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Investigation of a *Clostridium difficile* associated disease outbreak at Nanaimo General Regional Hospital August 2008.

Executive summary

NGRH experienced an outbreak of *Clostridium difficile* associated illness (CDI) which in retrospect started in June of 2008 and was decreasing by mid September 2008. On August 2008, the Vancouver Island Health Authority Infection Prevention and Control Program requested the assistance of the BC Centre for Disease Control in conducting an in-depth epidemiologic investigation of the outbreak in order to identify any modifiable factors to help prevent recurrence of CDI outbreaks in the future. At the time of this review in late August there were 64 confirmed cases of CDI with 8 deaths in the confirmed cases. Not all deaths were due to CDI and are being reviewed to determine the role that CDI played. Rates of CDI peaked at 22 cases/1000 admissions in August of 2008; over four times the average rate seen in Canada and significantly higher than rates in NGRH over the previous two years which had ranged from 1.3-2.4 /1000 admissions. Enhanced infection control practices and a concerted effort to identify and isolate cases appropriately led to the outbreak waning in late August/early September. The BC Centre for Disease Control was asked to conduct an infection control and epidemiologic review of this outbreak to assist NGRH in understanding the precipitating factors and the course of the outbreak in order to more fully appreciate the measures they needed to take to prevent further outbreaks. An infection control review was conducted on August 22nd and an interim report was prepared for the facility; two epidemiologists (from BCCDC and the Public Health Agency of Canada) then spent a week from August 25-29th onsite reviewing the case records and procedures at the facility to develop an epidemiologic picture of the outbreak.

The important antecedent factors discovered in this investigation include:

- NGRH is an older facility that is not well constructed to facilitate the prevention of transmission of infections. In particular the majority of the patient rooms are four bed wards with a single shared toilet or sets of two bed wards with a common toilet again for four patients.
- NGRH services a rapidly growing community with a significant elderly population with many patients requiring extended admissions or alternate levels of care. The facility operates over capacity on a continuous basis straining the ability of staff to pay sufficient attention to infection prevention issues.
- There are insufficient isolation rooms on each floor to allow for rapid and effective cohorting of patients who develop diarrheal illness due to CDI.



- The patient rooms are small and there are no dedicated healthcare worker hand washing sinks in the rooms. There is one sink meant to be used for handwashing in many of the four bed wards however, it is inconveniently placed behind a door in one corner and in most cases is effectively blocked by the patient beds.
- There are insufficient handwashing sinks on each floor of the facility with a single sink observed per floor in inconvenient locations and often obstructed by patient care equipment which must be kept in the hallways due to the lack of space in patient rooms.
- There is limited access to alcohol based hand rubs (ABHR) with none at the point of care and the dispensers that were present mounted at inconvenient heights in the hallways. In addition staff complained that the dispensers splashed when used and the product was not well liked.
- The infection control program is not sufficiently resourced to allow for appropriate level of surveillance activities and other essential components of an effective infection control program to be undertaken at the facility. There is a single infection control practitioner for this site and a second acute care site who also has responsibilities for several community facilities. While there was clear medical support and involvement, senior administrative support to the infection control program at the facility was not evident.
- There were insufficient numbers of cleaning staff to meet the basic daily needs of the facility and they were not adequately trained in appropriate cleaning procedures for a healthcare facility. They were not able to meet the increased demand for environmental cleaning that is required to control an outbreak of CDI.

These were the key factors which set the stage for the CDI outbreak which occurred the summer of 2008. Without effort at remediating or mitigating these factors the facility is at very high risk to experience further outbreaks of infectious disease whether it be from CDI or from rapidly spreading microorganisms such as Norovirus.

Clostridium difficile

Clostridium difficile is the most frequent cause of nosocomial infectious diarrhea in industrialized countries and has been responsible for a number of large outbreaks in hospitals, including several hospitals in Quebec, Ontario and Alberta. In Canada, 13% of inpatients with diarrhea who have their stools analyzed meet the case definition for *Clostridium difficile*-associated illness (CDI). Nosocomial *C. difficile* incidence is estimated to be 3.8-5.9 cases per 1,000 admissions or 66.3 cases per 100,000 patient days in Canada. Symptoms range in severity from asymptomatic carriage to mild diarrhea to life-threatening colitis. Approximately 8% of people who acquire CDI in hospital and develop illness experience complications such as



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dehydration, hypokalemia, gastro-intestinal bleeding sometimes requiring transfusion, bowel perforation or secondary sepsis; 1.5% die of causes directly or indirectly associated with CDI. A study in a Virginia, Illinois hospital found that patients with CDI were almost three times more likely to die than other hospitalized patients (after controlling for age, antibiotic usage and high-risk co-morbidities). Recent reports suggest that CDI incidence is increasing and illness is becoming more severe in North America. A strain identified in Quebec, Toronto and six American states was found to produce 20 times the levels of toxins than previously studied strains and has resulted in attributable mortality rates as high as 16.7%. This strain, called the NAP1 strain, has been found in as many as one third of CDI cases in BC. Hospitalized patients with CDI require longer hospital stays and additional diagnostic or interventional procedures. A study in the United States found that patients who became ill with CDI while hospitalized had total hospital costs that were 54% greater than patients who were not infected and there were as many as 10 readmissions per year in patients whose nosocomial CDI manifested after hospital discharge at an annual cost on \$128,200 per year per facility.

The spread of infection in healthcare facilities can be prevented by strict infection control practices (especially meticulous hand hygiene, appropriate use of gloves, and proper cleaning and disinfection of environmental surfaces and patient care equipment) and conducting surveillance for new cases and promptly isolating and treating identified cases.

Facility factors

The Nanaimo region has expanded in population dramatically in the past 10 years and is the second largest city on Vancouver Island. It is a transportation hub both to and from Vancouver Island and between the north, south and west of the island. Its population has increased by 10% between 2001 and 2006. People over 65 years of age make up 17% of the population of Nanaimo compared to 14% in the rest of BC. The NGRH was built as a community hospital in the 1960s and currently has 269 active beds. The facility consistently runs at close to or above census and the population of the community leads to requirement for extended stays and advanced level of care for a high percentage of inpatients. Almost all patients are admitted through a very compact and crowded emergency department which again is over capacity continuously. There are 6 main medical/surgical floors and most rooms have 4 patient beds with one shared washroom. There are only 16 single rooms in the facility and most of the double-bedded rooms share a single toilet facility with the next door double-bedded room. The rooms are small with barely 1 metre distance (the minimum distance for privacy) possible between patient beds. The rooms cannot meet the requirement for 2 metre space between beds in situations requiring contact precautions (such as CDI). The current CDI outbreak has affected all floors and wards of the facility and there are insufficient single bed/toilet rooms to accommodate the cases on contact precautions.



In addition the patient rooms have high ceilings making changing of curtains that separate the bed spaces difficult. A ladder is required to remove and replace privacy curtains and discussion with staff indicates this does not occur frequently. This can lead to a buildup of environmental contamination or 'bio-burden', particularly of *C. dif* spores. Because of the lack of space in the patient rooms most patient care equipment as well as clean and dirty laundry and supplies are kept in the hallways. This leads to a mixing of clean and dirty items as well as a very cluttered environment that makes environmental cleaning difficult. There are very small areas for performing such tasks as cleaning of bedpans and these were frequently found to have both clean and dirty items in them. A concerted effort was made as the CDI outbreak progressed to reduce the clutter on the floors and to specifically delineate clean and dirty areas of the floor. As well a system was reinforced of tagging clean items after the environmental staff had carried out the appropriate cleaning on them and storing them in designated areas. This was helpful in preventing cross contamination but was not consistently adhered to.

It should be noted that single patient rooms with dedicated toilet facilities is now preferred for all patient care and there is a growing body of literature to support both the patient safety benefit and the cost effectiveness of this measure (see referenced attached). Single patient rooms reduce risk of nosocomial infection and reduce the numbers of transfers that a patient must endure during an admission. Each transfer creates not only an increased risk of infection but is time consuming and a logistical burden on all ready strained staff. Consideration must be given to reducing the number of patients per room at NGRH in any further construction or renovation projects at the facility.

After recognition of increased CDI rates in 2005/2006 (7.1/1000 admissions) an automated system for cleaning of bedpans was installed on each floor (to service two wards on either end of the floor). At the time there was no engineering review or consultation process with nursing staff about these devices and subsequently a number of issues have arisen that has led to these cleaners not being used consistently. The issues are primarily of access and timing. There is a single bedpan washer per floor and it takes 13 minutes for each cycle. This makes it inconvenient and too time consuming for the nursing staff to use particularly as they need to stand by the machine to ensure the same bedpan is returned to the same patient. As well the bedpans must be loaded in a specific way and if this is not done correctly the pans are not only cleaned inadequately but the HCW can be splashed with aerosolized feces when the machine is opened. This has happened on several occasions leading to a loss of confidence in the machines by nursing staff. It is highly likely issues with inappropriate cleaning of bedpans have been a major factor in the spread of CDI in this outbreak. Not only is cleaning using the new washers an issue but on all wards investigated there were insufficient commodes or bedpans for the commode chairs for the patients who required them. A new system of disposable bedpan liners that can be easily disposed of was introduced in late August to help address the problem. Solutions to these problems need to be easily implementable and should be discussed with staff ahead of time to ensure they are feasible and appropriate.



While each of these issues by itself may not appear to be large the combination leads to a background environment that facilitates transmission of infections and puts the facility at increased risk for outbreaks. Some of these issues such as the lack of single patient rooms cannot be addressed rapidly and therefore additional attention needs to be placed on modifiable factors to ensure that the safety of the patients, staff and visitors to the facility is protected. Some of these factors will be explored in more detail below.

Environmental cleaning

C. difficile is a notoriously hardy bacterium because it can change into a spore form when stressed and these spores persist in the environment. In healthcare facilities these spores have been spread between patients and throughout the environment often on the hands of HCWs but also on contaminated equipment. Environmental cleaning is the cornerstone to managing CDI outbreaks and enhanced cleaning protocols must be adhered to rigorously. The most studied and effective agent for killing of bacterial spores is a 1:10 bleach solution; in Canada accelerated hydrogen peroxide solutions are also available that have been shown to be effective in killing spores. Key enhancements during an outbreak of CDI include rigorous twice daily cleaning of all high touch areas of the facility and twice daily cleaning of affected patient rooms. In addition an enhanced cleaning protocol for the entire patient space is required when a patient with CDI is moved or discharged. There is a strict evidence based methodology for cleaning in patient care areas that prevents cross contamination of areas. This protocol has been shown to be effective in reducing transmission of spores and other hardy microorganisms such as non-enveloped viruses and is the standard of care in healthcare facilities. At NGRH the cleaning responsibilities are contracted out to a private service. Discussion with NGRH staff show that there is an ongoing perception that there are insufficient housekeeping staff to clean the facility to the level required in the contract, particularly overnight and on weekends. In addition, there appeared to be insufficient numbers of trained staff available to meet the enhanced cleaning needs during the CDI outbreak. Review of cleaning protocols had not been done prior to the outbreak and limited review in August showed a number of protocol breaches that likely contributed to the increased bio-burden at the facility. Foremost was the discovery that the bleach solutions used by the cleaning staff were incorrectly constituted leading to the use of a much reduced concentration (1:1000 rather than 1:10) that was ineffective as a disinfecting agent. It is unclear how long this had been an issue but it was at least several months if not longer and was clearly a contributing factor to the propagation of the CDI outbreak. Review of the cleaning protocols and audit of cleaning practices was strongly recommended for the facility. A further concern was the fact that a facility wide effort to clean using bleach at the peak of the outbreak did not include high use areas such as the diagnostic imaging suite and the emergency department. The ED in particular appears from the epidemiologic review to be a possible amplifying area for the CDI outbreak. The ED should be included as a high priority area for intensive twice daily cleaning given the high volume of patients who pass through the area and the overcrowding that is routine.



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Consideration should be given to the development of a specialized 'clean team' of cleaning staff who receive additional training on cleaning and disinfection for infection prevention and control who are deployed in the event of an outbreak.

Infection prevention and control program resources

The infection control program at NGRH is under resourced and the reporting structure is complex and confusing. There is a single ICP for the 269 bed facility in addition to a two smaller acute care facilities (with 52-beds and 10-beds respectively) and two community facilities. The BC Provincial Infection Control Network has made evidence based recommendations for effective infection prevention and control programs in BC that are available at www.picnetbc.ca and referral to these would be helpful in addressing some of the issues that NGRH faces. In summary, evidence shows that effective IC programs have one trained ICP per 115 acute care beds with medical (physician with infection control expertise) and administrative support. Effective programs also have reporting structures that ensure that senior administration and medical staff are aware of key issues in the facility in a timely way. There are several issues that impede the effectiveness of the IC program at NGRH. Firstly a single ICP, regardless of experience, does not have the time in a day to be able to develop and monitor infection control practices effectively. The IT systems at the hospital make any surveillance a time consuming process with the requirement for double and triple entering of data. The ICP was not able to follow the outbreak of CDI effectively and did not have the support he needed to create an effective surveillance system. This inevitably led to delays in recognition of the increased rates of disease and declaration of an outbreak. There was mixed understanding on the wards about the outbreak and the requirement to notify the ICP. The reporting structure within the facility and within VIHA is a somewhat complex matrix and this has led to confusion and mixed messages about measures to contain the outbreak. The ICP reports directly to a physician on-site who heads the IC Committee at the facility. The overall lead for Infection Control at VIHA is a senior medical microbiologist located in Victoria. The involvement and support of the senior administrator of the facility was unclear and she was not available to meet with the investigators. The onsite physician and senior infection control administration (medical microbiology and patient safety/infection control) on the other hand was clearly involved though the latter are based in Victoria which made onsite assessment and direction complex.

In addition to surveillance, the cornerstone of an effective infection prevention and control program is hand hygiene (HH). Hand hygiene includes handwashing with soap and warm water when the hands are visibly soiled and the routine use of ABHR before and after patient contact. The standard in healthcare for hand hygiene is point of care ABHR (see references attached). HH with alcohol based hand rubs may not be sufficient for killing of *C. diff* spores (although evidence is increasing that it may have some effect) so the mechanical action of hand washing is preferred for spore removal when *C. diff* is present. However, if hand washing facilities are not readily available ABHR should be used immediately to kill the vegetative form of the bacterium



and other transient pathogens and hand washing then performed as soon as possible after. An alternative would be the use of alcohol impregnated hand wipes at the point of care followed by use of ABHR. NGRH does not have a formal HH program for staff and has a number of facility and program barriers to adequate HH. There are HCW hand wash sinks only in the 4-bed rooms but they are located behind a door making them inaccessible and rarely used. In addition there is a single handwashing sink in the hallway of each ward wing. These are built in to the wall and are shallow so splashing is a problem and they are difficult to keep clean. There are alcohol based hand rub dispensers mounted on the wall outside each patient room but none inside the rooms or at point of care. The dispensers currently in use have a pump mechanism that is awkward to use and is prone to splashing and the product itself is not well liked by staff in their discussions with the investigation team. In observing nursing activity on the wards the ABHR and sinks are not used with the frequency recommended in national guidelines to prevent the transmission of infections. These observations are consistent with a hand hygiene audit undertaken by the facility which also showed low rates of appropriate hand hygiene. The hospital is switching to a more easily accessed foam product that it is hoped will alleviate the splashing problem. New hand hygiene kiosks have been recently installed in public areas of the facility with the new product but the high risk ward areas remain an area of concern. We recommend NGRH substantially increase use of ABHR by providing point-of-care access in patient rooms and reinforcing with staff the critical importance of hand hygiene. An effective HH program will involve consultation with staff about products and placement of products as well as a multidisciplinary team approach to a healthy hands program that includes regular use of hand creams. Several model HH programs have been developed including a program recently launched in Ontario for all healthcare facilities (www.justcleanyourhands.ca) that may be helpful in developing a program at NGRH.

NGRH should look to develop a program that ensures patients are able to clean their hands prior to eating meals (either by assisting them or providing them with ABHR). This is a critical step in the transmission pathway of infectious diseases like CDI.

Laboratory and diagnostic issues

The laboratory at NGRH has the capability to rapidly test for C. dif antigen and maintains an up to date line list of all case tested and the results. Lab test results were available rapidly to the floor after specimens were sent. There was however a breakdown in communication between the lab and the ICP who was not always notified by the floor of cases and did not use the laboratory line list. Part of the difficulty facing the ICP was the need to convert and re-enter data into the infection control surveillance database. This led to delays and missed reports and hindered recognition of the outbreak. Efforts need to be made to establish an efficient consolidated database that will enable effective surveillance for CDI and other nosocomial infections. Epidemiologic expertise to regularly review and analyse the data would also boost the effectiveness of the infection prevention and control program. Surveillance for CDI (and MRSA) is a new requirement for accreditation and is a key component that needs to be improved at NGRH.



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The test used by the laboratory to determine if a person has *C. diff* changed in January of 2008. Prior to Jan 08 a single toxin test only was performed by the lab. In January a two step test was introduced that included a *C diff* antigen test as step one and a toxin test of the antigen test was positive. Only diarrheal stools are tested and reported back to the ward as Ag+/- toxin +/-.

Despite information on this change being provided to staff and clinicians several times there was clearly confusion in interpretation of tests in our discussions with staff. This led to misinterpretation of test results and on occasion people not being placed in precautions when they should have been or people being prematurely removed from precautions. The two step testing is slightly less sensitive than the toxin EIA test previously used and in the setting of a CDI outbreak symptomatic patients should be put on precautions immediately and a high level of suspicion maintained until symptoms resolved. We attempted to investigate the negative predictive value of the currently used tests but were unable to obtain all the necessary data from charts. The epidemiologic analysis includes both 'confirmed' and 'possible' cases to account for the potential that some of the symptomatic Ag+/Toxin- cases were true cases of CDI.. It is recognized that only a proportion of these possible cases were true cases but we were unable to estimate that proportion so include them for illustrative reasons. Subsequent information from the VIHA laboratory showed that the two step testing had a similar sensitivity to the previous used EIA in that lab and confirmed the fact that with increased prevalence as in this outbreak the proportion of false negative tests increased. Data from the laboratory showed a 7% false negative rate prior to the outbreak which increased to 20% during the outbreak. What was clear though is that the change in laboratory testing led to confusion and inconsistency in both treatment and implementation of precautions. Further efforts are needed to educate staff and clinicians on the new testing protocol and to evaluate the test in a high prevalence outbreak setting.

There was concern expressed that there may have been an outbreak ongoing in the community of CDI that could account for at least some of the increased cases seen at NGRH. In particular the ICP anecdotally noted that some patients were admitted with their disease with no previous admissions. To investigate this we obtained data on community tests for CDI from the private laboratory and reviewed charts on patients admitted to NGRH with CDI. There was no evidence of increased testing or increased proportion of tests positive for CDI from the community laboratory data. Chart review found that of the 12 confirmed cases who were classified initially as community associated all but 1 had had previous admission to the facility within 30 days or had been seen in the NGRH ED (8 of 12) within 30 days prior to onset of symptoms. There is no evidence to suggest an increase of CDI in the community but this data did lead to concerns that the ED may be an area of concern where the outbreak was being amplified.

Epidemiology and outbreak response

There was a delay in recognition of this outbreak for a variety of factors as listed above in particular the difficulty in collating and analysing of surveillance data and delays in reporting of



new diarrhea cases to the ICP. While individual measures were taken for each CDI case a concerted facility wide response was not started until July when the case rates rose to more than double their baseline. Even then outbreak response measures were implemented in stages and it was not until August that substantial measures to reduce environmental bio-burden were taken. At no time was an official outbreak team assembled and there was no outbreak response plan coordinated and communicated to staff, patients or the community. These are measures that are recommended for any facility wide outbreak and facilitate a coordinated, efficient and effective response. Members of an outbreak team should include infection control and laboratory staff, medical and nursing leadership, senior administration, environmental or housekeeping services, communications and local public health as a minimum. Initial steps of an outbreak response team include establishment of outbreak case definitions, rapid reporting of cases and daily reconciliation of surveillance numbers and line listed data, a detailed management plan to include case finding, cohorting, environmental measures and a detailed communications plan. Had this process been established it may have shortened the duration of the CDI outbreak and would have minimized the confusion experienced by staff and by patients and their families.

Recommendations

1. VIHA provide the resources needed for an effective infection prevention and control program at NGRH to include surveillance for healthcare associated infections in particular CDI;
2. VIHA establish a multidisciplinary committee to develop and implement a comprehensive hand hygiene program at NGRH;
3. VIHA develop an outbreak response plan for NGRH that includes establishment of an on site outbreak management team (including public health notification) and initial steps the team will take;
4. VIHA review the environmental cleaning contract and audit their environmental services to ensure appropriate levels of staffing and cleaning protocols are being adhered to and to ensure that sufficient surge capacity is available to respond rapidly to emerging needs. Consideration should be given to development of a specially trained 'clean team' for the enhanced environmental cleaning that is needed in an outbreak such as this one.
5. VIHA consider measures that can be taken to modify the facility to reduce the risk of transmission of infection and improve patient, staff and visitor safety (including conversion to single or double patient rooms, modifying of wards to ensure separation of clean and dirty supplies and linens, protocols to reduce crowding in the ED and on the wards etc.)



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Annex A Infection Control Audit initial report

Review of Infection Control and Environmental factors at Nanaimo Regional General Hospital for CDAD Control

(Prepared by Dr Bonnie Henry, BCCDC)

1. Key factors: hospital built in 1960s and is consistently overcrowded. Currently running at 98-101% over census of 269 beds. The community has expanded exponentially and this is the regional catchment hospital. There are 6 main medical/surgical floors and most rooms have 4 patient beds with one shared washroom. There are only 16 single rooms in the facility and most of the double-bedded rooms shared a single toilet facility with the next door double-bedded room. The rooms are small with barely 1 metre distance possible between patient beds. In addition they have quite high ceilings making changing of curtains difficult. The current CDAD outbreak has affected all floors and wards of the facility and there are insufficient single bed/toilet rooms to accommodate the cases. The facility will move to cohorting patients with CDAD to one ward over the next few days and re-enforce the need to immediately isolate symptomatic patients while testing is being done. In addition they will review policies for immediate treatment pending test results.
2. Hand hygiene facilities: There are HCW hand wash sinks only in the 4-bed rooms but they are located behind a door and rarely used. In addition there is a single handwashing sink in the hallway of each ward wing. These are built in to the wall and are shallow so splashing is a problem and they are difficult to keep clean. There are alcohol based hand rub (ABHR) dispensers mounted on the wall outside each patient room but none inside the rooms. The dispensers currently in use have a pump mechanism that is awkward to use and is prone to splashing. In observing nursing activity on the wards the ABHR and sinks are rarely used. The hospital is switching to a more easily accessed foam product that it is hoped will alleviate the splashing problem. New hand hygiene kiosks have been recently installed in public areas of the facility with the new product. We recommend NGRH substantially increase use of ABHR by providing point-of-care access in patient rooms and reinforcing with staff the critical importance of hand hygiene.



As well they must ensure patients are able to clean their hands prior to eating meals (either by assisting them or providing them with ABHR).

3. Due to the small room size much of the supplies needed for patient care are stored in the hallways and in several small storage rooms. There has been frequent mixing of clean and dirty supplies in these locations. In the past week a concerted effort has been made to separate the clean and dirty equipment and supplies in to different areas and a system of tagging of clean supplies has been implemented. This has assisted in reducing the clutter and cross contamination but there is still considerable extra equipment in the hallways and storage rooms that could be removed.
4. Patient care equipment that goes from patient to patient and room to room is currently not being cleaned between uses. In addition, disposable sleeves for blood pressure cuffs are not being used consistently. These may be contributing to spread of CDAD spores in the environment.
5. An automated system for cleaning of bedpans was installed 2 years ago on each ward. However, these cleaners are not being used consistently because of issues of access and timing. There is a single bedpan washer per floor and it takes 13 minutes for each cycle. This makes it inconvenient and too time consuming for the nursing staff to use. As well the bedpans must be loaded in a specific way and if this is not done they are not cleaned adequately and can splash the HCW when the machine is opened. This has happened on several occasions leading to a loss of confidence in the machines by nursing staff. It is highly likely issues with inappropriate cleaning of bedpans have been a major factor in spread of CDAD. A new system of bedpan liners that can be easily disposed of has been introduced this week that should help address this problem.
6. Housekeeping at NGRH is contracted to a local company who follow policies and procedures established by the ICP and the facility. An audit has not been done of how cleaning is being conducted and recent revelation of errors has raised questions about whether procedures are being followed correctly. A review of cleaning procedures in the past week has revealed that an inappropriately dilute bleach solution has been used for cleaning particularly for terminal cleaning of CDAD patient rooms. Spores from *C. difficile* are extremely hardy and it is highly likely this has been a major contributor to the persistence of spores in the environment in this outbreak. ICP support has been brought in to thoroughly review the cleaning policies and audit the cleaning staff. A thorough facility wide cleaning of all areas with 1: 10 bleach and Virox (including nursing stations, diagnostic imaging, public spaces etc) will be carried out in the next week.



7. The infection prevention and control program currently consists of a single experienced ICP to cover both the NGRH and a second smaller ACF (the 60 bed West Coast General). Due to the recent resignation of a second ICP, the NGRH ICP now also covers long-term care and community issues in the region. The ICP reports directly to a physician on-site who heads the IC Committee at the facility. The overall lead for Infection Control at the VIHA is a senior medical microbiologist located in Victoria. The NGRH ICP is responsible for surveillance for HAIs as well as all other aspects of the IPAC program at the facility. A recent switch in electronic systems at the facility has made surveillance more complex and time consuming. The Field Epi team will focus on reviewing in detail the process for identification and notification of cases of CDAD by nursing staff and how this information is transferred to the lab and ICP as well as the procedure for collating and analyzing of the data.

8. Other issues reviewed included
 - a. Recommending the facility enforce the visitor policy to reduce the crowding of patient rooms as much as possible. This will allow for more thorough cleaning and reduce the risk of transmission. This is particularly important for patients with CDAD. While it is recognized that family provide important care to patients, this measure of reducing visitors to two at a time is needed to break the transmission cycle of this outbreak.
 - b. Removal of all books, magazines, games etc that are not able to be cleaned and move from patient to patient.
 - c. Removal of cloth upholstered furniture in patient care areas as it cannot be adequately cleaned and can contribute to persistence of CDAD spores in the environment.
 - d. Review of antibiotic use patterns at the facility and as a long term project develop an antibiotic stewardship plan.
 - e. Development of an information sheet for patients and their families on CDAD and management of people recovering from CDAD at home.
 - f. BCCDC to review testing for CDAD in the community over the past year to see if there has been an increase of community associated disease in the Nanaimo region and the rest of BC.



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Annex B Epidemiologic summary

Prepared by Marsha Taylor, BCCDC and Dr Kathleen Dooley, PHAC

Epidemiological Summary

On August 11, 2008 NRGH requested assistance from BCCDC for outbreak investigation and management. A field epidemiologist from BCCDC and an affiliate from the Canadian Field Epidemiology Program were deployed to NRGH from August 25-29, 2008.

Activities conducted during field deployment:

1. Development and classification of cases based on case definitions for **Confirmed** (antigen positive, toxin positive) and **Possible** (antigen positive, toxin negative) cases.
2. Classification of cases by transmission setting (hospital associated vs. community associated).
3. Development of case linelist from fiscal period 801-present (Sept 22, 2008), including information on outcome (death, discharged, in hospital).
4. Chart review:
 - a. Possible cases between fiscal periods 801 and 805 (n=13)
 - b. Cases reported as toxin negative on first test and toxin positive on second test (n=2)
5. Interviews with nursing coordinators and staff related to outbreak management and infection control.
6. Review of colonoscopy procedures.
7. Review of hospital pharmacy data.
8. Mapping location of possible and confirmed cases (periods 801 and 802).



9. Review of community lab testing (upon return to Vancouver).

Case definitions¹

A) Case Classification

Receipt of diarrhea² stool specimen from a symptomatic patient admitted to NRGH on or after fiscal period 801 (April 1 2008) in one of the following categories³:

Confirmed case

Meets above criteria plus one of the following:

- a) Laboratory confirmation of EIA Antigen + AND Toxin + stool specimen
- Or
- b) Diagnosis of typical pseudo-membranes on sigmoidoscopy or colonoscopy or histological/pathological diagnosis of CDAD.
- Or
- b) Diagnosis of toxic megacolon

Possible case

Meets above criteria plus laboratory confirmation of EIA Antigen + AND Toxin – stool specimen

B) Transmission Classification

Hospital Associated CDAD

Cases as defined above with a lab receipt date at least three days or more (≥ 72hrs) after admission
Or
A case as defined above who has been discharged from hospital within 1 month (30 days)

Community Associated CDAD

A case as defined above who does not meet the hospital Acquired CDAD definitions

Descriptive Epidemiology

Table 1: Case Classification (as of Sept 22, 2008)

Case Classification	N (%)
<i>Confirmed</i>	64 (57.1)

¹ Case definitions modified from Provincial Infection Control Network Surveillance Protocol for Clostridium difficile Associated Disease I Acute Care Facilities in British Columbia (cases of Relapse CDAD and Reinfection were not captured and may be counted as either Nosocomial or Community Acquired)

² More than three loose stools within a 24 hour period

³ Receipt of diarrhea stool specimen was used as an estimate of date of symptom onset. Date of onset was not available without a further case review. For cases that had multiple stool specimens tested, date of onset was based on the date of first positive laboratory result (confirmed case) or the date of first laboratory test (possible case).



Possible	48 (43.3)
Total	112 (100)

Table 2: Transmission Classification by Case Classification (as of Sept 22, 2008)
Transmission

Classification	Confirmed	Possible	N (%)
<i>Hospital Associated</i>	57 (89.1)	35 (72.9)	87 (77.7)
<i>Community Associated</i>	7* (10.9)	13 (27.1)	20 (17.9)
Total	64	48	112 (100)

*Three confirmed community associated cases, unable to determine admission to a hospital in 30 days previous.

Between April 1-August 29, 2008, 16 deaths (8 confirmed and 8 possible) were reported.

As of August 29, 2008 12 (11 confirmed, 1 possible) individuals were currently hospitalized**.

** The number of cases currently in hospital is based on the date of a positive laboratory result; it does not capture cases who have been re-admitted to hospital.

Figure 2: Epidemic curve of CDAD cases among inpatients at NRGH from fiscal periods 801-806, 2008 (N=112).

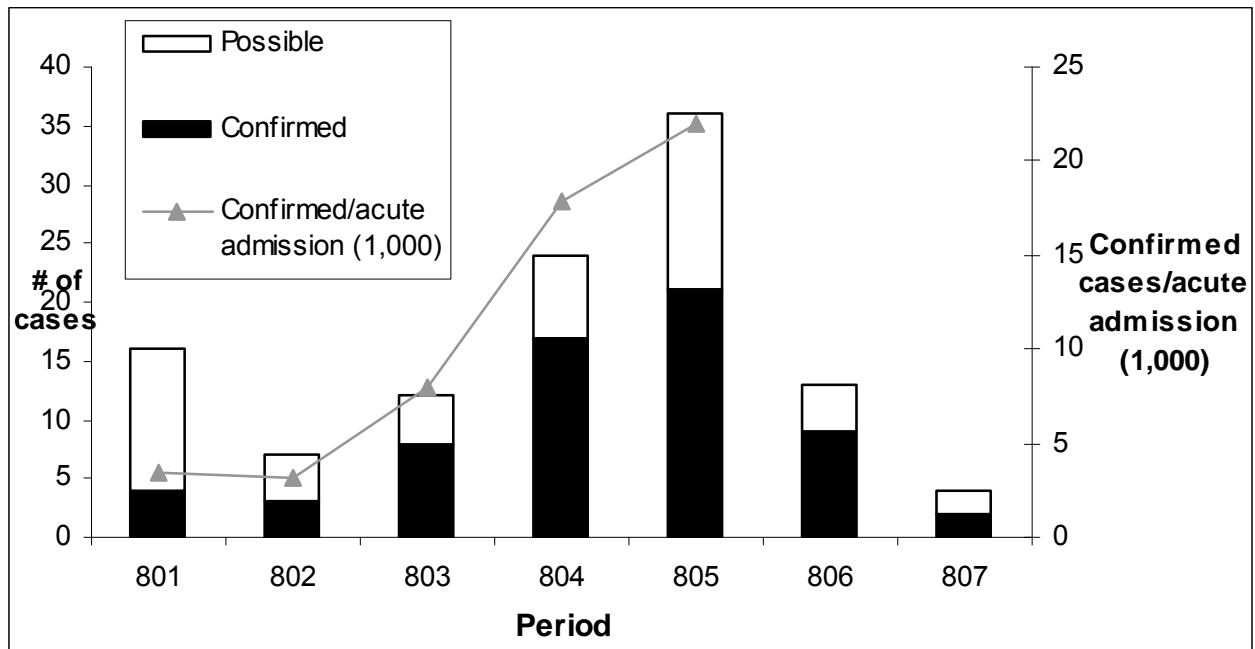




Figure 3: Epidemic curve of CDAD cases among inpatients at NRGH classified by transmission (N=112).

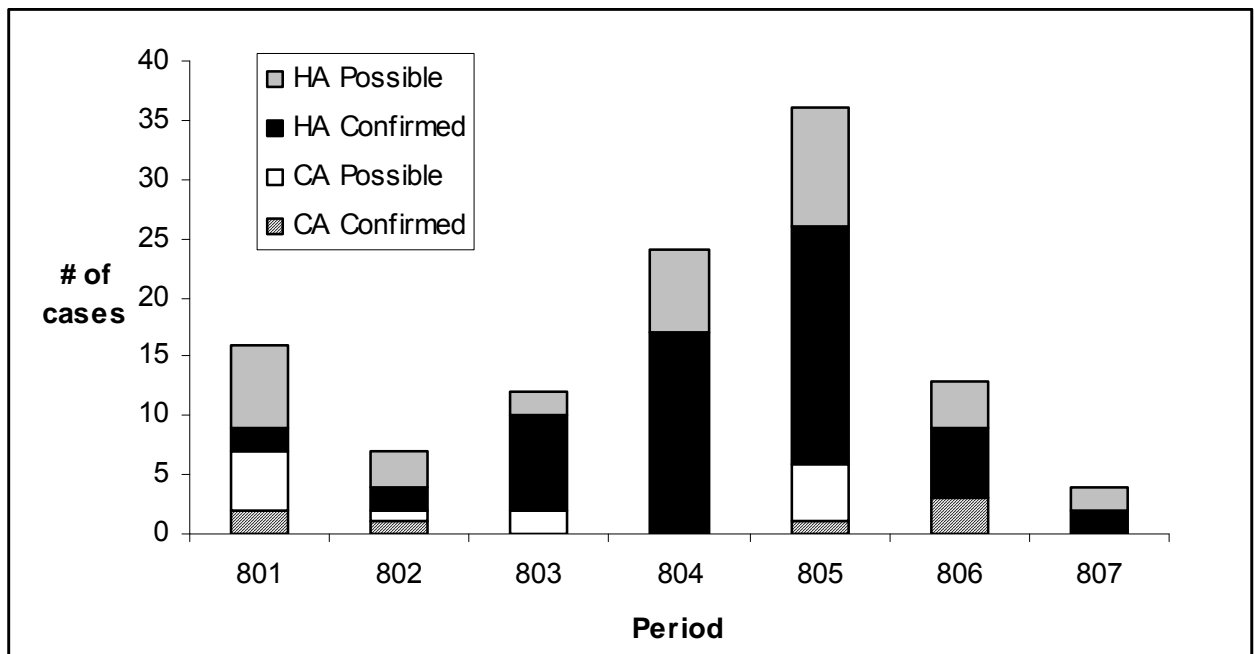


Table 3: Demographic characteristics for confirmed and possible cases



Case Classification

Characteristic	Confirmed	Possible
Age (yrs)		
Mean	76.7	70
Median	77	68
Range	48-96	7 –95
Sex	N (%)	N (%)
Males	37 (57.8)	24 (50.0)
Females	27 (42.2)	24 (50.0)
Median Length of Stay (d)***	19	11

***Median length of stay calculated for cases report between April 1-August 29, 2008

- 20 cases had been reported among outpatients or individuals who had visited the ER and not been admitted. 12 were confirmed cases and 8 were possible cases.
 - 3 (2 confirmed, 1 possible) cases had documented admission in the 30 days prior to their lab receipt date
 - 8 (5 confirmed and 3 possible) cases had documented visits to the ER or clinic including one case who had visited for dialysis treatment.
 - 3 (1 confirmed and 2 possible) cases reported no prior admissions in previous 30 days
 - History prior to lab receipt date is unknown for 6 (4 confirmed and 2 possible) cases
- 38 individuals had testing repeated (range of 2 to 6 tests)
 - 8 individuals initially tested as toxin positive and upon repeat tests were reported as toxin negative.
 - 5 individuals initially tested as toxin negative and upon repeat tests were reported as toxin positive
 - 1 individual initially tested as toxin positive, then toxin negative and then tested as toxin positive on subsequent testing.
- 8 confirmed hospital-acquired cases had a positive lab test within three days of admission; all had an admission in the previous 30 days. The median time from admission to positive lab test for all other confirmed hospital-associated cases was 17 days.

More confirmed cases were reported, however possible cases made up a large proportion of cases and in some periods there were significantly more possible cases than confirmed cases (801 and 802). Almost 90% of confirmed cases were hospital-associated and of the confirmed community associated cases,

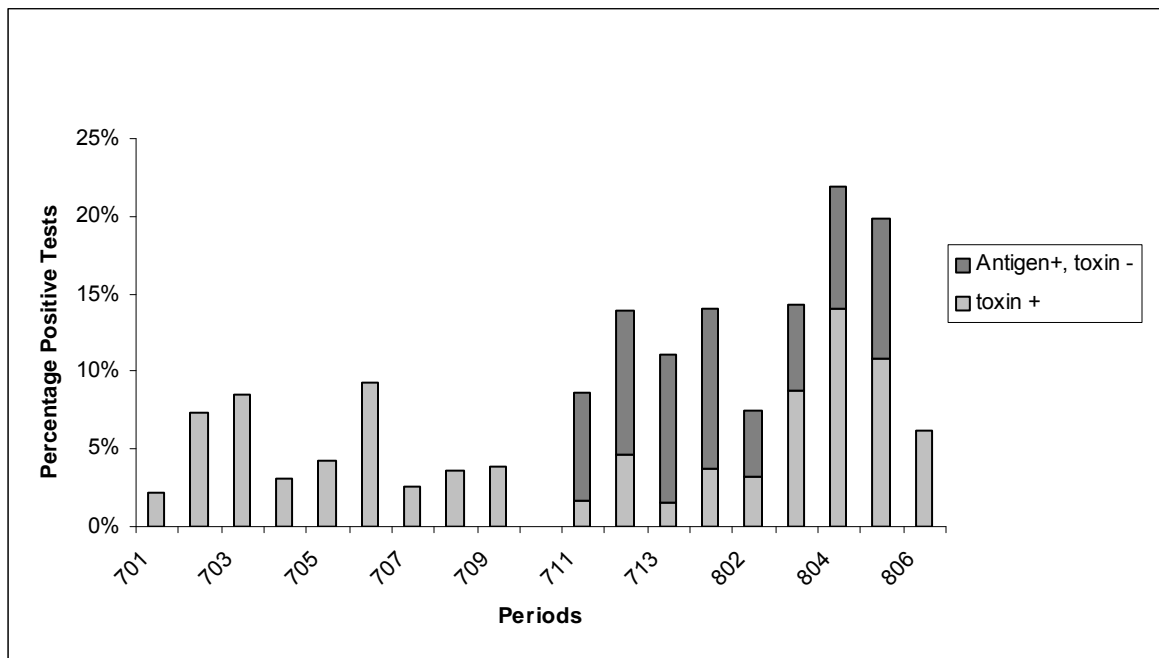


three had previous visits to the ER or clinic (data available on four cases), suggesting the possibility that they acquired their illness during a visit to the hospital even though they were not admitted. The epidemic peak was highest in periods 804 and 805 and has dropped in period 806 and 807. Among confirmed cases they had an older median and average age as well as a longer stay in hospital. There were a number of confirmed cases reported among outpatients and although their data is not typically included in analysis it is interesting to note that 88% of confirmed cases (where information is available) had contact with the ER/clinic or had been admitted previously. Repeat testing was relatively common among patients; reasons for this were not stated in any chart review or discussion with clinical staff. The median time from admission to lab receipt was over two weeks, the maximum was 68 days. This is consistent with the high number of hospital associated confirmed cases.

Percent positive of laboratory testing

A change in testing methods occurred at the beginning of period 711 (January 1, 2008). Prior to period 711, only toxin testing was done. Since 711 testing is done in series. First the specimen is tested for the antigen and if positive then toxin testing is performed. Specimens can be reported as antigen positive and toxin positive (suggesting active illness and production of toxin) or toxin negative (suggesting colonization but no active illness). If the specimen is antigen negative no further testing is done. Changes in testing protocols have been identified as a potential reason for changes in case counts. In this situation the percentage of tests considered confirmed through toxin positive did not change. However, since the change in testing a large percentage of individuals have been reported as antigen positive and toxin negative, this suggests that the individual is colonized with *C. difficile* but there is no toxin being produced. Test result interpretation and the management and treatment of these cases may not be consistent.

Figure 4: Percent positive testing for *C. difficile* from period 701 to August 29, 2008





Colonoscopy and Sigmoidoscopy Review

Between May 1 and August 28, 2008, five cases (3 possible and 2 confirmed) had a colonoscopy or sigmoidoscopy performed as an inpatient. Of the three possible cases, one was included in the chart review. The opinion of the physician was that symptoms of this individual were more compatible with inflammatory bowel disease than *C. difficile*.

Chart review

15 charts were reviewed. Thirteen charts were of possible cases between period 801 to 805. At time of review all cases had been discharged from their admission related to their lab test for *C. difficile*. Five (38%) received treatment for their diarrhea and 7(54%) had contact precautions documented in their charts. Two of the charts indicated that the individual had a history of a prior *C. difficile* infection. Two charts were reviewed on individuals who were initially reported as toxin negative and on subsequent testing reported as toxin positive. One case was provided with treatment and had contact precautions implemented, the other did not. The chart review indicated variation in how patients that were not toxin positive were managed and what treatment was provided during their admission. Information regarding their symptoms was adequate however documentation of implementing and removing contact precautions was poor. Treatment was provided to a small number of cases and this was based on clinic diagnosis. There did not appear to be any changes in treatment or management of these cases over different periods; however the number of charts reviewed was limited. How management and treatment provided compared with those cases that were toxin positive would demonstrate whether there was a difference in clinical management during this outbreak.

Interviews with clinicians

Interviews were completed with 6 nursing staff (both floor nurses as well as charge nurses) from 4 wards on August 31st 2008, at Nanaimo Regional General Hospital.

When asked to describe the steps taken once a patient is identified with loose stools, nursing staff consistently identified placing the patient on contact precautions immediately (including private commode use) and then sending the stool for tests including *C. difficile*. Some informants discussed placing a blue sheet on top of charts to facilitate informing the attending physician. In all cases, physicians are only notified when they are next in the hospital to visit patients. Therefore, the earliest opportunity for presumptive treatment is usually 1-3 days following first identification of symptoms. The Infection Control Practitioner (ICP) is not routinely notified of onset of new loose stool in a patient.

Once a toxin positive result has been obtained there was no consensus among nurses as to whether the physician would be called with the result. The immediacy of physician notification appeared to be situation dependant. It was unclear to what extent antigen positive/toxin negative patients were being treated.



Nurses were all in agreement that the criteria for a patient to be discontinued from contact precautions after a diagnosis of *C. difficile* were 1) no loose stools for a period of 72 hours AND 2) complete course of antibiotics. Most indicated they would confer with the ICP before making the final decision. Prior to the outbreak, some were taken off precautions if testing showed antigen positive/toxin negative.

When asked about the major challenges in managing *C. difficile* patients from a nursing perspective, nurses uniformly discussed crowded rooms, lack of washing basins and lack of individual bathrooms. Most also mentioned the scarcity in cleaning staff, especially on the weekends. In one informant's words "cleaning contracts are not being lived up to". With respect to equipment, there are not enough pots for the commode chairs (one example during interviews was given as 8 chairs and four pots for the floor), which sometimes results in stopping the cleaning cycles to get fresh pots. Another common theme was the pressure to remain over census and accept patients from the Emergency Department even if that results in bringing a symptomatic case into a ward room of vulnerable patients. It was stated that patient placement decisions are made in the absence of nursing or ICP input.

With regard to what measures would be helpful, the nurses interviewed would like to see better communication between administration and the floors as well as between floors. While most felt they had a good understanding of the outbreak and infection control measures at present, they all indicated that it took several months to get to that stage.

Hospital pharmacy

Antibiotic dose and order data was obtained from the hospital pharmacy clinical coordinator. Six antibiotics were documented, clindamycin, cefuroime, ceftriaxone, moxifloxacin, ciprofloxacin and vancomycin. Ciprofloxacin is the most commonly ordered and given in the highest doses in NRGH. The use of antibiotics has not significantly increased over the time period prior to the outbreak (up until period 804) among inpatients. Ongoing monitoring of antibiotic use should continue. The chart review identified that individuals who are admitted are often elderly and may be on a number of different antibiotics at time of admission.

Community lab testing

Table 4: Number of stool specimens tested for *C. difficile* and test results, Nanaimo, 2005-2008

	Jan 1 – Dec 31			Jan 1 – June 30
	2005	2006	2007	2008



Total number of stool specimens tested for <i>C. difficile</i>	475	559	530	248
Total number of specimens positive for <i>C. difficile</i> toxin(s)	86	83	70	41
Percentage of specimens positive for <i>C. difficile</i> toxin(s)	18.1	14.8	13.2	16.5

The private laboratory in Nanaimo that tests for *C. difficile* in clients in the community provided statistics on stool specimens tested for *C. difficile* between January 1 and June 20, 2008 and the previous three years (Table 4). There was no apparent increase in the number of stool specimens tested for *C. difficile*, or the percent of tested specimens that were positive for *C. difficile* toxin(s) in 2008 when compared to the previous 3 years.

Location mapping of confirmed and possible cases in period 801 and 802

Room and bed locations were investigated among confirmed and possible cases during periods 801 and 802. These two periods were selected as they were the time period immediately before the number of cases significantly increased and the outbreak was declared. By examining the movement of the cases during this time period it was hypothesized that widespread transmission throughout the hospital may be identified. During period 801 there were 3 confirmed cases and 12 possible cases. Of the confirmed cases two were admitted through the ER and two were admitted through day surgery. Both patients admitted for day surgery were admitted to the third floor after surgery. Of the possible cases 11 were admitted through the ER and one was admitted through day surgery. Six of the possible cases spent time on the fifth floor during their hospital admission and two spent time on the third floor. One confirmed case and one possible case were admitted to the third floor at approximately the same time and during their onset of illness. Cases were admitted to the same rooms, however based on admission, onset and discharge dates did not overlap directly.

During period 802 there were 3 confirmed cases and 4 possible cases. All three confirmed cases were admitted through the ER and all three spent some time of their admission on the sixth floor (one exclusively). All four of the possible cases were also admitted through the ER. Two of the possible cases spent their admitted time exclusively on the sixth floor. Based on admission, onset and discharge dates there was no obvious overlap or room identified among cases on the sixth floor.

Based on this review of the data it would suggest that during period 801 there may have been increased transmission on the third floor and possibly the fifth floor. During period 802 there was increased activity on the sixth floor. There were no direct connections over this time period among patients between the third and sixth floors, however it is possible that staff, hose-keeping and other services are shared. It was also noted the patients are moved from different floors and rooms quite frequently during their admission. It is likely that during periods 801 and 802 there was transmission of *C. difficile* and illness among patients and if management and hygiene were lacking during this time period as more people were



admitted or transferred they would have come in contact with these areas and their further transfer would continue the spread to other floors and wards. Although the ER is the location where the majority of hospital patients are admitted, it is interesting to note that 100% of patients in period 801 and 802 were admitted through the ER or day surgery. Due to the high volume of traffic and potential cross contamination the ER should be focussed on for intensive cleaning and personal hygiene.

Hypothesis generation

Based on the field investigation and epidemiological data review it is plausible that the increased transmission of illness within NRGH was due to a number of factors, overcrowding and resources strain may have played a role. One further component of data analysis would be a case control analysis using the time an individual spent in the ER as a proxy for over-crowding within the hospital, assuming that an individual would spend a greater time in ER before being admitted when there were less resources available within the hospital. This may also help to improve the understanding of the role of the ER in transmission and sustaining ongoing illness.

A review of whether individuals in four person rooms were at increased risk compared to those in two person or individual rooms. Based on review of cases the amount of time that they were in a four person room prior to onset could be determined and this could be used to assess whether there was increased risk of the individual becoming a confirmed case.

Although antibiotic use does not appear to be increasing within the facility, it may be useful to compare this to antibiotic use throughout the community or to other facilities comparable to NRGH.

Recommendations:

Based on the field investigation and epidemiological analysis the following recommendations have been made:

- There is a need for more resources directed towards infection control. The current situation of only one infection control practitioner (ICP) in a facility the size of NRGH is not adequate to ensure ongoing monitoring of all data sources (for all organisms of concern) as well as the practical components of teaching and working on the floors with clinical staff.
- There was not standard way for the ICP to extract the necessary data from one location. The essential data components for monitoring on a routine basis includes:
 - Demographic and admission information
 - Lab information (testing and results)
 - Outcome data (discharge, death, currently admitted)
 - Movement of patient between rooms

These data elements were found in multiple locations (lab linelist, regional access database, ICP developed linelist, Meditech) which it made it difficult to develop a complete picture on the



ongoing situation in a timely fashion. It also meant that there was often duplication of information between sources and the need for manual entry from one system to another. ICP and their data needs should be considered with any new data system that is being implemented.

- An outbreak team should have been assembled which included representatives from the hospital (including senior management), clinical staff, ICP and VIHA staff. Routine meetings, communication and circulation of data are required for interpretation and actions.
- During an outbreak there needs to be enhanced and timely surveillance, the format and tools used to monitor the outbreak should be modified and a standard case definition should be set and shared. At the outset of the investigation the team should set the definitions and develop the surveillance tools they will use, these will often differ from the routine format as there is a need to capture different information. The lab linelist was useful and timely but required modification to include information on outcome, case classification and actions for ICP. The outbreak format should include the minimum number of variables that will provide the essential information for action and it is recommended that an outbreak specific database be used for timely data extraction and analysis on an ongoing basis.
- When the change in testing occurred there was little communication to clinicians on proper interpretation. A memo was circulated but reinforcing the message and clear guidance during the outbreak may have improved case management and treatment.
- There was no onset date recorded systematically. Lab receipt date was used as a consistent date and due to hospital policy of taking a lab specimen immediately after a patient began exhibiting symptoms. During chart review, onset of diarrhea was not always clearly noted. Improved documentation of date of onset would help ensure accuracy of the epidemiological curve and routine monitoring.
- During an outbreak active surveillance could be undertaken to identify person under investigation (those with diarrhea) immediately. One suggestion would be for the implementation of basic syndromic surveillance on each ward that is reported to the ICP on a daily basis so they are aware of the activity on each ward.
- During outbreaks, encourage presumptive treatment of cases and ensure contact precautions are implemented immediately. This may be assisted by making *C. difficile* a critical test result during an outbreak to ensure that these actions are timely.
- ICP should sign all orders for discontinuation of contact precautions.
- More signage in ER and public areas of the hospital and on the wards to let the public and staff know there are increased rates of *C. difficile* and to very vigilant about hand washing and routine cleaning.
- Routine communication to all hospital staff about the status of the outbreak and what actions are currently being taken. Open communication and a forum to have questions answered are important for emphasizing the important role staff can take to minimize transmission. It also ensures standard information is shared.
- Charts should have clear documentation of onset, all testing, treatment and precautions implemented and removed.
- Development of a flow chart to assist clinicians in presumptive treating algorithms that maintain contact precautions in the face of negative CDAD results and encourage testing.
- Overall the wards and nursing staff appear to have a lack of available resources to ensure adequate hygiene at all times. Items such as bed pans, and clean equipment were scarce and support from house-keeping staff was minimal. Due to the over-crowding there was a pressure to place individuals in 4 person rooms even though this may breach recommendations from infection control. The hospital will need to address these issues and additional resources, particularly during an outbreak would be recommended.



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Appendix 1

Fiscal Period by Calendar Date

Period	Dates
801	April 1-May 1, 2008
802	May 2-May 29, 2008
803	May 30-June 26, 2008
804	June 27-July 24, 2008
805	July 25-August 21, 2008
806	August 22-September 17, 2008
807	September 18-October 15, 2008



Select References

Patient rooms

1. Canadian Standards Association. Infection Control During Construction or Renovation of Health Care Facilities. 2004. CSA Z317.13-03.
2. Canadian Standards Association. Infection Control During Construction, Renovation, and Maintenance of Health Care Facilities. 2007. CSA Z317.13 (2nd edition).
3. APIC Text of Infection Control and Epidemiology 2005.
4. Pilot Study on Comparative Assessment of Patient Care Issues in Single and Multiple Occupancy Patient Rooms. Submitted to The Coalition for Health Environments Research by Habib Chaudhury, Atiya Mahmood and Maria Valente. Simon Fraser University November 20, 2003.
5. Ulrich R., Quan X., Zimring, C. Joseph, A. et al. (2004). The role of the physical environment in the hospital of the 21st Century: a once-in-a-lifetime opportunity. Report to the Center for Health Systems and Design. [http://www.healthdesign.org/research/reports/physical_envIRON.php]. Accessed Sept 14, 2008.

Hand Hygiene

1. Henry B, et al. CHICA-Canada Position Statement on Hand Hygiene; Canadian Journal of Infection Control Summer 2008; 114-117.
2. Handwashing, cleaning, disinfection and sterilization in healthcare, Public Health Agency of Canada (1998).
3. Kac G, Podglajen I, Gueneret M, Vaupre S, Bissery A, Meyer G. Microbiological evaluation of two hand hygiene procedures achieved by healthcare workers during routine patient care: a randomized study. Journal of Hospital Infection (2005)60, 32-39.
4. Fagernes M, Lingaas E, Bjark P. Impact of a Single Plain Finger Ring on the Bacterial Load on the Hands of Healthcare Workers. ICHE 2007;28(10):1191-1195
5. Guideline for Hand Hygiene in Health-Care Settings, Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force (2003).
6. Gehrke C, Steinmann J, Goroncy-Bermes P. Inactivation of feline calicivirus, a surrogate of norovirus (formerly Norwalk-like viruses), by different types of alcohol in vitro and in vivo. Journal of Hospital Infection (2004)56, 49-55
7. Kramer A and Kampf G. Hand Rub–Associated Fire Incidents During 25,038 Hospital-years in Germany. Infect Control and Hospital Epi (2007)Volume 28,(6); 745 – 746.