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Brief report

Development and implementation of a cleaning standard algorithm to monitor the efficiency of terminal cleaning in removing adenovirus within a pediatric hematopoietic stem cell transplantation unit

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Adenovirus infections within the hematopoietic stem cell transplantation setting can lead to high rates of mortality and hospital-acquired cases have been associated with environmental reservoirs. To establish both location and levels of environmental adenovirus contamination, 48 cubicles containing 794 surfaces were screened postterminal clean over a 4-year period. After initial cleaning 23% of these sites had detectable adenovirus. These data were then used to develop and implement a cleaning standard algorithm for terminal cleaning that was implemented to ensure cubicles were adenovirus-free before the next patient admission.

Health care-associated infections (HAIs) lead to poor clinical outcomes and death.[1] Patients who are particularly susceptible to HAIs include those with severe underlying disease, long hospital stays, old age, and admission to intensive care units.[2] It is estimated that of the HAIs developed within intensive care unit settings, 20% are potentially due to environmental contamination.[3] Of those viruses causing HAI within the hematopoietic stem cell transplantation setting, adenovirus is 1 of the most notable. Acquisition or reactivation of adenovirus during hematopoietic stem cell transplant can lead to high morbidity and mortality in this patient group, with nosocomial outbreaks demonstrating high secondary attack requiring rapid infection control measures.[4] Not only do adenovirus outbreaks have significant clinical implications, but they also have substantial financial effects.[5]

Kleypas et al[6] suggest that the best way of reducing HAIs after hand hygiene is environmental control, which should be based on good cleaning. Regardless of cleaning product used, the degree of efficiency of the cleaning staff will ultimately determine its success because they determine both wiping action and contact time.[7] Due to these issues with the efficiency of terminal cleaning it is important that disinfection is not only achieved by adequately training staff to a standard, but there must also be monitoring and employee auditing to ensure efficient cleaning has been delivered.[8] Therefore if cleaning is undertaken to control adenovirus it must be monitored to ensure adenovirus removal has occurred.

We examined the use of molecular screening for adenovirus from 2005-2009 to evaluate terminal cleaning efficacy and discuss the designing of an algorithm based on these data to permit monitoring of terminal cleaning as an infection control intervention. Due to insufficient data (linked to changes in diagnostic and cleaning protocols) we are unable to compare data on the incidence

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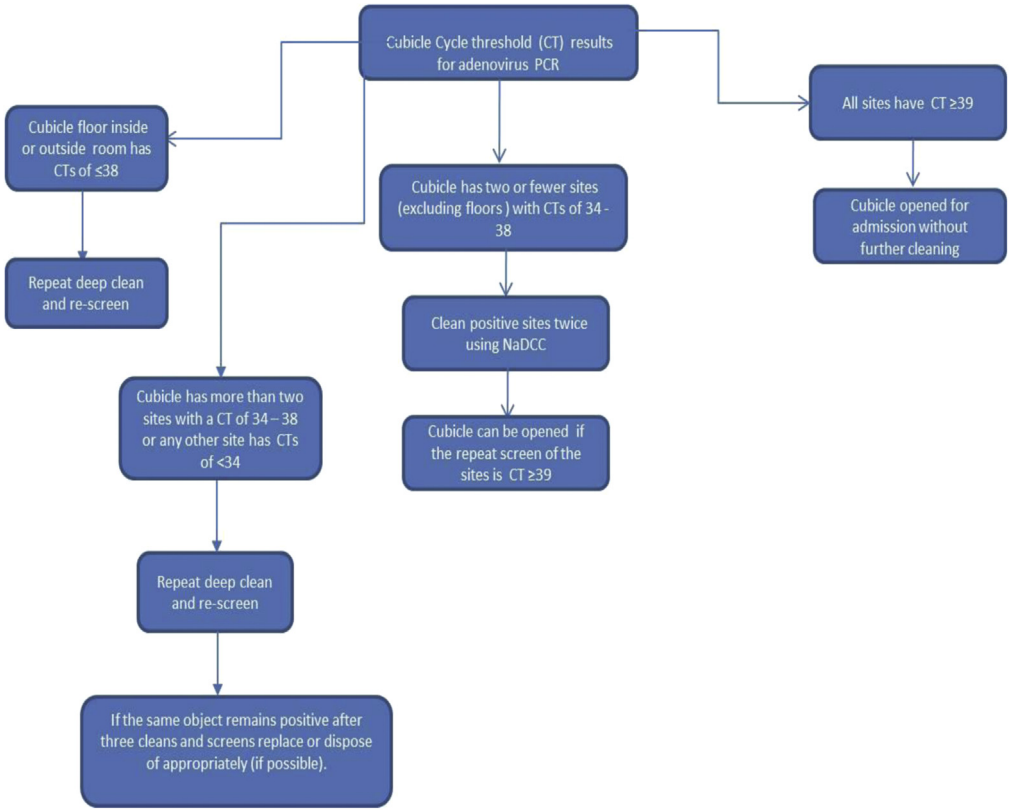

Fig 1. Routine monitoring algorithm for interpreting and using adenovirus polymerase chain reaction (PCR) results in relation to environmental screening. *CT*, cycle threshold; *NaDCC*, 1,000 ppm chlorine.

of adenovirus HAIs during this period of algorithm development and implementation and so have focused on cleaning quality.

METHODS

Terminal cleaning

Terminal cleaning after the discharge of an adenovirus-positive patient involves the removal of all linen and clinical equipment from the cubicle. The remaining items, floor, walls, and ceilings are cleaned using disposable cloths with 1,000 ppm chlorine. After cleaning, cubicles were inspected to ensure that the room was visibly clean and if the cubicle passed inspection it underwent molecular screening.

Environmental screening

Screening was undertaken using adenovirus polymerase chain reaction as previously published.[9] Cotton-tipped swabs were used to take samples of the following sites 2 hours after cleaning finished: floor under the sink, clinical waste bin, chair arms, door handles (bathroom and entrance), telephone, bathroom taps, bed frame, mattress, trolley, window sill, and floor outside the cubicle door.

Actions in relation to screening results

If any surfaces were found to be adenovirus DNA positive during the period 2005-2009 a complete reclean and screen was undertaken. From 2010 onward recleaning and screening were undertaken per the algorithm as described in the Results and Discussion.

Statistical analysis

To analyze data collected from 2005-2009 a standard linear regression analysis was used. Explanatory variables were object, season, cleaning number, and room, in turn. Akaike's information criterion was used in combination with analysis of deviance to test whether each variable had an influence on the outcome. All the analyses were made using MLwiN version 2.20 (Centre for Multilevel Modelling, University of Bristol, Bristol, UK).[10]

RESULTS AND DISCUSSION

Over a 5-year period (2005-2009) data were collected for algorithm design. Our collection included 794 surfaces screened for adenovirus in 48 cubicles.

Cubicle screening data, 2005-2009

No individual cubicle was linked with higher levels of adenovirus contamination or more failing sites. However there was a link to seasonality, with more failures occurring during the winter months compared with the autumn season ($P \leq .01$) and fewer failures during the summer months ($P \leq .01$). This may be linked to increased viral loads linked to primary acquisition, which occurs more frequently during the winter months.

Some cubicles required multiple cleans and screens to become virus-free. Eight of 48 cubicles failed the initial clean and screen, with 1 cubicle requiring 5 cleans to be declared virus-free. Second and fourth cleans were significantly less effective at removing adenovirus DNA than the initial clean, or third and fifth cleans ($P \leq .01$).