normal saline, specifically oxygen desaturation and increased risk of pulmonary infections, than did respiratory therapists...The results of the survey helped determine target areas for educational programs for nurses and respiratory therapists.”

A Multisite Survey of Suctioning Techniques and Airway Management Practices

Sole ML, Byers JF, Ludy JE, Zhang Y, Banta CM, Brummel K, Am J Crit Care. 2003 May;12(3):220-30; quiz 231-2

“A total of 1665 nurses and respiratory therapists at 27 sites throughout the United States responded ...Most sites had policies for management of endotracheal tube cuffs (93%), hyperoxygenation (89%) and use of gloves (70%) with closed-system suctioning, and instillation of isotonic sodium chloride solution for thick secretions (74%). Only 48% of policies addressed oral care and 37% addressed oral suctioning. Nurses did more oral suctioning and oral care than respiratory therapists did, and respiratory therapists instilled sodium chloride solution more and rinsed the suctioning device more often than nurses did ...Policies vary widely and do not always reflect current research. Consistent performance of practices such as wearing gloves for airway management and maintaining endotracheal cuff pressures must be evaluated. Collaborative, research-based policies and procedures must be developed and implemented to ensure best practices for intubated patients.”

It is perhaps not surprising that respiratory therapists tend to instill saline more than nurses. The studies and articles urging the abandonment of the practice arise entirely from the nursing literature. Now we must engage the issue and read the literature.

The routine instillation of normal saline with each and every suction event is probably a practice that should be abandoned. Certainly if I came on duty and was assigned a ventilated patient who was on a balloon pump with a cardiac index of 1.1, on an F_{IO_2} of 1.0 with an S_{pO_2} of 87%, I would be most hesitant to even suction, let alone instill saline.

But the flip side is that sometimes I can feel the tactile vibration of secretions by merely touching the ET tube. Taking the patient off the vent and manually bagging, I have then felt like I was ambu-bagging gas mixed with a big bolus of semi-hardened glue. Reaching for the NS vials, I have had nurses become distressed that I would resort to such a procedure “proven to increase infection.”

There is perhaps a fine line between curtailing a practice and banning it outright. But the question of when and in which patients one should instill saline is one that should be based upon bedside patient assessment. Therein lies another area where we need to improve on our own practice via collaborative efforts and discussions with the nurse. ♦