INNOVATIONS

Low-Cost Portable Suction-Assisted Laryngoscopy Airway Decontamination (SALAD) Simulator for Dynamic Emesis

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ABSTRACT:

Audience: The suction-assisted laryngoscopy airway decontamination (SALAD) simulator is designed to instruct emergency medicine residents, paramedic students, and students interested in emergency medicine.

Introduction: The ability to establish an adequate airway by intubation is a core procedural skill taught throughout emergency medicine training. Frequently, active emesis, massive regurgitation or hemorrhage during endotracheal tube placement can obstruct visualization of the larynx, increase risk of aspiration and complicate airway management.[1] Consequently, providers are expected to quickly stabilize a patient's airway during episodes of airway contamination to reduce complications and improve outcomes. Suction-assisted laryngoscopy airway decontamination (SALAD) is a systematic method that uses suction and the laryngoscope to clear the airway and visualize landmarks for placement of the endotracheal (ET) tube. Emergency medicine resident physicians are expected to perform a minimum of thirty-five intubations throughout training to become proficient in the procedure;[2] however, simulated intubation exercises that replicate dynamic fluid contamination from emesis or blood are often expensive or not utilized.[3] This SALAD model was created by Dr. DuCanto to economically replicate the airway of an actively vomiting patient requiring endotracheal tube placement. The dynamic trainer was developed for residents to learn and practice complicated intubation techniques and to be prepared for ET tube placement in the event that visual obstruction from gastric contents, vomitus or blood were to occur. We took the DuCanto model and made a modified, lower budget system with portability using a repurposed mannequin head. Attempts have been made previously but none published in the literature.[4]

Objectives: The economic and dynamic SALAD innovation recreates an actively vomiting patient and replicates visual obstruction from fluid contents during airway management.

By the end of the session, learners are expected to: 1) discuss the risks, benefits, indications and

contraindications associated with intubation of a vomiting or hemorrhaging patient. 2) Work with colleagues to effectively stabilize a patient who is actively vomiting or bleeding during airway management. 3) Competently perform intubation in the acute setting of visual obstruction from active emesis, hemorrhage, or massive regurgitation. 4) Increase speed and dexterity of intubation by applying the SALAD method when fluid obstructs visualization of the larynx.

Methods: A dynamic, high fidelity simulation trainer will be used to recreate the scenario of a patient actively vomiting or bleeding during emergent airway intubation. Polyvinyl chloride (PVC) tubing, a hand-operated water pump, an airway management trainer, and an LTV® vent connector are used to create a low-cost circuit that models active emesis. BARFume puke spray, Laerdal stomach contents, and Campbell's soup were used to create artificial vomitus. Residents will use suction and the laryngoscope to practice intubating on the airway management trainer while liquid is pumped to simulate visual obstruction from fluid contents.

Topics: Difficult airway, SALAD, intubation, airway placement, airway management, ET placement, airway, emesis, active emesis, vomit, vomiting, hemorrhage, hemorrhaging, oropharynx, airway contaminant, obstructed airway, visual obstruction, airway obstruction, airway visualization, rapid sequence intubation.

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List of Resources:

Learner Audience:
Medical Students, Interns, Junior Residents, Senior Residents, Paramedics, Attending Physicians

Time Required for Implementation:
Preparation: Approximately 30 minutes: 10 minutes to build the model, 10 minutes to create the fluid contents, and 10 minutes to connect the circuit and manual pump.
Didactics: Didactic session: total 45 minutes-1 hour.

Recommended Number of Learners per Instructor:
4 learners per instructor.

Topics:
Difficult airway, SALAD, intubation, airway placement, airway management, ET placement, airway, emesis, active emesis, vomit, vomiting, hemorrhage, hemorrhaging, oropharynx, airway contaminant, obstructed airway, visual obstruction, airway obstruction, airway visualization, rapid sequence intubation.

Objectives:
The economic and dynamic SALAD innovation recreates an actively vomiting patient and replicates visual obstruction from fluid contents during airway management.

By the end of the session, learners are expected to:

1. Discuss the risks, benefits, indications and contraindications associated with intubation of a vomiting or hemorrhaging patient.
2. Effectively stabilize a patient who is actively vomiting or bleeding during airway management.
3. Competently perform intubation in the acute setting of visual obstruction from active emesis, hemorrhage, or massive regurgitation.
4. Increase speed and dexterity of intubation by applying the SALAD method when fluid obstructs visualization of the larynx.

Linked objectives and methods:
Practicing SALAD intubation on a dynamic airway model is ideal for learners to become familiar with using suction and the laryngoscope prior to managing the airway of live patients. Learners are expected to review pre-reading material and participate in discussion of the SALAD technique in order to demonstrate understanding and indications of the procedure (objective 1). Learners will then form teams to manage a decompensating patient by applying the SALAD intubation technique to establish a secure airway on the dynamic model (objective 2). Faculty will observe and provide feedback to the participants throughout the session (objective 3). Using a stopwatch, one team member will record the elapsed time required to intubate the patient as a metric to emphasize the importance of quick intubation in the setting of airway contamination (objective 4). Learners and faculty will then debrief the session, exchange feedback and reflect on difficulties associated with SALAD intubation (objective 2). This format was selected to realistically replicate the scenario of intubation while simultaneously creating an environment where learners can ask questions and demonstrate competency in the procedure.

Recommended pre-reading for instructor:

- Weingart SD, Bhagwan SD. A novel set-up to allow suctioning during direct endotracheal and fiberoptic intubation. *J Clin Anesth*. 2011;23(6): 518-519. doi: 10.1016/j.jclinane.2010.08.021.

Podcasts:

- Weingart S, DuCanto J. "Having a vomit SALAD with Dr. Jim DuCanto-Airway management technique during massive regurgitation, emesis or bleeding." EM Crit-RACC Podcast-196. 3 Apr. 2017. EMCrit, https://emcrit.org/emcrit/having-a-vomit-salad-with-ducanto/. Published April 3, 2017. Accessed January 22, 2019.
- Weingart S, DuCanto J. "Airway tips and tricks with Jim DuCanto." EM Crit-RACC Podcast-73. EMCrit, https://emcrit.org/emcrit/james-ducanto-airway-tips/. Published May 3, 2012. Accessed January 22, 2019.

Learner responsible content (LRC):

- Nickson C. Suction assisted laryngoscopy airway decontamination (SALAD). Life in The Fast Lane. https://lifeinthefastlane.com/ccc/suction-assisted-laryngoscopy-airway-decontamination-salad/. Published August 21, 2018. Accessed January 22, 2019.

Video:

- DuCanto J. "Suction assisted laryngoscopy airway decontamination UW Madison." Video. https://vimeo.com/123169076. Published March 2015. Accessed January 22, 2019.

Implementation Methods:
In groups of four learners will spend:

- 5-10 minutes reviewing intubation protocol and the SALAD technique.
- 25-30 minutes using the innovation.

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- 10-15 minutes debriefing the session and discussing feedback.

Each resident is assigned a role:

1. First learner manages the airway and places the ET tube.
2. Second learner assists in airway stabilization.
3. Third learner manually pumps the liquid contents.
4. Fourth learner operates a stop-watch to record elapsed time for intubation.

Remaining learners are expected to actively engage in the simulation, assist with airway stabilization if appropriate, provide feedback, and ask questions.

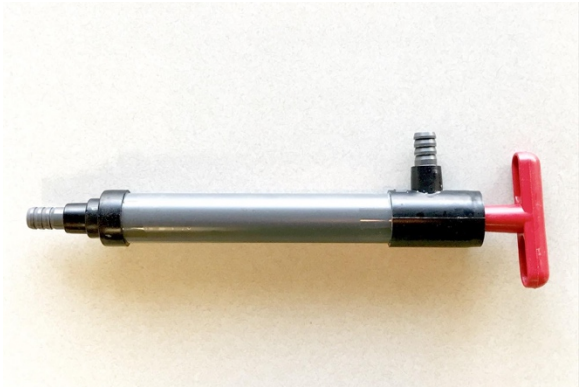
Times from the stop watch will be recorded to assess competency of speed. The instructor will provide feedback and assess competency of the intubation technique.

List of items required to replicate this innovation:

- Laerdal Airway Management Trainer: $2,215 (estimated cost for new model; used model also can be modified and is recommended in order to keep costs low.)

- LTV vent circuit connector: $8 https://www.amazon.com/Carefusion-55001504-Airlife-Ventilator-Monitoring/dp/B00Q0RRCXU/ref=sr_1_fkmr0_1?s=industrial&ie=UTF8&qid=1548865352&sr=1-1-fkmr0&keywords=ventilator+circuit+adapter+15mm+to+15mm

- Hand-operated water and chemical siphon/drum pump, 32 strokes/gallon: $31 https://www.amazon.com/Hand-operated-chemical-siphon-strokes-gallon/dp/B003LYY4FY/ref=sr_1_3?ie=UTF8&qid=1548792388&sr=8-3&keywords=hand+pump+32+strokes



- 10’ of 5/8" ID x 13/16" OD x 3/32" Wall Excelon RNT® Clear PVC Tubing: $.60/ft https://www.usplastic.com/catalog/item.aspx?itemid=24693&catid=1065

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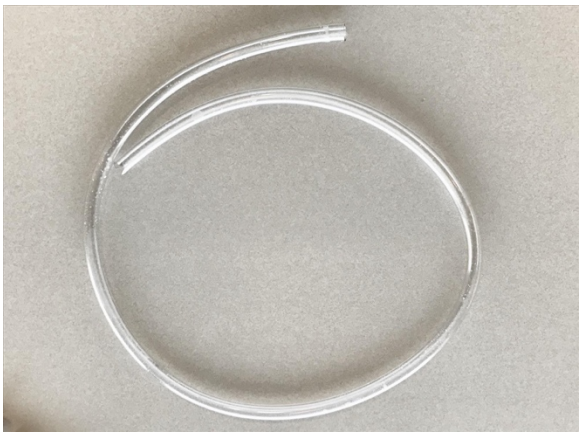
- 5’ of 1/2" ID x 11/16" OD x 3/32" Wall Excelon RNT® Clear PVC Tubing: $.49/ft https://www.usplastic.com/catalog/item.aspx?itemid=24693&catid=1065



Simulated vomit materials:

- BARFume Puke Spray $9.29 https://www.amazon.com/s/ref=nb_sb_noss?url=search-alias%3Daps&field-keywords=barfume

- Can of Campbells’ Chicken Noodle Soup $1.20

- Laerdal Concentrated Simulated Vomit $42.25 https://www.laerdal.com/us/item/252800 Multiple uses per container

Approximate cost of items to create this innovation:
Cost of vomitus solution material: $53

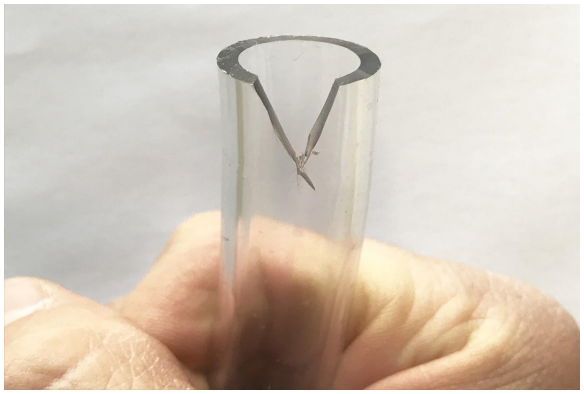
Cost of pump and circuit materials: $50

Cost of new Laerdal® Airway Management Trainer: $2,215 (optional to purchase new but the authors used a repurposed older mannequin which substantially decreased cost of model).

This airway adaptation could likely be applied to most airway mannequins.

Detailed methods to construct this innovation:
Assembly:

1. Take 5’ tubing and cut a “v” shape ~3/4” deep and ~½: wide. When cutting width, the sides of the cut pressed together should reduce the outside tubing diameter to approximate the internal diameter of the vent adapter



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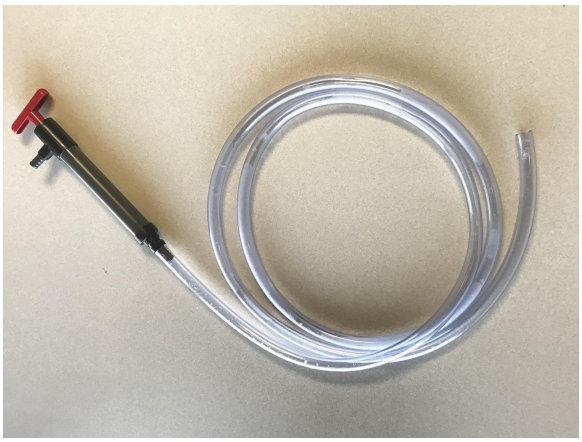
2. Firmly insert the cut end into the vent tubing connector so that the entire cut is inside the connector (otherwise it will leak).

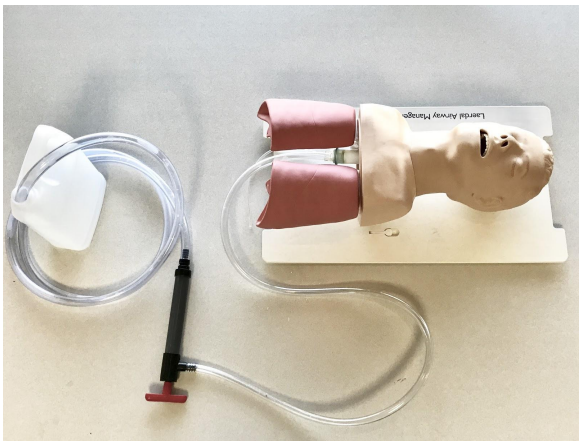
3. Insert the assembled end piece into the esophagus port on the mannequin.

4. Attach the other end of 5' tubing to the outflow port of the hand-pump

5. Connect an end of the 10' tubing to the inflow port of the pump. The other end will be placed into the container you'll be drawing "emesis' from (ie, 5gal bucket, 1gal jugs). This will slide over the barbs and ~3/4" of the base of the pump, which may require a twisting motion to accomplish.



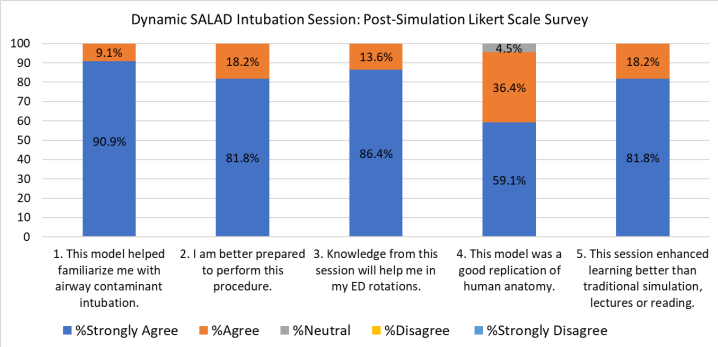
Assembled Product:



Results and tips for successful implementation:
The SALAD simulation model was used to supplement a didactic lecture series on advanced airway management for resident and medical student learners. The model was tested on twenty-two learners during protected education time. The breakdown of learners included: fifteen emergency medicine residents, one off-service resident, one physician assistant fellow, and five medical students. A post-session survey using a five-point Likert scale of strongly agree (score of 5) to strongly disagree (score of 1) was administered to evaluate the utility and success of the SALAD simulation model. All twenty-two participants responded to the survey directly following the session (100% response rate). 90.9% of learners strongly agreed and 9.1% agreed that the simulation model increased their familiarity

with difficult intubation. 100% of learners either strongly agreed (81.8%) or agreed (18.2%) that the dynamic SALAD model was better than a traditional airway model and made them feel better prepared to intubate a patient in the Emergency Department. 86.4% of learners strongly agreed and 13.6% agreed that the low-cost SALAD model provided knowledge for the emergency department rotation. Overall, the survey results suggest the innovation is beneficial to learners and is an improvement from the traditional airway manikin with a cumulative average of 4.79 out of 5 and median score of 5 out of 5.

Survey Statement	Mean	Median
1. This model helped familiarize me with airway contaminant intubation.	4.91	5
2. I am better prepared to perform this procedure.	4.82	5
3. Knowledge from this session will help me in my ED rotations.	4.86	5
4. This model was a good replication of human anatomy.	4.55	5
5. This session enhanced learning better than traditional simulation, lectures or reading.	4.82	5
Overall Assessment	4.79	5



During the learning session, minor spills did occur but use of the hand pump enabled the operator to make sure vomit stayed mostly in airway and did not spill out of mouth. The skills lab was performed on an adjustable plastic work table. The "vomitus" moved easily through the tubes and no episodes of clogging occurred. Final clean-up of model was very easy. Device including head was taken outdoors and hosed down to wash out any vomitus in airway mannequin and to flush plastic tubing.

Suggestions for future implementation: replicated "vomitus" solution was used during the session by combining 1-2 pumps of BARFume puke spray, Laerdal® stomach contents and 1 can of Campbell's® soup. Preparation took 10 minutes and participants felt that the consistency and odor of the homemade solution successfully mimicked organic emesis. Other recipes could be created. Alternatives to consider include red dyed liquid to replicate hemorrhage or green colored solution to replicate bilious emesis.

References/suggestions for further reading:

1. Gaither J, Spaite D, Stolz U, Ennis J, Mosier J, Sakles JJ. Prevalence of difficult airway predictors in cases of failed prehospital endotracheal intubation. *J Emerg Med*. 2014;47(3):294-300. doi: 10.1016/j.jemermed.2014.04.021
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4. Boyer C. What you need to know about SALAD: a new airway management technique. https://www.emsworld.com/article/12277918/what-you-need-to-know-about-salad-a-new-airway-management-technique. Published January 2017. Accessed January 25, 2019.
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