Mitigating Hand Contamination at Recycling Depots: Are Hand Wash Stations in Metro Vancouver Meeting Public Health Standards?

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Abstract

Background and Purpose: Although the number of recyclers and amount of accepted materials and their contaminants has increased over the decades, the adequate provision of hand washing equipment to mitigate the transfer of infectious agents at recycling depots has not been well studied. Minimal Standard (MS) depots and STAR-Rated (SR) depots are inspected by Encorp Pacific (Canada) auditors, not health inspectors, and claim to provide adequate hand hygiene equipment. This study compared the adequate provision of essential hand washing equipment at MS and SR depots in Metro Vancouver to determine if they met public health standards.
Methods: Inspections of presence/absence of essential hand washing equipment (tap with running water, soap in soap dispenser, hand drying equipment and signage) were carried out at 35 depots throughout Metro Vancouver (Vancouver West End to Abbotsford). Depots recorded with all components were assigned a Pass grade; depots with any one missing component or more were assigned a Fail grade. MS/SR and Pass/Fail grade was analyzed using Chi-squared test on NCSS 9 Statistical Software (NCSS).
Results: Of the 35 depots surveyed, fails were present in both MS depots and SR depots. Very few depots had signage. Main reasons for Fails included broken hand dryers and lack of soap. All depots with hand wash stations had running water. Pearson's Chi-square results for observed Pass/Fail and MS/SR depots compared to expected values were unable to reject null hypothesis (P-value 0.911 > 0.05) even when provision of signage was excluded as a criterion (P-value 0.537 > 0.05).
Conclusion: There was no association between depot standard rating and provision of essential hand washing equipment. Lack of signage failed 74.3% of depots but excluding signage from the criteria failed 34.3% of depots. Hand washing is important in mitigating risk of infection from hand contamination from household recyclables and those sorted from waste. Inspecting depots and educating operators from a public health viewpoint may increase provision of essential hand washing equipment and increase hand washing compliance in public users.

Keywords: hand washing, hygiene, wash station, hand contamination, infection, signage, compliance, Metro Vancouver, recycling

Introduction

Since 1997, residents across British Columbia have been sorting and dropping off recyclables for cash refund, at local depots within their communities (Wittmer 2014). Depots are owned by private contractors under Encorp Pacific (Canada) (EPC), a provincial stewardship agency of the Beverage Container Stewardship Program Regulation, BC Reg. 604/97. Since May 2014, Multi-Material BC has included additional, accepted recyclables (e.g. Styrofoam, meat trays, egg cartons, milk jugs, metal cans and other residential packaging) (MMBC, 2014). As a result, recycling depots have become high-traffic locations where the public congregates and sorts by hand, an increasing list of materials from often untraceable origins. Since there is the potential of materials carrying hazardous substances, there is increasing concern on how to mitigate the transfer of potential pathogens and chemical contaminates to customers hands and the health risks these facilities may have on public health.

Yearly, auditors from EPC inspect facilities based on cleanliness, customer service, staff training and general aesthetic layout (EPC, 2010). Facilities are rated Minimal Standards (MS) or STAR-Rating (SR) primarily based on aesthetic appeal and customer satisfaction. Incentives and 3-STAR or 5-STAR ratings are provided, after inspections, to depots that provide additional, aesthetic appeal requirements and facility upgrades to attract customers. Currently, the checklist type inspection has no input from Health Authorities or Environmental Health Officers (EHOs). Inquiries on Google Scholar, Medline, UBC Database and EPC (2014) online showed no current reports on the adequacy of hand wash stations at recycling depots in Metro Vancouver.

These gaps in evidence raise concerns on the current conditions of hand washing stations at recycling depots and whether they meet public health standards. With the growing amount of products being accepted and the increasing number of recyclers, prevention strategies such as hand washing need to be in place to safeguard public health. This study surveyed the provision of essential hand

washing equipment by conducting inspections at MS and SR recycling depots in Metro Vancouver.

Literature Review

Users at Risk

EPC's provincial survey of users aged 19+ showed that the majority of regular recyclers are middle-aged or older, with 38% of users being 55+ (EPC, 2013). Twenty nine percent are families that have children; of those, 14% have young children (EPC, 2013). These statistics likely under-report the number of users at risk since children are not surveyed. Increasing trends of recycling programs for school fundraising increases the number of children who may be exposed potential health risks. The elderly and children are two groups with lower immunity and who are more susceptible to communicable diseases.

Low-income Groups: Often left unsurveyed, are informal recyclers, who sort through garbage receptacles for refundable containers for cash refund (Gutberlet *et al*., 2009). Studies worldwide and in Canada consistently show informal recyclers have lower or compromised immunity, higher prevalence of chronic diseases and higher incidence of communicable diseases (e.g. Hepatitis-B, influenza, tuberculosis and various other respiratory, dermal and gastro-intestinal infections) (Binion and Gutberlet, 2012; Gutberlet *et al*., 2009). It is estimated that more than a thousand people may depend on binning as their partial or entire source of income in Vancouver and that this number is expected to increase (Tremblay *et al.,* 2010). Surveys showed travel patterns and organized territories around depots in various communities throughout Metro Vancouver (Tremblay *et al*., 2010), which may have special implications on the communicable disease spread, with recycling depots as the foci. As informal recyclers migrate to, from and within metropolitan areas such as Victoria and Vancouver (Gutberlet *et al*., 2009), they may spread diseases and put the public and themselves at risk of contracting diseases.

Sick workers: Additionally, an overwhelming number of research articles have shown that workers at recycling and waste management depots are more prone to occupational related infections and illnesses (Lavoie *et al.*, 2001; Lavoie *et al.*, 2006; Paulsen *et al.*, 1995). Employees at sorting depots, around the world, often report respiratory infections, diarrhea and conjunctivitis but are rarely vaccinated against common infectious diseases, including tetanus and poliomyelitis ((Binion and Gutberlet, 2012). A review of the Employee Handbook shows no sick worker policy (Bottle Depot, 2010). Sick workers at depots could transmit disease through sneezing, coughing, dermal contact during daily transactions with the public.

These findings show that depots are locations where there may be higher number of persons who carry communicable diseases and who can potentially infect other users. A significant portion of users are also immuno-compromised individuals (Binion and Gutberlet, 2012; Gutberlet *et al.*, 2009). However, a survey of Health Canada (2014) and health authority websites (Fraser Health, 2014; Vancouver Coastal Health, 2014) yielded no reported outbreaks directly associated with recycling depots to date. Regardless, the potential health risks associated with recycling depots cannot be ignored since they involve of a significant number of persons of varying health status, congregating at community centers, on a routine basis.

Risks at Recycling Depots

Environmental risk factors at recycling depots vary depending on the source of the material, type of material, surface texture, and the ability of pathogens to survive on surfaces (Lavoie *et al.,* 2006). Physical safety due contact with recyclables mixed with sharp objects, broken glass and medicinal waste is also a concern (Binion and Gutberlet, 2012). Much research has qualitatively described the presence/absence of certain pathogens at solid waste management facilities, including recycling depots (Binion and Gutberlet, 2012; Lavoie *et al.,* 2006). However, little research exists on the current risks that are present at recycling depots in B.C.

Binion and Gutberlet (2012) and Lavoie *et al.* (2006) studied the general amount of filth at recycling depots and categorized pathogens of public health significance to include bacteria (*Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, *Clostridium difficile*, *Shigella spp.* and dermal yeasts), fungi, viruses (Hepatitis B and HIV), protozoa and parasites (*Toxoplasmosis gondii*). They also observed pests as vectors. Median rates for the viable fraction of aerosolized bacteria and fungus was measured to be 12,850CFU/m^3 for personal exposure and 6500CFU/m^3 for background exposure at urban recycling depots, which was surprisingly higher than mixed urban waste facilities (Lavoie *et al*., 2006). Studies at sorting facilities determined that the presence of fecal coliforms, fungus, bacteria and dust are at high enough concentrations to cause adverse health effects on workers with long term exposure (Poulsen *et al*., 1995). Although these studies have shown that high amounts of contamination exist at recycling depots, the public health risks of short term exposure have yet to be determined.

Pathogen Growth: Rinsing recyclables physically removes debris but also introduces moisture for pathogen growth. Mould and bacterial load of recyclables depend on their source and whether recyclables are stored open to air (Binion and Gutberlet, 2012). Bacteria, fungi and viruses have shown to persist longer on plastics at cooler temperatures with high humidity, while there is no difference in persistence on other surfaces (Kramer *et al*., 2006). *Staphylococcus aureus*, *Streptococcus pyogenes*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Clostridium difficile*, *Shigella spp.* and other gastrointestinal viruses can survive for months on inanimate, dry surfaces in both nosocomial and laboratory environments (Kramer *et al*.,

2006). Respiratory tract viruses (e.g. influenza) can survive on surfaces for a few days (Kramer *et al*., 2006). Wet paper products are shown to be a more effective reservoir (Lavoie *et al*., 2006). High humidity and low temperatures are consistent with storage of rinsed recyclables in spaces such as basements or closets that have cool temperatures with little ventilation. Recycling depots often have forced air ventilation to control odors but the cool, moist environment may aid in pathogen growth.

Few studies have examined the sanitation of tray surfaces that are handled repeatedly by the public for sorting. Nosocomial research has shown that high touch surfaces such as plastic trays increase contamination rates and patient infections (Dancer, 2010). Reusable trays may be comparable to plastic surfaces in nosocomial environments that also have high touch and high inoculation rates (Kramer *et al*., 2006). However, the study may not accurately reflect situations at depots where surfaces can be simultaneously contaminated with microbes from various sources. Trays are of a particular concern since they may be handled by many customers without being disinfected in between use. Lack of disinfection of trays and moist environments, may lead to development of biofilms that harbor and aid pathogen growth.

Transmission of Infectious Agents

Users handle recyclables and sorting trays, which are fomites, coated with organic/inorganic debris and have biofilm and potential pathogens described above. At the recycling depot, sorting counters (plastic or stainless steel) and sorting trays (plastic or cardboard) are not required to be cleaned periodically by staff. Even with regular cleaning of high touch surfaces, such as trays, Boyce (2007) showed that this may not always remove pathogens but rather accumulate pathogens and cause them to become reservoirs and sources of contamination.

Transmission: Reports showed that the most successful (100%) transmission rate was observed on nosocomial surfaces contaminated with high counts of *E.coli*, *Salmonella spp.* and *Staphylococcus aureus* (Kramer *et al*., 2006). Lower transmission rates were observed with viruses (Kramer *et al*., 2006). Hands, especially using gloves that are contaminated with viruses, can be sources that re-contaminate multiple surfaces (Boyce, 2007; Kramer *et al*., 2006). Employees, wearing gloves, can spread potential pathogens to other surfaces and persons during transactions and while helping customers sort. Infection risk by surfaces verses dermal contact with lesions from carriers is about the same for pathogens with low infectious dose (e.g. *S. aureus*, 15 cells can induce infection; *C. difficile* and Norovirus) (Otter *et al*., 2011).

Route of Exposure: Due to the nature of hand sorting materials that have had little disinfection, it is expected that the risk of hand contamination by microbes is relatively high. Persons can be infected by dermal contact with infectious agent or chemicals on recyclables, through the skin, cuts and lesions. Persons can also absorb chemical contaminants by accidently touching their eyes (mucus membrane) and ingest pathogens and substances by touching their mouths (fecal-oral route) before performing hand hygiene or after inadequate hand washing (Fig. 1).

Best Practices in Hand Washing

Best practices for hand hygiene in nosocomial environments include the use of warm, running water, lathering for 15 seconds with soap from a dispenser, rinsing thoroughly with running water and drying with paper towel (BC Ministry of Health, 2012). Water needs to be free of contaminants so it does not introduce additional contaminants to hands (BC Ministry of Health, 2012). Alcohol is ineffective when hands are visibly soiled and bar soaps are not allowed (BC Ministry of Health, 2012). Antibacterial hand sanitizers have been shown to be effective only when used in large amounts (Michaels *et al*., 2003).

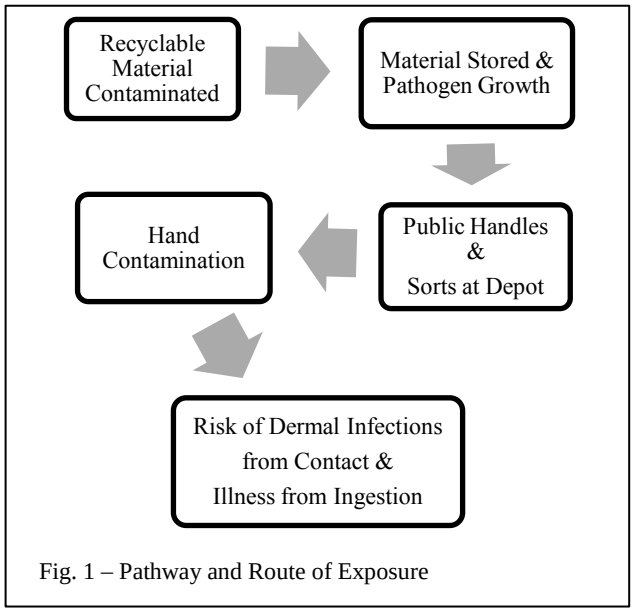

Fig. 1 – Pathway and Route of Exposure

Hand Dryers: These are only effective if they are high speed (drying within 10-15s) or if the user rubs hands while drying (Todd *et al*., 2010). Dryers that do not sufficiently dry hands after 10-15s could cause user frustration and long line ups or result in users drying by wiping on clothing (BC Ministry of Health, 2012). Both result in unwanted recontamination of hands. Health care settings suggest disposable paper towels and waste paper bins placed near the exit is the most effective in preventing re-contamination (BC Ministry of Health, 2012). Hand dryers are not to be installed unless touchless taps are installed (BC Ministry of Health, 2012).

Public Health Significance: Adequate hand washing stations for customers would provide a vital control step to mitigate hand contamination. Hand washing stations promote customers' hand and personal hygiene, which are

essential concepts for protecting public health. Systematic reviews of community hand hygiene shows strong correlational evidence between increasing hand washing practice and a decrease in respiratory illnesses (e.g. influenza) in children of middle to low-income families (Warren-Bash *et al*., 2013).

Proper hand hygiene stations allow opportunities to help improve preventative education and the health of marginalized individuals. Informal recyclers increase infection risk when they come into direct contact with pathogens through binning but studies conclude that most continue recycling without personal protective equipment, treatment or medical care (Gutberlet *et al.*, 2009). Hand washing at recycling depots may be the only form of hygiene treatment for these marginalized groups.

Current Hand Washing Stations at Depots

To date, there are 171 recycling depots in B.C. registered under EPC, comprising of 700 employees and 98 locations within Metro Vancouver (EPC 2014; EPC 2013). Depots are situated at community centers and receive an abundance of visitors on a daily basis. From the overview of EPC's Annual Report and Stewardship Plans, it is clear that their focus is on the aesthetic appeal of the facility including customer comfort, in order to attract more recyclers and generate more revenue (EPC, 2013; EPC, 2014; EPC Stewardship Plan, 2014). As a result, it is speculated that facilities lack public health input and research based standards.

EPC has taken initiatives to require all their depots to have hand wash stations in order to meet minimum standards for operation (EPC, 2013). All depots are required to have a hand wash sink, soap and hand drying equipment (paper towel dispenser or hand dryer) (EPC, 2011). There is no mention of the type of soap, type of air dryer or requirements for potable water. There is no mention of hand washing signage requirements. Auditors inspect facilities 1-2 times per year and depending on request by operators for upgrades to a STAR-Rated depot. However, auditors are not likely to have a public health background since their criteria checklist is based on customer comfort.

EHOs can play a role in research, inspection and advocacy for prevention programs and policy changes. EHOs can ensure that all facilities are designed and operate with public health and safety in mind. With the growing amount of products being accepted at depots and the growing number of recyclers, prevention strategies such as hand washing policies need to be in place at recycling depots to safeguard public health.

Research Objectives

The purpose of this research project is to determine the adequacy of provision of essential hand washing equipment (e.g. running water, soap in dispenser, hand drying equipment and signage) of Minimal Standard (MS) depots compared to STAR Rated (SR) depots in Metro Vancouver:

Ho: There is no association between the adequacy of hand wash stations (Pass/Fail) and the assigned depot rating (MS/SR).

Ha: There is an association between the adequacy of hand wash stations (Pass/Fail) and the assigned depot rating (MS/SR).

Methods and Materials

Information on recycling depots, available from EPC online (www.return-it.ca/locations/) was collected on a Microsoft Excel spreadsheet (DepotLocations.docx) and numbered randomly. Data collection involved traveling by vehicle to 35 locations (out of the total of 69 depots) throughout Metro Vancouver (furthest west point was Yaletown and furthest east point was Abbotsford) (Fig. 2). Inspections of the facilities' hand hygiene stations was achieved by using a "test shopper" method, during business hours (Monday to Saturday) over a one week period. No MS/SR rating information was collected from EPC online until the inspections were tallied at the end to ensure that no biases were given to depots at the time of inspection.

Fig. 2. Map surveyed regions showing number of depots in each city across Metro Vancouver, from Vancouver West End to Abbotsford (EPC, 2014).

Inspections were completed by entering the facility, locating the hand wash station (visually or by asking staff), visually observing whether signs were present, turning on the tap to check for running water, checking the soap dispenser function and quantity of soap and checking the working function of the hand dryer or availability of paper towels from a dispenser. Hot and cold water or hand sanitizer was noted in observations. Inspections were carried out in approximately 2-3 min at each facility and included minimal interaction with customers or staff. Presence/absence of each component was recorded on Form 1 (Appendix I). Observations such as wording of signage, approximate temperature of water, variations in type of equipment (e.g. paper towel dispenser, high speed hand dryer, bar soap) were noted.

Facilities that had all four components, at the time of inspection, received a Pass (P) grade; any one missing component received a Fail (F) grade. Data was described by calculating proportions and percentages using Microsoft Excel. The number of P/F in MS and SR depots was analyzed using Chi-squared test on NCSS 9 Statistical Software (NCSS) to determine if adequacy of hand wash stations was dependent on the depot standard rating.

Exclusion Criteria

Due to time constraints and feasibility, easily accessible depots along major routes and intersections were captured. Selection of depots along the route was random but effort was made to capture as many depots as possible, in as many communities across Metro Vancouver as possible. Depots that accepted only electronic waste, located within other corporations such as Staples and Futureshop or those independently owned under or regulated by BC Liquor were excluded. EPC minimally regulates these stores and has no expansion prospects in their Stewardship Plan to include other products (EPC, 2014), which may have potential public health significance.

EPC allows some MS depots to have hand sanitizer stations (EPC, 2014), which would automatically fall under "Fail" according to Form 1. It is not known how many MS depots currently use hand sanitizer (EPC, 2014). Hand sanitizer was shown by the Literature Review to be ineffective when hands are covered in debris (BC Ministry of Health, 2012; Todd et al., 2010), such as in the case handling recyclables. These depots will be counted and noted under in Form 1.

Feasibility: The study was feasible in that the time spent at each depot is minimal, since hand washing at each station required about 2-3 minutes. Paper forms incurred a minimal cost. The most time consuming and costly portion of the study was traveling between depots from Vancouver to Abbotsford. Rerouting and locating depots in the various communities required an average of 15-40min between each inspection.

Ethical Considerations

The risks of this study were negligible. Traveling to depots and hand washing as a "test shopper" did not pose any evident risks more than normal risks as a visiting customer. Inspections of this sort have been completed in Alberta by inspection employees, where no evident risks to workers were listed (Beverage Container Management Board, 2012). Inspections can contribute to the understanding of existing public health measures and those that can be improved upon at recycling depots.

Business names and individual names were not identified to protect the autonomy of the depot, its workers and customers. This ensured that the businesses were not affected. Entry into the premises was like any other customer allowed public access onto the grounds of the business. No restricted, private or staff entrances were used. Checklist evaluation of the premise (Form 1) was completed outside of the business premises, minimum one block away, to avoid influencing customer or employee reactions.

Results

A total of 35 depots were surveyed from in Metro Vancouver from Vancouver (West End) to Abbotsford including 15 SR depots and 20 MS depots. Ten out of 15 depots had the highest standard rating of 5-STAR (5S) while the 5 others were 3-STAR (3S) (Form 1, Appendix I). Selection of depots was random, since the depot standard rating was unknown during time of inspection. Depots are also independent of each other since they are independently owned and operated as private contractors under EPC or the Regional District.

Descriptive Statistics

Three depots had only hand sanitizer, which in this study's definition is inadequate and a Fail designation. Not including those that failed because of hand sanitizer use only, all other depots that supplied hand wash stations had running water. Out of those that provided hand wash stations, 65.6% provided sufficient soap, while the rest (34.4%) had empty soap dispensers or soap that was diluted with too much water that insufficient soap suds could be formed for adequate hand washing (Fig. 3). One location had only bar soap, which by definition is considered a Fail.

Of those that provided hand drying equipment, 71.9% were functional. Other depots had either broken hand dryers with no other forms of hand drying provided (e.g. no paper towels) or hand dryers that had insufficient speed (no drying of hands achieved after more than 30 seconds of drying). Most locations have automatic or fully opened doors for user entry and exit, which allows users to avoid recontamination of hands when they exit.

Both types of hand hygiene stations, regardless if they are providing hand sanitizer or wash stations were assessed for adequate signage. No hand sanitizer stations provided

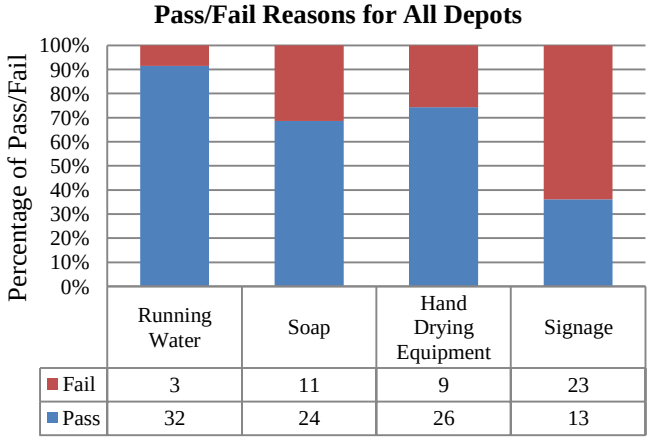

Fig. 3 - Pass/Fail proportions for each criteria for all 35 recycling depots.

signage reminding users of hand hygiene. Of the depots that hand wash stations, 37.1% of depots provided signage. The most common type of signage provided were large lettering above hand hygiene stations that read "CLEAN UP HERE". These signs matched the other signs around the facility and supplied by EPC. No depots provided signage on proper hand wash procedures. One location provided a printed sign by the owner that had "HAND WASH" in both English and Chinese. Other signage observed were facility maintenance signs, usually apologizing for non-functional hand dryers.

As a result, 12 (34.3%) of depots failed to provide adequate hand wash stations and 23 (65.7%) passed, if signage was not included as a criteria for passing. If hand wash signage was included as a criteria, 26 (74.3%) of depots failed and only 9 (25.7%) passed out of the 35 surveyed.

Inferential Statistics

Results which included signage as a criterion at MS (15 F; 5 P) and SR (11 F; 4 P) depots (Fig. 4) were compared to expected counts assuming independence of MS (14.9 F; 5.1 P) and SR (11.1 F; 3.9 P) depots (Results, Appendix III). Pearson's Chi-square value (χ^2=0.0125) did not exceed expected value of χ^2=3.84 and null hypothesis was not rejected (P=0.911 > P=0.05) (Table 1). There was no association between MS/SR depot rating and Pass/Fail of hand wash stations when a signage criterion was included.

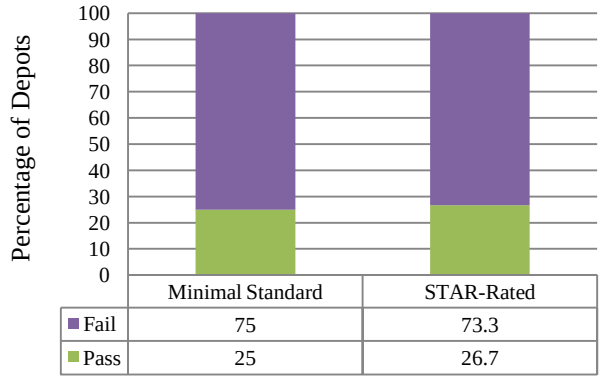

Fig. 4 - Pass/Fail and depot standard rating results including signage as criterion.

Results which excluded signage as a criterion for MS (6 F; 14 P) and SR (6 F; 9 P) depots were compared to expected counts assuming independence of MS (6.9 F; 13.1 P) and SR (5.1 F; 9.9 P) depots (Results, Appendix III). Pearson's Chi-square value (χ^2=0.380) did not exceed Chi-square distribution table value (at P=.05, DF=1, χ^2=3.84) and null hypothesis was not rejected (P=0.537 > P=0.05) (Table 1). There was no association between MS/SR depot rating and Pass/Fail of hand wash stations when a signage criterion was excluded.

Chi-squared tests were also applied to each of the criterion that evaluated depots individually, to see if there was an association of lack of provision of each of the essential hand washing equipment and the depot rating (Results, Appendix III). Results showed that there was no association between MS/SR depot rating and Pass/Fail provision of soap (χ^2=0.0442 < χ^2=3.84; P=0.833 > P=0.05), hand drying equipment (χ^2=0.2682 < χ^2=3.84; P=0.605 > P=0.05) or signage (χ^2=0.0912 < χ^2=3.84; P=0.762 > P=0.05) (Table 1).

Chi-Square test may not have been reliable for expected frequency contingency tables for Pass/Fail with signage, soap and hand drying equipment as a criterion, since these contingency tables had at least one expected cell value of less than 5 (Table 1). Including more depots in Metro Vancouver would yield a larger sample size and more reliable data. The chance of β-error would also decrease with a larger sample size.

Table 1 – Inferential Statistic Results for all Pass/Fail Criteria and MS/SR Depot Rating

Test Label	χ^2 -Value	P-Value	Reject H_o at α = 0.05
P/F Soap and MS/SR Depot Rating	0.0442*	0.833	No
P/F Hand Drying Equipment and MS/SR Depot Rating	0.268*	0.605	No
P/F Signage & MS/SR Depot Rating	0.0918	0.762	No
P/F Rating without Signage as criterion and MS/SR Depot Rating	**0.380**	**0.537**	**No**
P/F Rating with Signage as criterion and MS/SR Depot Rating	**0.0125***	**0.911**	**No**

*Expected cell value had at least one value less than 5

Discussion

Separating mixed recyclables from household or mixed waste, especially for informal recyclers, can be a hazardous task with many health concerns (Wilson *et al.*, 2009). Bare hands are most frequently used and thus the most common route of pathogen transmission (Zanni, 2008). Therefore, the significance of frequent hand hygiene cannot be overstressed (Burnett et al., 2009). Industries have suggested that the most ideal facility should include a hand washing station, as well as another washing unit to clean contaminated trays (Underwood, 2003). However, this study surveyed the minimum requirements for adequate hand hygiene at depots and determined that many did not pass the criteria.

The results showed that provision of essential hand washing equipment was inconsistent. Of the three depots that had hand sanitizer only, one had SR designation. This was contrary to the advertized inspection criteria that required SR depots to have hand wash stations. This suggested that inspections do not emphasize the importance

of hand washing over hand sanitizer use, even though consistent studies have shown hand washing is more effective in reducing hand contamination when debris is present (BC Ministry of Health, 2012).

All other depots provided running water. However, no water samples were taken to ensure that water provided was potable. Potable water is required for hand washing so that washing does not add contaminants to hands (BC Ministry of Health, 2012). Many of these depots were located in industrial zones, at the city outskirts, which had increased risk of contaminated water supplies.

Surprisingly, more than a third of depots failed to provide sufficient soap and differed on types of soap provided, regardless if they were MS or SR depots. Luby *et al.* (2005) showed that children, less than 5 years old, who lived in households using plain soap and who had hand washing education had 50% less incidence of lower respiratory tract diseases than controls. There was no significant difference between plain soap and antibacterial soaps (Luby *et al.*, 2005). However, most depots diluted soaps with water, preventing adequate lathering. This was likely due to cost and also suggested that staff at these depots do not understand the importance of soap provision in hand washing.

Observations showed that majority of soap provided was commercially bought and varied between depots, with one depot providing bar soap. Bar soaps are unacceptable due to hand contamination between users (BC Ministry of Health, 2012). EPC inspection criteria and SR standard checklist for hand wash stations was likely not detailed enough to include type of soap and depots likely did not train staff to understand the public health significance.

Provision of hand drying equipment was also inconsistent in both MS and SR depots. SR depots did provide more high speed dryers, as required by the SR checklist. However, those MS and SR depots that had broken hand dryers or insufficient drying speed do not provide enough hand drying. Studies have shown that insufficient hand drying by dryers was more likely to allow users to dry hands on clothing and re-contaminate hands (BC Ministry of Health, 2012). Most locations did have automatic or fully opened doors for user entry and exit, which allowed users to avoid recontamination of hands by door handles when they exit. However, open door concept was likely used to increase ventilation of the facility and not a consideration of hand hygiene, since strong odors of alcohol and juice fermentation could be noticed upon entry.

Broken hand dryers with aged and stained signs posted next to them suggested that hand dryers have been non-functional for a long period of time without repair. These depots did not provide alternative methods of hand drying (e.g. paper towels), which showed that staff was also not aware that this aspect was important for hand hygiene.

Overall, very few depots provided paper towels, which showed that cost or environmental concern was important to operators.

Unexpectedly, findings showed that there was no association with provision of essential equipment at hand wash stations and whether depots were MS or SR, regardless if the criterion for signage was included or excluded. However, including signage as a criterion was a major factor for failing depots. Almost three quarters of all depots failed, regardless of their standard rating, when signage was included as a criterion. The failure rate decreased to a third when results were analyzed without signage as a criterion. This showed that signage is not an important consideration for either MS or SR depots. Those that provided signs did have large, colored signs that were likely to attract customer to hand wash, though no further signage displayed proper hand washing techniques. Studies have recommended that signage should be included as an essential component of hand hygiene promotion (Ott *et al.*, 2009).

Overall, findings were contrary to publically advertised perceptions that SR depots have higher standards in general. It was expected that SR depots would have more adequate hand wash stations since the facilities have undergone aesthetic upgrades, audits and inspections and their staff have full training. However, the results suggested that perhaps the public health significance of hand wash stations was overlooked during inspections and daily staff maintenance, regardless the facility's MS or SR standard rating.

Limitations

Chi-Square test may not have been reliable for expected frequency contingency tables for Pass/Fail with signage, soap and hand drying equipment as a criterion, since these contingency tables had at least one expected cell value of less than 5 (Table 1). Including more depots in Metro Vancouver would yield a larger sample size and more reliable data. The chance of β-error would also decrease with a larger sample size.

Only 35 depots were surveyed out of 69 total depots in Metro Vancouver. The small sample size limits both the accuracy and validity of the data. Fewer SR depots were surveyed than MS depots, limiting the validity of SR depot data inferential statistic analysis with MS depot data. Equal number of SR and MS depots could have been randomized and selected prior to inspections. Regional depots could have been listed and analyzed separately since they operate independently from private EPC contractors and have different standards. Regional depots could have higher or lower standards and contributed to biased results.
The "test shopper" methods of inspections used in this project has been shown to be reliable when inspections were consistent and geographic area is limited (Albersmeier *et al.*, 2009; Jones *et al.*, 2004). Metro Vancouver spreads over many municipalities and two health authorities. The large geographic area contains depots of varying standards depending on facility location (e.g. urban, industrial and rural setting), which could have limited the reliability of the

data collected to reflect urban settings and highly populated, community center locations. Future inspections could focus on locations within the densely populated areas of the Lower Mainland and separate inspections and analyses could focus on the Fraser Valley.

As with all inspections, these observations are also "snapshots" of the depot operation and may not accurately reflect how the depot is maintained the majority of the time. For example, the soap dispenser may have run out of product at that time during the inspection and the operator was just about to refill the dispenser. Future inspections could increase the number of visits to depots to three different times, to increase reliability of findings.

Conclusions

Depots are corporately owned and privately contracted locations open to the public to sort recyclables for refund. Depots receive high amounts of traffic daily and numerous persons of varying backgrounds and health status. The risk of hand contamination from hand sorting recyclables and contacting high touch surfaces at depots is high. Thus, hand hygiene after sorting recyclables is an important step in mitigating risks of infections from hand contamination. EPC has been shown to improve aesthetics and advertizing of recycling depots over the years and included the criteria for both MS and SR depots to include hand hygiene stations. However, not much is known about the quality and maintenance of these stations and whether they meet public health standards.

This study surveyed hand hygiene stations of 15 SR and 25 MS depots in Metro Vancouver. Lack of signage was determined to be the most evident criteria for failing. Lack of signage failed 74.3% of depots but excluding signage from the criteria only failed 34.3% of depots. Null hypothesis was not rejected both when signage was included ($P=0.911 > P=0.05$) and excluded (P-value $0.537 > 0.05$) as a criterion for passing, which determined that there was no association between MS/SR depot rating and Pass/Fail of hand wash stations in either case.

Recommendations

Previous studies in other environments in hospitals and in the community have shown that lack of essential, proper equipment, the same ones this study surveyed, are key barriers in hand wash compliance (Pragle *et al.*, 2007). However, other studies have found that increasing available equipment and hand sinks is not the only factor involved and did not directly increase hand wash compliance. Staff monitoring and hand hygiene promotion, such as through signage and pamphlets, has been shown in literature to increase compliance rates and help benefit both consumers and workers (Lankford *et al.*, 2003; Ott *et al.*, 2009; Pragle *et al.*, 2007).

Simple changes such as adding signage to hand wash stations at all depots and staff training to monitor compliance and equipment could be implemented and increase Pass rates of depots. Adding pictures or various languages to describe proper methods of hand washing could further improve compliance and proper hand hygiene. These types of signage are readily available through local Health Authorities.

EHOs can be part of the consultation team when constructing new depots and hand hygiene stations. EHOs should provide insight on hand hygiene research and communicate this to EPC and depot owners. EHOs can advocate eliminating installation of hand sanitizers at depots and ensuring these are replaced with proper hand wash equipment. Policies should be made to ensure Hand wash stations should be place well in public view, be made easily accessible and near exits to increase hand wash compliance. Designs should ensure potable water connection and addition of essential hand washing equipment. Before introducing new programs such as school bottle drives, EHOs could encourage additional audits and inspections at depots to ensure hand wash stations are well maintained and functional to meet demands and children's needs (e.g. lower counter sinks).

Staff could also be educated on importance of hand hygiene to public and occupational health. Staff should be trained to assess the rate of incoming customers verses the rate of soap usage and be able to monitor, refill and upkeep equipment at stations even during busy times. This would promote hand wash compliance and reduce the spread of infections.

Future Research Suggestions

Much research on both hand washing and contaminant level in recycling depots is needed to accurately assess the impact of these facilities on public and worker health. Future studies could determine the user hand wash compliance rate at various MS and SR depots in Metro Vancouver and whether aesthetics of SR depots has an impact on compliance rate.

Studies could also extend the "test shopper" method by surveying all depots, educating operators who failed and surveying a second time to determine compliance rate of operators after public health education. Studies could also help quantify the contaminate levels in depots through bacteriological sampling, water quality and indoor air quality sampling and determine whether contaminant levels are lower or exceed recommended guideline values.

Acknowledgements

The authors thank the British Columbia Institute of Technology – Environmental Health for supporting this research.

Competing Interest

The authors declare that they have no competing interests.

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Appendix I

Form 1: Hand Wash Station Observations

P=Pass; F=Fail; MS=Minimal Standard Depot; SR=STAR-Rated Depot

Depot No.	Water	Hot/Cold Water	Soap	Hand Dry	Signage	Pass/Fail Rating	Standard Rating	STAR Rating
1	P	C	P	P	F	P	MS	
2	P	C	F	F	F	F	MS	
3	F	(Hand Sanitizer)	F	F	F	F	MS	
4	P	C	P	P	F	P	SR	5S
5	P	C	P	P	P	P	MS	
6	P	H	P	P	F	P	MS	
7	P	H	P	P	P	P	SR	5S
8	P	C	P	P	F	P	SR	3S
9	F	(Hand Sanitizer)	F	F	F	F	MS	
10	P	H	P	P	P	P	MS	
11	P	H	P	P	P	P	MS	
12	P	H	P	P	F	P	SR	5S
13	P	H	F	P	F	F	MS	
14	P	H	P	P	F	P	MS	
15	P	H	P	P	F	P	MS	
16	P	H	P	P	P	P	MS	
17	P	C	P	F	F	F	SR	5S
18	P	C	P	P	F	P	MS	
19	P	H	P	P	F	P	MS	
20	P	H	F	F	P	F	MS	
21	P	C	P	P	F	P	MS	
22	P	H	P	P	P	P	MS	
23	P	H	P	P	F	P	MS	
24	P	H	P	P	F	P	SR	5S
25	P	H	P	P	P	P	SR	5S
26	P	C	F	P	P	F	SR	5S
27	P	C	F	P	P	F	MS	
28	P	C	F	P	F	F	SR	3S
29	P	C	P	P	P	P	SR	5S
30	P	C	P	P	F	P	MS	
31	P	H	F	P	P	F	SR	3S
32	F	(Hand Sanitizer)	F	F	F	F	SR	3S
33	P	H	P	P	P	P	SR	5S
34	P	H	P	P	F	P	SR	5S
35	P	C	F	P	F	F	SR	3S

Appendix II

Pilot Studies

Pilot studies recorded observations at 3 locations in Vancouver, Burnaby and Abbotsford. The pilot studies concluded all 3 locations had no hot water (only cold running water), full soap dispensers and paper towels or blow dryers. However, there is discrepancy in signage (visible or none). MS Vancouver location had signage above the hand wash station and 5-STAR Abbotsford location had signage overhead (no signs at the hand wash station); this earns both locations a pass. But the Burnaby location, a 5-STAR rated facility, had no hand washing signage anywhere in the facility; this earns the location a fail.

The pilot study showed that hot/warm, running water criteria is too harsh to access facilities by, since no facilities, either MS or SR provided hot/warm water to customers (likely due to cost). It is debateable whether hot/warm water is necessary to eliminate debris and pathogens on hands (BC Ministry of Health, 2012; Jumaa, 2005; Todd *et al.*, 2010). BC Ministry of Health (2012) guidelines indicate running water is more essential.

However, signage is an easy and necessary standard to assess. Signage is also an easy and cost effective change to implement and has been shown in studies to increase hand hygiene compliance (BC Ministry of Health, 2012).

Appendix III
Results: Cross Tabulation Reports
P/F with Signage included in criterion

Data Summary Report

P_F_Depen_Signage	Rating	Count
F	MS	15
F	SR	11
P	MS	5
P	SR	4

Counts Table

	P_F_Depen_Signage		
Rating			
	F	P	Total
MS	15	5	20
SR	11	4	15
Total	26	9	35

Expected Counts Assuming Independence Table

	P_F_Depen_Signage		
Rating			
	F	P	Total
MS	14.9	5.1	20.0
SR	11.1	3.9	15.0
Total	26.0	9.0	35.0

Chi-Square Contributions Table

	P_F_Depen_Signage		
Rating			
	F	P	Total
MS	0.0014	0.0040	0.0054
SR	0.0018	0.0053	0.0071
Total	0.0032	0.0093	0.0125

Tests for Row-Column Independence
(Rating by P_F_Depen_Signage)
H0: "Rating" and "P_F_Depen_Signage" are independent.
H1: "Rating" and "P_F_Depen_Signage" are associated (not independent).

Test	Type	Chi-Square Value	DF	P-Value	Reject H0 at α = 0.05?		
Pearson's Chi-Square†			2-Sided	0.0125	1	0.9111056663	No
Yates' Cont. Correction			2-Sided	0.0000	1	1.0000000000	No
Likelihood Ratio		2-Sided	0.0124	1	0.9111887303	No	
Fisher's Exact		2-Sided			1.0000000000	No	
Fisher's Exact (Lower)		1-Sided			0.6939191694	No	
Fisher's Exact (Upper)		1-Sided			0.6058077999	No	

† WARNING: At least one cell had an expected value less than 5.

P/F Rating without Signage as a Criterion

Data Summary Report

P_F_Indep_Signage	Rating	Count
F	MS	6
F	SR	6
P	MS	14
P	SR	9

Counts Table

Rating	P_F_Indep_Signage		
	F	P	Total
MS	6	14	20
SR	6	9	15
Total	12	23	35

Expected Counts Assuming Independence Table

Rating	P_F_Indep_Signage		
	F	P	Total
MS	6.9	13.1	20.0
SR	5.1	9.9	15.0
Total	12.0	23.0	35.0

Chi-Square Contributions Table

Rating	P_F_Indep_Signage		
	F	P	Total
MS	0.1071	0.0559	0.1630
SR	0.1429	0.0745	0.2174
Total	0.2500	0.1304	0.3804

Tests for Row-Column Independence
(Rating by P_F_Indep_Signage)
H0: "Rating" and "P_F_Indep_Signage" are independent.
H1: "Rating" and "P_F_Indep_Signage" are associated (not independent).

Test	Type	Chi-Square Value	DF	P-Value	Reject H0 at α = 0.05?		
Pearson's Chi-Square	2-Sided	0.3804	1	0.5373706399	No		
Yates' Cont. Correction		2-Sided	0.0660	1	0.7971807175	No	
Likelihood Ratio	2-Sided	0.3789	1	0.5381664205	No		
Fisher's Exact	2-Sided			0.7210233593	No		
Fisher's Exact (Lower)	1-Sided			0.3969595847	No		
Fisher's Exact (Upper)	1-Sided			0.8355209492	No		

P/F Soap vs Depot Rating

Data Summary Report

P_F_Soap	Rating	Count
F	MS	6
F	SR	5
P	MS	14
P	SR	10

Counts Table

	P_F_Soap		
Rating			
	F	P	Total
MS	6	14	20
SR	5	10	15
Total	11	24	35

Expected Counts Assuming Independence Table

	P_F_Soap		
Rating			
	F	P	Total
MS	6.3	13.7	20.0
SR	4.7	10.3	15.0
Total	11.0	24.0	35.0

Chi-Square Contributions Table

	P_F_Soap		
Rating			
	F	P	Total
MS	0.0130	0.0060	0.0190
SR	0.0173	0.0079	0.0252
Total	0.0303	0.0139	0.0442

Tests for Row-Column Independence
(Rating by P_F_Soap)
H0: "Rating" and "P_F_Soap" are independent.
H1: "Rating" and "P_F_Soap" are associated (not independent).

Test	Type	Chi-Square Value	DF	P-Value	Reject H0 at α = 0.05?		
Pearson's Chi-Square†			2-Sided	0.0442	1	0.8334969529	No
Yates' Cont. Correction			2-Sided	0.0000	1	1.0000000000	No
Likelihood Ratio		2-Sided	0.0441	1	0.8336912474	No	
Fisher's Exact		2-Sided			1.0000000000	No	
Fisher's Exact (Lower)		1-Sided			0.5596959585	No	
Fisher's Exact (Upper)		1-Sided			0.7192806822	No	

† WARNING: At least one cell had an expected value less than 5.

P/F Hand Dry vs Depot Rating

Data Summary Report

P_F_HandDry	Rating	Count
F	MS	4
F	SR	2
P	MS	16
P	SR	13

Counts Table

	P_F_HandDry		
Rating			
	F	P	Total
MS	4	16	20
SR	2	13	15
Total	6	29	35

Expected Counts Assuming Independence Table

	P_F_HandDry		
Rating			
	F	P	Total
MS	3.4	16.6	20.0
SR	2.6	12.4	15.0
Total	6.0	29.0	35.0

Chi-Square Contributions Table

	P_F_HandDry		
Rating			
	F	P	Total
MS	0.0952	0.0197	0.1149
SR	0.1270	0.0263	0.1533
Total	0.2222	0.0460	0.2682

Tests for Row-Column Independence
(Rating by P_F_HandDry)
H0: "Rating" and "P_F_HandDry" are independent.
H1: "Rating" and "P_F_HandDry" are associated (not independent).

Test	Type	Chi-Square Value	DF	P-Value	Reject H0 at α = 0.05?		
Pearson's Chi-Square†			2-Sided	0.2682	1	0.6045423073	No
Yates' Cont. Correction			2-Sided	0.0042	1	0.9483850396	No
Likelihood Ratio		2-Sided	0.2738	1	0.6008195642	No	
Fisher's Exact		2-Sided			0.6804381577	No	
Fisher's Exact (Lower)		1-Sided			0.8328445748	No	
Fisher's Exact (Upper)		1-Sided			0.4805718475	No	

† WARNING: At least one cell had an expected value less than 5.

P/F Signage & Depot Rating

Data Summary Report

P_F_Signage	Rating	Count
F	MS	13
F	SR	9
P	MS	7
P	SR	6

Counts Table

	P_F_Signage		
Rating			
	F	P	Total
MS	13	7	20
SR	9	6	15
Total	22	13	35

Expected Counts Assuming Independence Table

	P_F_Signage		
Rating			
	F	P	Total
MS	12.6	7.4	20.0
SR	9.4	5.6	15.0
Total	22.0	13.0	35.0

Chi-Square Contributions Table

	P_F_Signage		
Rating			
	F	P	Total
MS	0.0146	0.0247	0.0393
SR	0.0195	0.0330	0.0525
Total	0.0341	0.0577	0.0918

Tests for Row-Column Independence
(Rating by P_F_Signage)
H0: "Rating" and "P_F_Signage" are independent.
H1: "Rating" and "P_F_Signage" are associated (not independent).

Test	Type	Chi-Square Value	DF	P-Value	Reject H0 at α = 0.05?		
Pearson's Chi-Square	2-Sided	0.0918	1	0.7619222882	No		
Yates' Cont. Correction		2-Sided	0.0000	1	1.0000000000	No	
Likelihood Ratio	2-Sided	0.0916	1	0.7621560161	No		
Fisher's Exact	2-Sided			1.0000000000	No		
Fisher's Exact (Lower)	1-Sided			0.7445503055	No		
Fisher's Exact (Upper)	1-Sided			0.5182537763	No		