Literature Review:
Infection control measures for outbreaks of norovirus in care settings

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Contents

1 Objectives

The aim of this review is to examine the extant professional literature regarding appropriate infection control measures for outbreaks of norovirus in care settings. The specific objectives of the review are to determine:

Patient Placement/Assessment for Infection Risk

1. Is bay/ward/care home closure an effective measure in controlling an outbreak of norovirus?
2. How long should bays/wards and care homes remain closed after the last new norovirus case and after uncontrolled episodes of vomiting and/or diarrhoea?
3. Is patient cohorting an effective measure in the management of a norovirus outbreak?
4. Is staff cohorting an effective measure in the management of a norovirus outbreak?
5. Is the exclusion of non-essential staff from care settings an effective control measure during an outbreak or norovirus?
6. Is visitor exclusion from care settings an effective control measure during norovirus outbreaks?

Hand Hygiene

7. Is alcohol based hand rub (ABHR) effective against norovirus?

Personal Protective Equipment

8. Is there sufficient evidence of airborne transmission of norovirus to recommend the use of respiratory protection?

Environmental Disinfection and Decontamination

9. What environmental cleaning products are recommended to inactivate norovirus?
10. How should carpets and soft furnishings be decontaminated after a norovirus outbreak?
11. What environmental cleaning procedures are required prior to re-opening of a care setting after an outbreak of norovirus?

Note 1: For the purposes of this review, care setting includes but is not limited to general practice, dental and pharmacy (primary care), acute-care hospitals, emergency medical services, urgent-care centres and outpatient clinics (secondary care), specialist treatment

centres (tertiary care), long-term care facilities such as nursing homes and skilled nursing facilities (community care), and care provided at home by professional healthcare providers (home care).

Note 2: For the purposes of this review, a ward is defined as an area forming a division of a care setting (or a suite of rooms) shared by patients who need a similar kind of care.

A bay is defined as an enclosed area within a ward that may contain one bed (single bay) or a partly closed area multiple beds (multi-bed bay). For a bay to be suitable for bay closure it must have doors which can be closed, a wash-hand basin and toilet facilities which are not shared by asymptomatic patients.

2. Methodology

This targeted literature review was produced using a defined methodology as described in the National Infection Prevention and Control Manual: Development Process. Definitions of the grades of recommendations can be found in this linked document.

A previous literature review for norovirus control was conducted in 2010 by Health Protection Scotland (HPS). This review examines the published literature from 2008 to June 2018.

3. Recommendations

This review makes the following recommendations based on an assessment of the extant professional literature on appropriate infection control measures for outbreaks of norovirus in care settings.

Is bay/ward/care home closure an effective measure in controlling an outbreak of norovirus?

Bays/wards/care homes should be closed to new admissions during an outbreak of norovirus.

Grade D recommendation

How long should bays/wards and care homes remain closed after the last new norovirus case and after uncontrolled episodes of vomiting and diarrhoea?

The bay/ward/care home should remain closed until:

- there have been no new confirmed cases of norovirus for at least 48 hours; and
- there has been no vomiting and/or diarrhoea for at least 48 hours which is suspected to be caused by norovirus; and
- it has been terminally cleaned to the satisfaction of the nurse in charge or care area manager.

Good Practice Point (GPP)

Is patient cohorting an effective measure in the management of a norovirus outbreak?

Patient cohorting should be considered during an outbreak of norovirus, as per the HPS transmission based precautions literature review: Patient placement (Isolation/cohorting).

AGREE rating: Recommend

Patient cohorting may be appropriate when single rooms are not available and there is more than one patient with the same confirmed infection.

AGREE rating: Recommend

Patient cohorting should be combined with other infection prevention and control measures e.g. hand hygiene, PPE and environmental decontamination.

Grade D recommendation

Patients should be separated by at least 3 feet (1 metre) from each other in a cohort area and bed curtains can be drawn as an additional physical barrier.

AGREE rating: Recommend

Is staff cohorting an effective measure in the management of a norovirus outbreak?

Staff cohorting should be considered during an outbreak of norovirus as per the HPS Transmission based precautions literature review: Patient placement (Isolation/cohorting).

AGREE rating: Recommend

Is the exclusion of non-essential staff from care settings an effective control measure during an outbreak of norovirus?

Non-essential staff should be excluded from affected care settings during an outbreak of norovirus.

Good Practice Point (GPP)

Is visitor exclusion from care settings an effective control measure during norovirus outbreaks?

Temporary suspension of visiting in care settings during norovirus outbreaks should be considered by the care area manager/ICT/HPT. A decision to suspend visiting in a care setting must be effectively communicated internally to all staff members and externally to relatives and the public.

Good Practice Point (GPP)

Is alcohol based hand rub (ABHR) effective against norovirus?

ABHR should not be used alone for routine decontamination of hands when there is an outbreak of norovirus. Hands should be decontaminated with liquid soap and warm water.

Grade D recommendation

Is there sufficient evidence of airborne transmission of norovirus to recommend the use of respiratory protection?

There is insufficient evidence of airborne transmission of norovirus to recommend the use of respiratory protection. However, fluid resistant surgical facemasks (FRSMs) should be considered during norovirus outbreaks as a Standard Infection Control Precaution (SICP) to protect staff from any risk of splashing when cleaning spillages of body fluids such as vomit or diarrhoea, and as a contact precaution when vomiting is present.

Good Practice Point (GPP)

What environmental cleaning products are required to inactivate norovirus?

Environmental cleaning/disinfection with 1000 parts per million (ppm) available chlorine should be used to inactivate norovirus.

Grade D recommendation

How should carpets and soft furnishings be decontaminated after a norovirus outbreak?

Carpets and soft furnishings within the patient care area should be steam cleaned or decontaminated with water and detergent according to manufacturers' instructions after an outbreak of norovirus.

Grade D recommendation

What environmental cleaning/disinfection procedures are required prior to re-opening of a care setting after an outbreak of norovirus?

Bed/window curtains and bedding should be removed and laundered as infectious linen and extensive environmental disinfection should be carried out as described in the HPS Transmission Based Precautions Literature Review: Management of Care Equipment and Environmental Decontamination.

Good Practice Point (GPP)

4. Discussion

4.1 Implications for practice

Is bay/ward/care home closure an effective measure in controlling an outbreak of norovirus?

Closure of bays/wards/care homes to new admissions is an infection control measure frequently implemented during norovirus outbreaks.

Four studies were identified that analysed previous outbreak data.[1-4] It is not possible to determine the impact of closure in isolation due to the available evidence being part of bundled infection control strategies.

Evidence from one study suggests that whole ward closures can be prevented where ward structures allow cohorting of symptomatic patients in closed bays or rooms, supported by transmission based precautions.[3]

Results from a mathematical modelling study found that ward closures are required to break the chain of transmission where there is a high turnover of patients i.e. when the mean duration of hospital stay ranges from 0.1-20 days.[4] Notably, the statistical power of the study was weak, and due to the questionable validity of mathematical studies the results should be interpreted with caution.

Regarding the timing for initiation of closure, there is some evidence to suggest that the duration of norovirus outbreaks are significantly shorter when wards are closed within 3 days of the onset of the primary case, compared with wards closed after 4 days.[2] This finding is similar to that of a previous study that reported a shorter duration of norovirus outbreak when wards are closed within 3 days.[5] However, in outbreaks where wards were not closed, the length of outbreaks were similar to the prompt closure group and also had fewer patients and staff affected and fewer cases per day of outbreak compared with prompt closure.[2] It is possible that ward closure was not necessary in those outbreaks as there were effective non-closure infection control measures in place. Extrapolation of these findings suggests that where possible, ward closures should be implemented promptly i.e. within 3 days of onset of the primary case.

The Centres for Disease Control (CDC) norovirus guidance recommends that *"closure of wards to new admissions or transfers should be considered as a measure to attenuate the*

magnitude of an outbreak of norovirus gastroenteritis; the threshold for ward closure varies and depends on risk assessments by infection prevention personnel and facility leadership."[6]

Bays/wards and care homes should be closed to new admissions during an outbreak of norovirus.

(Grade D recommendation)

How long should bays/wards and care homes remain closed after the last new norovirus case and after uncontrolled episodes of vomiting and/or diarrhoea?

There is very limited evidence to determine how long closure should remain in place after the last new case of norovirus or after uncontrolled episodes of vomiting and/or diarrhoea. In theory, timing will be directly related to both the incubation period and symptomatic period of norovirus infection.

Only one study was identified, which analysed data from published outbreak reports to determine mean and median incubation periods and symptomatic periods for norovirus infection.[7] All reported durations were less than 48 hours (32.8 – 43.0 hours), which is within the current HPS recommendation for ward closure time. Notably, this study made calculations based on aggregated outbreak data that differed in setting and population demographics therefore was at risk of ecological fallacy and had a high risk of bias.

CDC guidance has no specific recommendation for the length of time bays/wards and care homes should remain closed.[6]

The bay/ward/care home should remain closed until:

- there have been no new confirmed cases of norovirus for at least 48 hours; and
- there has been no vomiting or diarrhoea for at least 48 hours which is suspected to be caused by norovirus; and
- it has been terminally cleaned to the satisfaction of the care area manager and the ICT/HPT.

(Good Practice Point (GPP))

Is patient cohorting an effective measure in the management of a norovirus outbreak?

Cohorting of affected patients has been implemented as a means to interrupt transmission of norovirus. Dependent upon facility characteristics, approaches for cohorting symptomatic patients during outbreaks include placement in single rooms, in multi-occupancy rooms with other symptomatic patients and/or exposed asymptomatic patients, or within designated care areas, bays or sections within a ward/facility for larger cohorts.

Due to the considerable variation in the approaches and implementation for cohorting, comparison between studies is limited.

Five studies were identified[8-12], only one of which was a prospective study.[9] It is not possible to determine the impact of patient cohorting in isolation in any of the identified studies due to the available evidence being part of bundled infection control strategies.

The limited evidence indicates that nightingale style ward configurations are a hindrance to the implementation of effective patient cohorting, as isolation of symptomatic patients is made more difficult by the open layout and lack of isolated bays or single rooms.[9;12;13]

Closure of wards is often used as an outcome measure to determine the efficacy of patient cohorting, owing to the fact that ward closure is implemented as part of an escalation plan in uncontrolled outbreaks. A prospective intervention study that implemented patient cohorting at the start and end of outbreaks reported that prior to the intervention, 90% of outbreaks were managed by closure of an entire ward, compared with only 54% in the period after the intervention.[9] There was a significant reduction in duration of closure after the change in strategy (6 days vs. 5 days, P = 0.007).

CDC guidance recommends the following; "*during outbreaks, place patients with norovirus gastroenteritis on Contact Precautions for a minimum of 48 hours after the resolution of symptoms to prevent further transmission. When patients with norovirus gastroenteritis cannot be accommodated in single occupancy rooms, efforts should be made to separate them from asymptomatic patients.*"[6] The evidence for this statement was rated as very low quality.

Patient cohorting should be considered during an outbreak of norovirus, as per the HPS Transmission based precautions literature review: Patient placement (Isolation/cohorting) (AGREE rating: Recommend).

Patient cohorting may be appropriate when single rooms are not available and there is more than one patient with the same confirmed infection.

(AGREE rating: Recommend)

Patient cohorting should be combined with other infection prevention and control measures e.g. hand hygiene, PPE and environmental decontamination.

(Grade D recommendation)

Patients should be separated by at least 3 feet (1 metre) from each other in a cohort area and bed curtains can be drawn as an additional physical barrier.

(AGREE rating: Recommend)

Is staff cohorting an effective measure in the management of a norovirus outbreak?

There is very limited evidence to determine whether staff cohorting is an effective measure in the management of a norovirus outbreak. There is a large body of expert opinion based on outbreak reports which incorporate staff cohorting as part of bundled infection control strategies. There were no studies identified that assessed staff cohorting in isolation.

Expert opinion suggests that staff cohorting may be of particular importance in care settings where there is limited patient turnover, high nursing contact, full bed occupancy and thus difficulty in cohorting patients.[14-16]

Staff cohorting should be considered during an outbreak of norovirus as per the HPS Transmission based precautions literature review: patient placement (isolation/cohorting)

(AGREE rating: Recommend)

Is the exclusion of non-essential staff from care settings an effective control measure during an outbreak of norovirus?

There is very limited evidence on this topic; no studies were identified for inclusion in this review. Exclusion of non-essential staff has been advocated by expert opinion[17] and a number of published guidance documents.[6 18] The evidence base for these recommendations is of low quality, consisting largely of outbreak reports involving bundled

infection control strategies therefore it is not possible to determine the effect of this measure in isolation. Exclusion of non-essential staff is recommended by CDC[6] and HPA.[18]

Non-essential staff should be excluded from affected care settings during an outbreak of norovirus.

(Good Practice Point (GPP))

Is visitor exclusion from care settings an effective control measure during norovirus outbreaks?

There is limited evidence to determine the role of visitors in the transmission of norovirus. In theory, visitors to care settings in which a norovirus outbreak is occurring could risk contaminating further areas of the same care setting.

Analysis of outbreak reports has suggested that visitors may be a source of introduction of norovirus into care homes[19] and acute units.[20] However it cannot be determined if transmission in these cases originated from staff or visitors, or if the original index case originated from the community or a care setting.

The current practice in Scotland varies considerably. The current recommendation is for ICTs/HPTs and care area staff to consider the need for temporary suspension of visiting (TSV) based on the presenting outbreak, and based on a number of non-infection control considerations.[21] For example, exceptions may be made when assessment deems the visit to be essential i.e. visits to children, seriously ill or dying patients, or when the visit is considered to be an essential component of a patient's recovery.

There is very little evidence on the effectiveness of excluding visitors as an infection control measure during a norovirus outbreak. Only two studies were identified however neither study assessed the impact of visitor exclusion on an outbreak.[21;22] One of these studies investigated the acceptability of TSV during norovirus outbreaks in Scotland from the perspectives of patients, visitors and the wider public, and reported that the majority (84.6%) of respondents indicated that the possible benefits of TSV are greater than the possible disadvantages.[22]

There has been a call for clarity on TSV policy in Scotland and from a research perspective consistent implementation would allow assessment of the efficacy of TSV. However due to situations where exceptions are made for essential visits, implementation will be at the discretion of individual teams and consequently will vary considerably between healthcare settings and boards.

The temporary suspension of visiting to care settings during norovirus outbreaks should be considered by the care area manager/ICT/HPT. A decision to temporarily suspend visiting to a care setting must be effectively communicated internally to all staff members and externally to relatives and the public.

(Good Practice Point (GPP))

Is alcohol based hand rub (ABHR) effective against norovirus?

Much of the evidence base for the effectiveness of ABHR against norovirus is from laboratory- based experimental studies, testing a wide variety of concentrations and formulations. However there has been little consistency between the methods, the test materials, the viral challenge and the contact time. Due to the difficulties of in vitro propagation of human norovirus, feline calicivirus and murine calicivirus have been used as norovirus surrogates. However, as norovirus and its surrogates exhibit different physiochemical properties, it is unclear whether inactivation of surrogates reflects efficacy against human strains.[23]

Three studies were identified for inclusion. The two non-experimental studies were of very low quality with high levels of bias and confounding; neither study analysed ABHR in isolation, or assessed the virucidal efficacy of the ABHRs.[24;25] One of these studies extrapolated findings to suggest that preferential use of ABHR over soap and water for routine hand hygiene is associated with increased risk of norovirus outbreaks.[24] The experimental study found that ABHRs were ineffective at inactivating feline calicivirus.[26]

ABHR should not be used alone for routine decontamination of hands when there is an outbreak of norovirus. Hands should be decontaminated with liquid soap and warm water.

(Grade D recommendation)

Is there sufficient evidence of airborne transmission of norovirus to recommend the use of respiratory protection?

Airborne transmission is defined as "*the transmission of infectious airborne particles (aerosols) of small size (<5μm diameter). Particles of this size can remain suspended in the air for long periods of time and may be dispersed over large distances by air currents. "Droplet nuclei" are aerosols formed from the evaporation of larger droplet particles. Aerosols formed from droplet particles in this way behave as other aerosols, such as those generated*

from environmental sources or aerosol generating procedures (AGPs). Aerosols can penetrate the respiratory system to the alveolar level."[27]

Although norovirus is an intestinal pathogen, aerosols could, if inhaled, settle in the pharynx and be swallowed thus reaching the intestines. There is limited evidence of airborne spread of norovirus. Evidence consists of extrapolated findings from environmental sampling studies and experimental laboratory studies with simulated vomiting models.

Evidence suggests that the likely source of airborne spread is via the formation of droplet nuclei from vomit.[28] Analysis of data from outbreak reports to determine spatial associations[29] and attack rate patterns[30;31] occurring as a result of vomiting support airborne transmission however this evidence base is weak with a high risk of bias and confounding. A simulated vomiting study revealed that droplets produced during an episode of projectile vomiting can travel great distances (>3 m forward spread and 2.6 m lateral spread).[32] Results from a second simulated vomiting study using a norovirus surrogate, bacteriophage MS2, demonstrated aerosolisation and extrapolated findings to suggest that similar small percentages of aerosolised norovirus particles would be sufficient to pose a transmission risk.[33] Although the authors do not state the diameter of aerosolised MS2 particles, a previous study using similar methodology reported a diameter of 30-100nm which is significantly smaller than 5µm.[34] Interpretation of results is limited by the unknown validity of norovirus surrogates.

Three studies were identified in the search[33;35;36], two studies tested for the presence of norovirus in environmental samples in healthcare settings during norovirus outbreaks.[35;36] Norovirus RNA was detected in air samples[35], dust and air vent samples[36], providing evidence of airborne presence. However it is important to note that current detection methods cannot distinguish environmental sources of human norovirus RNA from intact virus particles that may be presumed infectious[37]. In this regard, viral RNA that persists in the environment could lead to false positive identification of infectious norovirus. In the aerosol study, murine norovirus type 1 (MNV-1) preserved its infectivity and integrity; the researchers extrapolated the results to suggest that aerosolised norovirus particles remain infective and are a likely mode of transmission during an outbreak.[35]

CDC guidance advocates masks to prevent droplet contact but does not consider the risk from aerosolised particles; *"if norovirus infection is suspected, adherence to PPE use according to Contact and Standard Precautions is recommended for individuals entering the patient care area (i.e., gowns and gloves upon entry) to reduce the likelihood of exposure to infectious vomitus or faecal material...use a surgical or procedure mask and eye protection*

or a full face shield if there is an anticipated risk of splashes to the face during the care of patients, particularly among those who are vomiting".[6]

As per HPS Standard Infection Control Precautions (SICPs), masks are recommended when cleaning spillages of body fluids such as vomit or faeces to protect against splashing. The NIPCM currently categorises the type of transmission based precaution (TBP) required for norovirus infection as 'contact' precaution, and recommends the use of a fluid resistant surgical facemask (FRSM) if vomiting is present. Due to the abrupt onset of vomiting typical of norovirus, prolonged wearing of masks in high risk areas would be required to mitigate the risk of transmission resulting from a vomiting episode. Prolonged wearing of masks in high risks areas would also protect against the potential risk of aerosolised viral particles.

There is insufficient evidence of airborne transmission of norovirus to recommend the use of respiratory protection. However, fluid resistant surgical facemasks (FRSMs) should be considered during norovirus outbreaks as a Standard Infection Control Precaution (SICP) to protect staff from any risk of splashing when cleaning spillages of body fluids such as vomit or diarrhoea, and as a contact precaution when vomiting is present.

(Good Practice Point (GPP))

What environmental cleaning products are recommended to inactivate norovirus?

The use of 1000 parts per million (ppm) available chlorine for environmental cleaning is currently recommended as best practice to inactivate norovirus. The evidence base, which consists of experimental studies with norovirus surrogates, and outbreak reports, is well documented.

The search identified five studies for inclusion.[38-42] Four experimental laboratory studies tested the efficacy of a number of disinfectants at inactivating norovirus surrogates. Three of these studies used sodium hypochlorite as a control.[38-40] Although some alternative disinfectants were effective, sodium hypochlorite demonstrated superior efficacy. The third study compared the efficacy of an alternative cleaning protocol (microfibre and steam cleaning) against that of a chlorine releasing agent in a hospital setting during a norovirus outbreak.[42] The results were inconclusive due to the small sample size and poor study design.

Environmental cleaning with 1000ppm available chlorine should be used to inactive norovirus.

(Grade D recommendation)

How should carpets and soft furnishings be decontaminated after a norovirus outbreak?

There is very limited research into appropriate and effective methods for decontaminating carpets and soft furnishings after an outbreak of norovirus. To date, the use of detergent and steam cleaning have been advocated and are currently recommended by CDC[6], and Public Health England.[18] It is not possible to determine the impact of steam cleaning from outbreak reports due to it being part of bundled infection control strategies.[43]

Experimental studies have demonstrated the efficacy of steam cleaning against norovirus surrogates however neither soft furnishings nor carpet were used as test material.[44]

Only one study was identified in the search. A comparison of the efficacy of microfibre and steam cleaning against a conventional 2-step cleaning method utilising a chlorine releasing agent (control) in a hospital setting during a norovirus outbreak failed to reveal any conclusive evidence.[42] The study was of poor quality due to the small sample size and multiple confounding factors. Window drapes (curtains) were the only item of soft furnishing that received steam cleaning and a description was not given of the method or number of curtains that were cleaned. In the control ward, window drapes were taken down, presumably for laundering however specific details were not provided.

Further research is needed to strengthen the evidence base for this topic.

Carpets and soft furnishings within the patient care area should be steam cleaned or decontaminated with water and detergent according to manufacturers' instructions after an outbreak of norovirus.

(Grade D recommendation)

What environmental cleaning procedures are required prior to re-opening of a care setting after an outbreak of norovirus?

Terminal decontamination is required to reduce the risk of ongoing environmental transmission of norovirus. In addition to effectively inactivating norovirus, decontamination protocols must be workable in practice and cause minimal disruption.

The HPS Transmission Based Precautions Literature Review: Management of Care Equipment and Environmental Decontamination has considered the evidence pertaining to the most appropriate environmental decontamination procedure.[45] The following

recommendations are made: *"the room should be decontaminated from the highest to the lowest point (e.g. curtain rails to floors) and from the least contaminated to the most contaminated (i.e. from infrequently touched surfaces to surfaces such as shower and toilet areas), changing cleaning equipment/solutions when they become dirty or at 15 minutes intervals or when moving to new task or location. The NHSScotland National Cleaning Services Specification states that items such as bed screens, curtains and bedding should be removed prior to the room being decontaminated. Neutral detergent followed by a disinfectant containing 1000 parts per million (ppm) available chlorine (av cl) (or a combined detergent/disinfectant (1000ppm av cl)) should be used for decontamination of the isolation room/cohort area".*

There are a number of novel 'no-touch' decontamination technologies that have been described in the literature, including hydrogen peroxide vapour (HPV), ozone gas, and ultra-violet light.[46] Only HPV is currently advocated by HPS for use in situations where environmental contamination is contributing to an outbreak, however it is not currently recommended for routine use for terminal cleaning and should not replace current environmental cleaning procedures.[45] A number of NHS boards in England utilise UV light in addition to standard environmental cleaning procedures however the evidence base for its efficacy is limited.[47]

Only one study was identified for inclusion. The efficacy of HPV decontamination following a norovirus outbreak was tested experimentally using two norovirus surrogates dried onto plastic plates and placed in multiple locations in a hospital test room.[48] Viable surrogates could not be detected following HPV treatment in the test room. HPV efficacy can be reduced by an excess of organic substances, therefore manual cleaning to eliminate visible dirt always has to be performed before applying hydrogen peroxide; this would significantly increase the time burden for decontamination teams.

Bed/window curtains and bedding should be removed and laundered as infectious linen and extensive environmental disinfection should be carried out as described in the HPS Transmission Based Precautions Literature Review: Management of Care Equipment and Environmental Decontamination.

(Good Practice Point (GPP))

4.2 Implications for research

This review identified limited evidence for assessing the most appropriate infection control measures for outbreaks of norovirus in care settings, particularly community care settings. Further research is required to strengthen the evidence base for bay/ward/care home closure which is a commonly implemented infection control measure, and to determine the appropriate length of time bays/wards/care homes should remain closed to new admissions. Additionally, there is a need to strengthen the evidence base for staff cohorting, which is an intuitively logical and frequently implemented control measure.

To date the efficacy of disinfection procedures (hand hygiene and environmental cleaning) for human norovirus is evaluated by using surrogate viruses however their suitability and validity as surrogates is questionable. The development of a robust and reproducible cell culture system would allow determination of the infectivity of aerosolised particles, shed particles and environmental fomites and allow assessment of the efficacy of control measures. The development of such a system would facilitate determination of the virucidal efficacy of ABHR against norovirus, particularly their efficacy against that of hand washing with soap and water, and also allow comparison of the efficacy of novel decontamination techniques against current decontamination procedures.

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