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Aqueous Ozone Cleaning System Assessment at Vancouver Coastal Health

Vancouver CoastalHealth

Project Objectives

Part of British Columbia's GreenCare Sustainability Strategic Framework focuses on delivering patient care with zero toxicity with a goal to minimize waste generated and toxic chemicals used by the health care system and supporting operations. It was with this guiding principle in mind that Vancouver Coastal Health (VCH) and its supporting partners set out to explore aqueous ozone (AO) as a safe and more environmentally-sustainable alternative to chemical cleaners currently in use at VCH and Providence Health Care's (PHC) hospitals, health centres and residential homes.

With project leadership provided by Lower Mainland Facilities Management and Lower Mainland Business initiatives Support Services, and together with their support services provider Crothall Healthcare, the team set about to first conduct a Chemical Toxicity Baseline Study with BC-based Prism Engineering. Step two included exploring AO as a safer alternative. Crothall Healthcare had been using AO for floor cleaning* in another BC hospital and were confident the pilot would have positive results.

Aqueous Ozone

AO employs a technology that infuses oxygen and electricity into ordinary tap water, creating a solution that can be used to sanitize hospital surfaces. VCH's Infection Control Department had approved the solution for all general purpose cleaning, which is over 27,000 litres or 75% of the annual chemical cleaner use. These cleaners discharge over 2,500 kg of chemicals of concern into the environment, or 70% of the total annual chemical discharge. A switch to the AO solution would replace a large proportion of existing chemical cleaners used in health care sites across BC's lower mainland.

Current Cleaning Methodology

Cleaning products are currently dispensed by housekeepers using an automated dilution system. Wearing safety gloves, staff dispense water and chemicals into cleaning buckets, floor cleaning machines and small cart-mounted pails. Microfibre® cloths and mops are placed into the bucket to absorb cleaner. The cleaning solution is then applied directly to surfaces such as floors, furniture, switch plates, mirrors, glass and counter tops. Once the first wipe has picked up dirt and other fibres, a second wipe is performed to disinfect factoring in a recommended ten- minute drying time.

Assessing Environmental Impacts of Cleaning Chemicals at VCH Sites

To best determine the environmental impacts of the chemical products currently in use, the research team examined relevant Medical Safety Data Sheets (MSDS), conducted a literature review and explored the options for capturing data from hospital waste water. Their focus was on the following:

1. Volume of cleaning chemicals
2. Types of chemicals, including chemicals of concern, and weights
3. Water waste
4. Packaging waste, and
5. Transportation and Life Cycle Analysis (LCA).

While it was not possible to determine the specific ecological impacts from cleaning products without further study, other environmental impacts of the current system highlight the benefits of switching to the new technology.

Benefits of Aqueous Ozone

A number of benefits accrue when conventional cleaning products are exchanged for AO technology including:

1. Reduced risk to human health
2. Additional cleaning benefits
3. Eligibility for LEED credit, and
4. Favourable financial implications
5. Reduced environmental impacts (chemicals of concern, water consumption, reduced packaging)

Study Results

The following tables show both volume and weight of chemicals consumed under the current cleaning regime.

Use		VOLUME (Litres/Year)
GENERAL CLEANERS To be replaced	Toilet Bowl Cleaner	9,478
	Floors	11,985
	Multi-Surface General Purpose Cleaner	3,083
	Glass & Steel	2,103
	Carpets	638
	General Cleaners - to be replaced	27,287 (76%↓)
PATIENT ROOM Will Remain	General Patient Room Disinfectant	4,493
	Disinfectant	3,933
	Multi-purpose Cleaner Degreaser	328
	Patient Room Totals - not to be replaced	8,754 (24%)
	TOTAL	36,041

Table 1: Volume of Cleaning Chemicals

Use		Chemical Weight (Kg/Year)	Chemical of Concern Weight (Kg/Year)
GENERAL CLEANERS To be replaced	Toilet Bowl Cleaner	332	332
	Floors	1,816	1,816
	Multi-Surface General Purpose Cleaner	362	299
	Glass & Steel	126	42
	Carpets	79	49
	Replacement Totals	2,715 (67%↓)	2,538 (70%↓)
PATIENT ROOM Will Remain	General Patient Room Disinfectant	1,123	944
	Disinfectant	139	99
	Multi-purpose Cleaner Degreaser	75	50
	Patient Room Totals - not to be replaced	1,337	1,093
	TOTALS	4,052	3,631

Table 2: Type and Weight of Cleaning Chemicals

Cleaner Product Quantities

Housekeeping used over 36,000 litres of cleaning product per year across VCH and PHC sites in 2016. Using specific gravity and chemical quantity figures on the relevant MSDS sheets combined with litres of product used, the total weight of chemicals used at VCH and

** Note there is a difference between cleaners and disinfectants. While cleaners remove particles such as dirt and dust, disinfectants are antimicrobial agents that kill microorganisms living on objects.*

and PHC sites in 2016. Using specific gravity and chemical quantity figures on the relevant MSDS sheets combined with litres of product used, the total weight of chemicals used at VCH and PHC sites in 2016 was calculated: 4,052 kg. Of this, 90% or 3,631 kg is associated with a Chemical of Concern (Table 2). The implementation of AO will result in a decrease of approximately 2,538 kg/year, or 70% less chemicals concern being discharged into the environment.

There is the possibility that some of these chemicals may adhere to the surfaces and not discharged with the water, and as provided in Table 6, the actual quantities of chemicals discharged to waste water could be up to 30% of the estimated quantities.

Water Used for Cleaning

It is important to note that water is used in three ways when preparing cleaning solutions:

1. Purchased: As a product included in purchased cleaner concentrate
2. Dilution: To dilute concentrated cleaning product

product use

Water Used for Cleaning	Volume Litres/yr
Purchased water within cleaning products (VCH & PHC 2016)	~ 32,020
Dilution water needed to use cleaning product	17,584,496
Subtotal: Assume this water volume stays the same with AO	17,616,500
System Flushing Water (flushing required when switching cleaners)	3,303,830 Before AO
Water Use with AO	330,383 After AO
Water Savings with AO	**2,973,447 (90%↓)**

Table 3: Water used for cleaning

Packaging Waste

Attention must also be paid to the impacts of packaging waste associated with traditional cleaning chemicals. Estimates show a total number of 21,493 packages, including plastic and cardboard shipping containers.

Type of Packaging Waste	# Containers/yr
2.5 L Plastic bottles of cleaner containers purchased (2016)	17,100 (83%↓)
Cardboard shipping containers	4,393 (72%↓)

Table 5: Types of packaging waste

Exposure Risk by Cleaner Type

Although more research would need to be done on the specific chemical cleaners used by VCH and PHC cleaning staff, including further mapping out of the cleaning process to quantify number of exposures and well as paths to exposure, we do know healthcare cleaning staff are at some risk of adverse human health impacts. One study states "…sensitization may occur even at trace concentrations."

Multiple studies show increasing incidences of asthma and asthma-like symptoms among cleaning staff. Epidemiological investigations support a direct link to developing or worsening respiratory symptoms and there is evidence to support claims that cleaning products negatively impact human health, however, specific chemicals responsible for respiratory symptoms have not yet been identified. No such complaints have been presented to VCH to date.

Type of Cleaner	Inhalation	Dermal
Floor cleaning	Low	Low
Floor stripping/waxing	High	Low
Window/Mirror	Medium	High
Sink	Medium	High
Counter	Medium	High
Toilet bowl	Medium	Medium

*Table 6: Exposure risk by cleaner type***

Summary of Other Benefits to Using Aqueous Ozone

Researchers are confident in saying the use of AO brings with it possible reduced risks to human health including reduced slips and fall incidents, skin contact and issues associated with inhalation of chemicals. Further, enhanced cleaning performance was noted including a greater consistency in cleaning practices, no streaks on surfaces, the potential to reduce Hospital Acquired Infections, and longer life/reduced deterioration of floors and furniture. The technology also meets EcoLogo and Green Seal standards, can provide LEED credits and forms part of the Healthier Hospitals Safer Chemicals Challenge framework. While transportation and LCA impacts could not be fully evaluated in this study, it is expected that with reduction of transportation for product delivery there would be associated GHG reductions. From a financial perspective, it would cost less to use AO than the five regularly used cleaning chemicals. Other costs would also be reduced, including water and sewer charges, packaging and recycling costs as well as reduced labour costs associated with slips and falls and other health impacts.

Very small increased electricity costs would occur as a result of running the AO unit.

Summary of Environmental Results if Aqueous Ozone Used

Environmental	Value	Notes
Quantity of general cleaners used (litres/yr)	↓ 27,287 (76%)	
Chemicals in general cleaners (kg/yr)	↓ 2,715 (67%)	Possible range 30 – 100% • 815 – 2,715
Chemicals of Concern in general cleaners (kg/yr)	↓ 2,538 (70%)	Possible range 30 – 100% • 762 – 2,538
Water use (litres/yr)	↓ 2,973,447 (90%)	Reduced water costs: • Purchase of water • Waste water cost
Packaging waste (# containers/yr) **Plastic** **Cardboard**	↓ 17,100 (83%↓) 4,393 (72%↓)	~ Reduced # collection lifts ~ Reduced labour for: • materials handling • secure recycling markets (* plastic market)
Transportation delivery GHG emissions / LCA	↓	No actual estimates

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** Bello, A., M. Quinn, M.M., Perry, M.J., Milton, D.K. (2009). Characterization of occupational exposures to cleaning products used for common cleaning tasks-a pilot study of hospital cleaners. Environmental Health, 8(11) 1.

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