June 27, 2011

Reducing the HAI Risk Attributable to Hospital Suction Canisters: An Evidence Based Approach

Michael J. Scala, RN, BSN, EMT-P

ABSTRACT

Suction collection canisters are used in almost every patient care area. They form a reservoir where solid and liquid components are separated from air and aerosols. Once these collection vessels have been employed clinically, they become an environmental reservoir of pathogens in that patient care area.Ventilator Associated Pneumonia (VAP) bundles commonly include the recommendation that collection canisters be changed at a minimum of Q24hrs. This literature review will attempt to demonstrate an evidence based canister change protocol supportive of the reduction of this potential HAI vector. This evidence based protocol recommendation could represent over $1000 worth of savings per ICU bed per year.

Clinical Education Presented By:

BOEHRINGER®

Reducing the HAI Risk Attributable to Hospital Suction Canisters: An Evidence Based Approach

Michael J. Scala, RN, BSN, EMT-P

Introduction

Suction collection canisters are used in almost every patient care area. The canisters provide a reservoir where solid and liquid components are separated from air and aerosols. The air and aerosols are then allowed to be withdrawn into the central suction system. Collection canisters are typically 800-2000ml in volume and contain a disposable rigid shell or a flexible inner liner. In clinical use they allow biological fluids to be contained at room temperature. Endogenous and exogenous organisms can thrive in this closed environment supported by suctioned physiological debris and nutrients.

Once these collection vessels have been employed clinically, they become an environmental reservoir of contaminants and pathogens in that patient care area. Ventilator Associated Pneumonia (VAP) bundles commonly include the recommendation that collection canisters be changed at a minimum of Q24hrs. The primary motivation for these recommendations is to attempt to remove the suction collection circuit as a potential vector for infection to the patient. This paper will review the evidence in support of a Q24hrs change protocol and propose an alternative protocol for evidence based canister change decisions.

History

Central suction systems became prevalent in hospitals starting in the 1950's. Hospital collection canisters initially were glass jars which would be emptied per shift or daily. These glass jars were easily disinfected or autoclaved prior to use on the next patient. In the early 1980's disposable collection canisters started to become more common. Today the most common collection means in the United States is a disposable collection canister although other areas of the world still routinely use permanent reprocessable collection canisters.

Published Clinical Protocols

A web based search was conducted of publicly available information to identify hospitals with published Q24hrs protocols for changing hospital collection canisters. These institutions are identified in Table 1 along with the exact change recommendations they use for suction collection sets.

The reduction of risk from the suction collection circuit revolves around determining an effective change interval for the disposable components of the circuit. By regularly changing circuit components it is believed the vector of exogenous organisms from the suction circuit to the patient may be broken before the organism burden placed on the patient is too great.

Table 1: Published Canister Change Protocols

Institution	Collection Canister Protocol
Children's Medical Center of Dayton; Dayton, Ohio	*"Daily change of the suction canister and Yankauer catheter"*
Louisiana State University Health Sciences Center; Shreveport, Louisiana	*"All suction canister liners and connecting tubing shall be changed when grossly soiled and/or at least every 24 hours. The entire setup is discarded when the patient is transferred or discharged."*
Allina Hospitals, Mercy and Unity Hospitals; Minnesota	*"Change Yankauer and tubing to canister Q 24 hrs (0600) - be sure to label tubing"*
National Association of Children's Hospitals and Related Institutions	*"A new suction canister and kit will be obtained q 24 hrs"*
John Dempsey Hospital-Department of Nursing The University of Connecticut Health Center; Farmington, CT	*"Change suction canister and tubing a minimum of every 24 hours." "a. Change suction canister when more than ¼ full to assure maximal effectiveness."*
Lucile Packard Children's Hospital; Santa Clara, CA	*"Bedside suction equipment e.g. Yankauer, suction tubing, and canister Minimal q 24 hours"*

For most suction procedures there is a one-way flow of material from the patient to the collection circuit. The majority of liquids are captured by gravity in a suction canister and the remaining air and aerosols are removed by the central suction system. One exception to this rule is when intermitting suction is utilized. Intermitting suction

creates an intentional backflow from the suction regulator, through the collection circuit, to the patient. These interventions create a contributory infection vector to the patient from the suction equipment.

A review of the contemporary published research on suction collection systems indicates there is attributable risk from suction collection canisters. An *in vivo* study implicated a change in collection canister handling policy with an outbreak of Acintebacter in a wound clinic. An *in vitro* study of intermitting suction determined that contaminants from the wall suction regulator could be delivered to the suction canister and back to the patient in as little as 24 hours . None of the protocols reviewed in Table 1 cite evidence to support or disprove the Q24hrs protocol chosen by the institution.

Background

Hospital suction systems typically include five common components, listed in order from those distal to those proximal to the patient. - -

Central Pump - - This large piece of capital equipment is maintained by plant engineering. These pumps are commonly located in the basement of the hospital with other physical plant assets.

Piping - - Large diameter pipes connect the central pump with the quick connect outlets found in patient care areas. The pipes vary in size from ½" to 3" in diameter depending on where they are located in the facility.

Suction Regulator - - Located in the patient care area to reduce the high vacuum found in the piping system down to clinically effective levels for patient care. Intermitting regulators are also used to automatically apply intervals of suction followed by periods of canister venting to allow for reflux to the patient. This intentional backflow from intermitting suction interventions allows a return vector for exogenous pathogens. These clinical interventions typically terminate in the mucous membranes of the naso-gastic space. Given the potential cross contamination with delicate tissues, these instruments should be treated as Semi-Critical instruments according to the Spaulding reprocessing guidelines.

Collection Canister - - Rigid canisters serves to capture patient materials by gravity to prevent them from reaching the Suction Regulator, Piping or Pump.

Patient Attachments - - These are items used to facilitate suctioning of the patient and they may include, Ballard® catheters, Levin tubes, Salem™ sumps, or Yankauer suction wands.

By design, suction collection canisters are intended to collect liquids to prevent them from being drawn into the central suction system. Even with contemporary canisters including aerosol filtration, downstream components are not protected from patient contamination. Since suction regulators, piping and the central pump are not routinely switched between patients, they can harbor infectious

Table 2: Risk Assessment of Suction System Components

Component	Contains Exogenous Pathogens at Initiation of Therapy?	Contains Exogenous Pathogens after 4 hours of Therapy?	Backflow to Patient?	Overall Risk to Patient
Cental Pump	Very Likely (ref. AIA/FGI 2010)	Very Likely	Unlikely. Always charged with high vacuum and separated from patient care areas by considerable distance.	Low Risk, does not possess the ability to backflow to the patient.
Piping	Very Likely (ref. AIA/FGI 2010)	Very Likely	Unlikely. Always charged with high vacuum. Most systems will alarm if central vacuum levels dip.	Low Risk, unlikely to possess the ability to backflow to the patient.
Suction Regulator	Very Likely	Very Likely	Very Likely, especially during intermittent suctioning.	Very Likely for Intermitting Suction Interventions.
Suction Collection Canister	Unlikely, units typically shipped in clean, non-sterile packaging.	Likely	Very Likely	LOW RISK if changed on a routine basis.
Patient Attachement	Unlikely. Patient attachments typically shipped STERILE.	Likely	Very Likely	LOW RISK if changed on a routine basis.

agents from previous patients.

For any of these components to present a risk to a patient, two conditions must occur - -

The component must contain an exogenous organism deleterious to the patient **AND**

The component must have the ability to transport that organism back to the patient.

Table 2 was developed to visualize the contributory risk of each of these system components. This chart details the propensity for a system component to contain exogenous pathogens, as well as its ability to deliver these to the patient. The chart was highlighted Green, Yellow, and Red to describe the relative risk of each system component. From the patient's standpoint for these components to present a real risk to the patient, there would need to be an unbroken chain of risk (red) from left to right on the table for each component in question.

Literature Review

A review of published clinical research was conducted on PUBMED (National Institutes of Health, U.S. National Library of Medicine). Research was conducted to identify any previously published peer reviewed articles that evaluated the infection risk from suction procedures supportive of a Q24hrs canister change protocol. Seven applicable articles were identified dating back to 1965. The citation for each article, its authors recommendations, and clinically relevant supporting information is listed below.

The study by Sole et. al. demonstrated a risk of exogenous pathogens at 24hrs, but was silent on a recommendation for a time period to change the suction collection set to break this vector of contamination. The study by Maragakis et. al. demonstrated that failing to change the collection canisters between patients could have led to an outbreak of Acinetobacter. This study did not investigate a time based recommendation to remove this infection risk.

Table 3: Peer Reviewed Suction Research

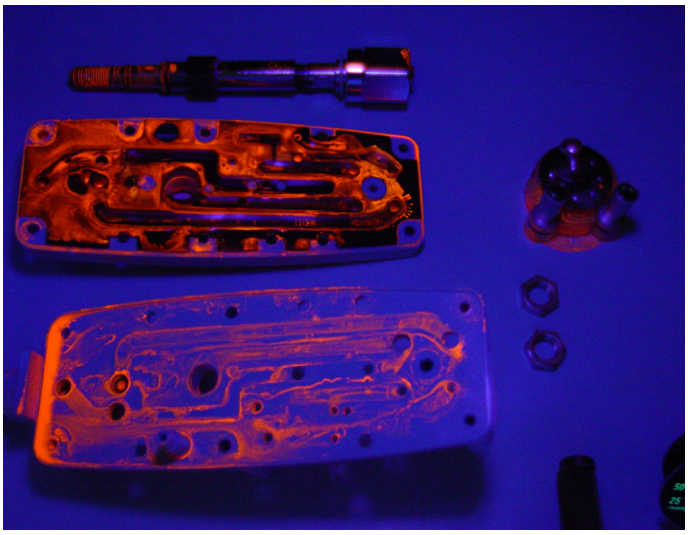
Study	Recommendations	Supportive Data
Sole ML, Poalillo FE, Byers JF, Ludy JE. *Bacterial growth in secretions and on suctioning equipment of orally intubated patients: a pilot study*. Am J Crit Care. 2002 Mar;11(2):141-9.	"The equipment used for oral and endotracheal suctioning becomes colonized with potential pathogens within 24 hours. It is not known if reusable oral suction equipment contributes to colonization; however, because many bacteria are exogenous to patients' normal flora, equipment may be a source of cross-contamination."	Colonization data from 20 subjects intubated at least 24 hours. No data presented on what point during that 24hr period colonization occurred.
Crow, S. *Disposable Suction Canisters*. Infection Control, Vol. 5, No.5 (May, 1984), pp. 235-236	"It seems reasonable to use the smallest canister needed and to change the canister every 24 hours or when full (whichever comes first)."	None cited
Hannah J, Craddock S. *Frequency of changing suction canisters and suction tubing: a descriptive study*. Gastroenterol Nurs. 2007 Sep-Oct;30(5):332-6.	"Although 56.44% of facilities are changing the canister after each patient, there is no standardized practice regarding changing of the suction canister."	None cited. Survey Data Only
Maragakis LL, Cosgrove SE, Song X, Kim D, Rosenbaum P, Ciesla N, Srinivasan A, Ross T, Carroll K, Perl TM. *An outbreak of multidrug-resistant Acinetobacter baumannii associated with pulsatile lavage wound treatment.* JAMA. 2004 Dec 22;292(24):3006-11.	"The change in procedure allowing suction canister inserts to fill before replacing them may have played a role in transmission of the organism."	Microbioligical and DNA analysis of 5 infected patients
Pugliese G, Mackel D, Mallison, G. *Recommendations for reducing risks of infection associated with suction collection procedures*. AM J INFECT CONTROL 8:72, 1980	"To minimize the associated risk, suction collection units and associated suction tubing should be changed at least every 8 to 12 hours, ideally between each hospital shift and in all circumstances between use on patients."	None Cited.
Zelechowski G, *Suction collection and its relation to nosocomial infection*. AM J INFECT CONTROL 8:22, 1980	"Suction collection units, filters, and connecting tubing should be changed after use on patients or every 8 to 12 hours."	None Cited.
Bassett, DCJ, Neonatal Infections with Pseudomonas Aeruginosa Associated with Contaminated Resuscitation Equipment. LANCET 1:781, 1965	"The isolation of the same strain from the aspirator bottles, which were difficult to disinfect and capable of reversed flow, established the possibility that these were the source."	Chart histories from 300 examined mature and premature babies.

In Vitro Data

None of the peer reviewed literature that disclosed a recommendation about collection circuit changes was able to cite a time period that would reduce the risks associated with contaminated collection circuits. The lack of a recommendation based on clinical data requires examining circuit changes from a risk based standpoint. An *in vitro* study showed that contaminants from a suction regulator could contaminate a suction collection canister at levels above $1x10^3$ cfu/ml in as little as 30 minutes. This same contamination was found in a patient analog in less than 24 hours. This would mean a Q24hrs protocol would not provide for adequate patient protection from downstream exogenous organisms.

In this same study, of the five brands of suction regulators currently marketed in the United States, only the Boehringer regulator demonstrated safety in the patient analog at 24hrs, and this same study showed that contamination was still not detectable at 48hrs.

A number of factors facilitate the improved performance of the Boehringer Suction Controls. Efficient internal design enables higher clinically available flow rates . These increased flow rates allow for pathogens drawn into the suction control to be readily moved to the central suction system. Once contaminants have transitioned to the central suction system, patient risk via backflow from the suction regulator is reduced. Other suction regulator designs have tortuous pathways that trap pathogens in the interstices of the control. The buildup of internal contamination may be directly related to the ability of these units to be a vector of infection to the patient.



Flourescent dye highlighting internally contaminated areas

Discussion:

A survey of critical care nurses identified that 93% of hospitals had published protocols for how they handle their collection canisters. Of these hospitals 53% were on already on a Q24hrs change protocol and 43% of the respondents felt their current policy reflected best evidence based practice. The majority of hospitals already employ a Q24hrs canister change practice. These protocols utilize additional disposable medical products, without providing any demonstrated patient benefit. The cost of the disposable equipment, the staff time to change these attachments, and the cost of red bag medical waste must be considered as part of these protective measures.

Potential Capital Equipment Savings:

There are numerous potential cost savings that could be achieved with the proper deployment of capital equipment combined with an evidence based canister change protocol.

Hospitals typically are looking to standardize all of their medical suction regulators. Given the short service life and continual maintenance of plastic models it is sometime expedient to have Central Supply inventory one model of regulator. Standardization of medical suction regulators typically means that intermitting suction regulators are installed in every outlet of the hospital. Intermitting suction is exclusively used in ICU environments for naso-gastric decompression. The remaining clinical suction interventions could be accomplished with less expensive continuous suction regulators. The only identified patient risk for infection from suction regulators comes from intermittent suction regulators. Standardization increases patient risk, increases capital expenditures, but does provide for additional clinical utility.

Proper deployment of quality suction regulators should be cost neutral versus standardization with plastic regulators. A typical ICU headwall employs four suction sources for oral care, airway management, naso-gastric drainage and thoracic suctioning. Three continuous suction regulators and one intermitting regulator can be used in place of four plastic intermitting regulators with no adverse effect on the capital expenditure.

Disposable Device Savings:

Hospitals presently employing a Q24hrs canister change protocol could save money and gain an evidence based practice by using a Boehringer Intermittent regulator in conjunction with a Q48hrs canister change policy.

Listed below are the attributable costs from hospitals presently employing a Q24hrs canister change protocol. This model is demonstrated based upon a single staffed bed, a single Intensive Care Unit, and all of the ICU beds of a typical 300 bed hospital. Since it would be atypical to have a patient undergo intermittent suction while on a step down floor, only the ICU's of the hospital have been used for this comparison.

Table 4: Savings Q48hrs vs. Q24hrs	
	Per ICU Bed
Avg Census	70%
Beds	1
Canisters/Pt	1.4
Canister/Tubing	$2.30
Staff Cost	$3.42
Disposal Cost	$0.31
Yearly Cost Q24hrs	$2,153
Yearly Cost Q48hrs	$1,076
Net Savings / YR	**$1,076**

Assumptions:

- 70% Average Inpatient Census
- 1.4 Canisters employed per patient (Every patient uses a Canister used for endotracheal suction catheter and 40% of patients use a canister for intermittent nasogastric drainage)
- $2.30 Canister Cost (typical contract price for 200 bed acute account)
- $0.31 Disposal Cost (1lb of material in the collection canister and tubing at an estimated cost of $0.31/lb)
- $3.42 Staff Cost reflects 3 minutes of nursing time at an estimate of $1.14 per nursing minute.

Conclusion:

The present Q24hrs canister change protocol does not demonstrate evidence based patient safety given a thorough review of available contemporary literature and the use of the most common medical suction regulators. An *in vitro* model postulated by Kaye, et. al. demonstrates patient safety with a Q48hrs protocol using Boehringer medical suction regulators. Clinician could both address the cross contamination risks presented by intermitting suction and reduce patient care costs by employing a Q48hrs recommendation in combination with Boehringer suction controls.

References:

Kaye, Keith, et. al. (2010). *Suction regulators: a potential vector for hospital-acquired pathogens*. Infection Control and Hospital Epidemiology, 31(7), 772-774.

Maragakis, Lisa, et. al.(2004). *An outbreak of multidrug-resistant acinetobacter baumannii associated with pulsatile lavage wound treatment*. JAMA, 292(24), 3006-3011.

"*Use of Filters on Medical Gas System Outlets and Vacuum System Inlets*" User Experience Network™, ECRI [Health Devices Dec 1994;23(12):494-5] .

Guidelines for Design and Construction of Healthcare Facilities:Facility Guidelines Institute; 2010 Edition. § 2.1-8.4.4.2 Vacuum systems

Neary, Michael, et. al "*The Clinical Importance of Unrestricted Flow in Hospital Suction Systems*" Clinical white paper published August 2008 by Boehringer Laboratories, LLC.

Hill, John, et. al "*The Efficacy of Backflushing Suction Regulators as a Method of Internal Disinfection"* Presented at the 55th Annual International Respiratory Conference (AARC 2009).

Kaye, Keith, et. al *"An Evidence Based Approach to Determining Hospital Suction Canister Change Protocols"* Presented at the 37th Annual Meeting of the Association for Professionals in Infection Control and Epidemiology (APIC 2010).

Karpowicz, John, et. a."*Your Hospital's Cost of Disposable Suction Regulators*" Clinical white paper published September 2010 by Boehringer Laboratories, LLC.

Boehringer Suction Regulator Processing Protocol

Routine Cleaning	On a routine basis, the external surfaces of the suction regulator must be treated in a similar fashion to other patient contact surfaces in your facility.
Service or Fluid Intrusion	Prior to performing service or after fluid intrusion, the suction regulator must be handled in accordance with your hospital's infection control policies and should be cleaned and sterilized.
Patient Turnover	To minimize the risk of cross contamination, it is recommended that intermitting suction regulators be cleaned and sterilized in-between patient uses.
Alternative to Patient Turnover	Cleaning and sterilization of suction regulators between patients may be avoided by implementing a 48 hour or sooner canister change protocol when using Boehringer suction regulators. In vitro testing has not demonstrated this effect with any other marketed suction regulator.

For detailed instructions on cleaning and sterilizing the 3800 Series Suction Regulators please refer to: "Boehringer Platinum Series Suction Regulator Recommendations for Cleaning and Reprocessing" (Document 3800.044 Rev -) Available at www.boehringerlabs.com.

*At any point in time if your facility deems it necessary, the 3800 Series Suction Regulators can be cleaned and sterilized in order to minimize risk for patients and staff at your facility.

Boehringer Laboratories, LLC. ● 300 Thoms Dr. ● Phoenixville, PA 19460 USA
1-800-642-4945 ● www.boehringerlabs.com