Journal of Hospital Infection 91 (2015) 87–92

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevierhealth.com/journals/jhin

Letters to the Editor

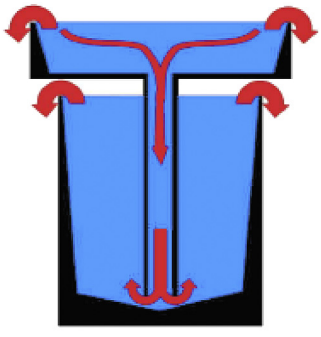
Variability of ATP amount in last rinse water of automated washer-disinfectors demands monitoring of every load

Sir,

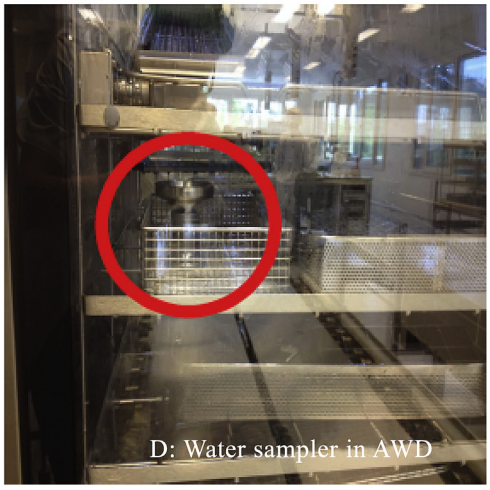
Decontamination processes for medical devices, such as washing, disinfection, and sterilization are essential steps in infection control. The end result of a washing–disinfection process is critical for the next step in decontamination, or for the safe use of a device on a patient in cases where no further decontamination is applied. It would be helpful for daily practice and the development of evidence-based standards if a data set were available to demonstrate the reproducibility of automated washer-disinfectors (AWDs).[1,2] We were unable to identify such a data set in the literature, and therefore decided to perform an inventory study. This encompassed 18 AWDs distributed over eight hospitals in four European countries. The cleanliness of a reprocessed instrument cannot be judged

A: Beaker and funnel

B: Water sampler complete



C: Water sampler schematic



D: Water sampler in AWD

Figure 1. Water sampler (WS). (A) Components of the WS: a funnel and a beaker. The funnel is so wide that water can only access the beaker via the funnel. (B) WS as used in an automated washer-disinfector (AWD). The stainless steel WS is constructed such that it does not tip over during an AWD process, e.g. by the force of a water spray. (C) The principle of the WS: the red arrows indicate the water flow direction. During a process, water will be collected by the funnel and flow into the beaker. The funnel outlet extends almost to the bottom of the beaker. The bottom of the rinse water collector is constructed such that the water present in the beaker is pushed upwards and out of the beaker. Hence, at the end of a process the WS essentially contains the last rinsing water. (D) The position of the WS in all AWD tests in this study.

solely by visual inspection. Therefore the last rinse water from an AWD process was collected with a water sampler (WS; Valimed AB, Umeå, Sweden) (Figure 1). The last rinse water indicates whether processed instruments have been rinsed with contaminated water; using contaminated rinse water will result in insufficiently decontaminated instruments.

Our study protocol specified that before an AWD cycle was run an empty WS was to be placed in the load of the AWD on the mid-shelf (one-half of the height) at one-quarter of the depth and one-third of the width calculated from the left wall of the unloading door (Figure 1). After a full cycle the WS funnel was removed from its beaker and a Clean-Trace™ (3M, St Paul, MN, USA) water test sample stick was dipped in the water sample. This stick was positioned back in its sleeve, activated, and shaken for 10 s. Next, the activated test stick was placed inside its associated Clean-Trace NGi luminometer and the displayed relative light unit (RLU) value was registered.[3,4] Before each process the WS was emptied. The protocol also required a negative control and an empty process run with the AWD. The negative control was performed by activation of the test stick without sampling. An empty process run was a run with only a WS as load in the AWD. All results were recorded in a data sheet together with additional data on the AWD, including location, load, loading pattern, loading amount, human visual inspection, and detergent. All equipment was used according to the manufacturers' instructions and all investigators were appropriately trained.

To investigate the rinse water from the WS, the ATP method was chosen because its results are quantitative and objective. This is in contrast with the tests based on subjective interpretation, e.g. colour changes and amount of removed test soil.[2] Other available quantitative tests often require read-out methods that are neither practicable nor easy to implement in the reprocessing of medical devices in a central sterile supply department, e.g. the total organic carbon method.

Each load of each of the 18 AWDs was monitored for at least one working week. This yielded a total of 1006 data points, consisting of 64 negative controls, 62 empty loads, and 880 regular process runs. The individual results of the AWDs and the cumulative results are presented in Figure 2. The median (interquartile range) of the negative controls was 4 (3, 6) RLU and for the empty cycles 5 (4, 7) RLU, i.e. similar results. Regular cycles showed a much broader distribution of RLU values with a median (interquartile range) of 24 (12, 49) and large variations, from 1 to 6578. Using the Mann–Whitney *U*-test for non-normal distributions the ATP values from empty and regular loads showed a statistically significant difference ($P = 0.0001$). These results demonstrate that the high RLU values in the regular processes must originate from the load and reveal the added value of the WS-ATP method for cleanliness detection of an AWD-processed load.

In the literature, different thresholds for the RLU value have been suggested to classify the process as a pass. If a threshold of 200 RLU had been used, 4% of the processes would have exceeded this level and therefore have been classified as a fail.[3,5] With a threshold value of 300 RLU the failure rate would have been 3%, and with 400 RLU 2%. Eleven of the 880 (1%) regular processes showed even higher ATP values of >500 RLU in the final rinse water.

Further correlations with additional recorded information were not established, because the amount of data was insufficient.

Visual inspections of instruments after AWD processing that are applied in many hospitals cannot assess cleanliness of all instrument surfaces. Obviously, the broad variation in RLU results demands every load monitoring of AWD processes to

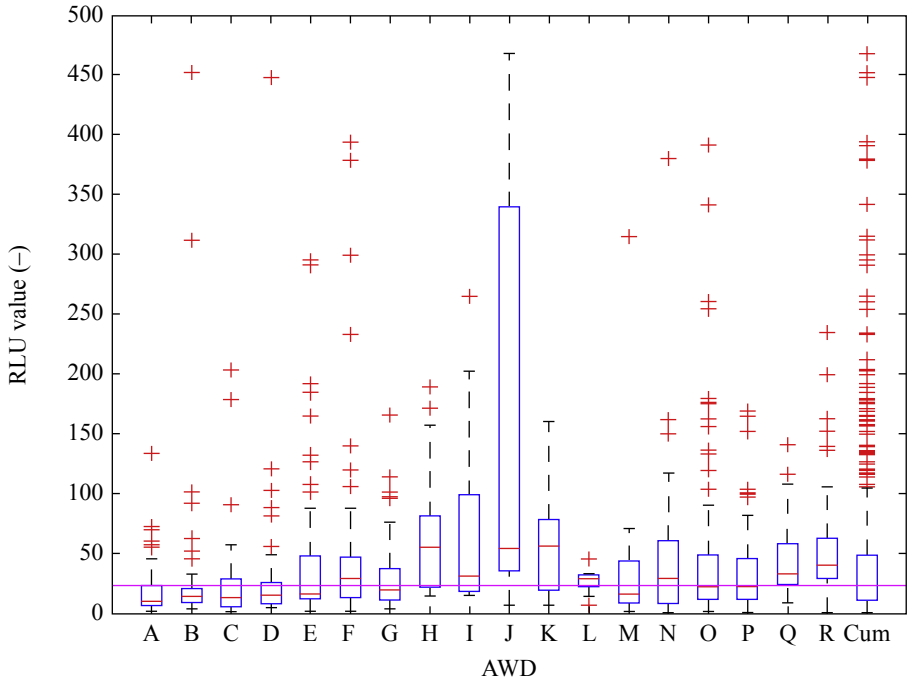


Figure 2. Results of all 18 automated washer-disinfectors (AWDs) (A–R) and the cumulative (Cum) results of all 18 AWDs presented in a box plot. The *y*-axis represents relative light unit (RLU) values from 0 to 500. The mean of the cumulative results was 24 RLU and is denoted by the magenta horizontal line. Eleven of the 880 processes had an RLU value >500 and were distributed over eight AWDs (E, D, H, I, J, L, O, and Q).

ensure the end result of a AWD process. Based on our results we suggest that the WS–ATP method is potentially valuable in the daily monitoring of AWDs.

Acknowledgements

The authors wish to thank the staff of the central sterile supply departments of the Centralsjukhuset Karlstad (Karlstad, Sweden), the Catharina Hospital (Eindhoven, The Netherlands), Norrlands Universitetssjukhus (Umeå, Sweden), Lievenberg Ziekenhuis (Bergen op Zoom, The Netherlands), Radboud University Nijmegen Medical Centre (Nijmegen, The Netherlands), Regionaal Ziekenhuis Heilig Hart Leuven (Leuven, Belgium), Regionaal Ziekenhuis Heilig Hart Tienen (Tienen, Belgium), and Ospedale S. Maria del Carmine (Trento, Italy) for their co-operation, constructive input, and data acquisition.

Conflict of interest statement
None declared.

Funding sources
None.

References

1. International Organization for Standardization. ISO 15883. Washer-disinfectors. Part 2: Requirements and tests for washer-disinfectors employing thermal disinfection for surgical instruments, anesthetic equipment, bowls, dishes, receivers, utensils, glassware, etc., 2006.
2. International Organization for Standardization. ISO 15883. Washer-disinfectors. Part 5: Test soils and methods for demonstrating cleaning efficacy, 2005.
3. Alfa MJ. Monitoring and improving the effectiveness of cleaning medical and surgical devices. *Am J Infect Control* 2013;**41**(Suppl. 5):S56–S59.
4. Fushimi RMT, Takashina M, Yoshikawa H, *et al*. Comparison of adenosine triphosphate, microbiological load, and residual protein as indicators for assessing the cleanliness of flexible gastrointestinal endoscopes. *Am J Infect Control* 2013;**41**:161–164.
5. Alfa MJ, Fatima I, Olson N. Validation of adenosine triphosphate to audit manual cleaning of flexible endoscope channels. *Am J Infect Control* 2013;**41**:245–248.

J.P.C.M. van Doornmalen Gomez Hoyos[a,b,*]
R.A.C. van Wezel[c]
F. Tessarolo[d,e]

[a]*Eindhoven University of Technology, Department of Applied Physics, Eindhoven, The Netherlands*

[b]*3M Deutschland GmbH, Infection Prevention Division, Neuss, Germany*

[c]*Catharina Hospital, Department of Clinical Pharmacy, Eindhoven, The Netherlands*

[d]*Healthcare Research and Innovation Program (IRCS-FBK-PAT), Bruno Kessler Foundation, Trento, Italy*

[e]*University of Trento, Department of Industrial Engineering, Mattarello Trento, Italy*

* Corresponding author. Address: Eindhoven University of Technology, Department of Applied Physics, P.O. Box 513, 5600 MB, Eindhoven, The Netherlands. Tel.: +49 170 568 00 85.
E-mail address: j.p.c.m.v.doornmalen@tue.nl
(J.P.C.M. van Doornmalen Gomez Hoyos).

Available online 16 June 2015

http://dx.doi.org/10.1016/j.jhin.2015.05.008

How to isolate a patient with *Cladophialophora bantiana* infection? An opinion

Sir,

In 2009, Li and de Hoog presented a review on cerebral phaeohyphomycosis.[1] Based on our recent experience of caring for a patient with *Cladophialophora bantiana* infection involving both the central nervous system and bone, we would like to propose infection control precautions for patients infected with this biosafety level 3 pathogen.

C. bantiana is best known as an agent causing cerebral phaeohyphomycosis in immunocompetent humans.[1] The fungus rarely causes pulmonary, cutaneous or soft tissue infections.[2] Mortality rates of cerebral phaeohyphomycosis approach 100% without treatment, and are approximately 50% even with surgery and antifungal therapy.[1] The route of invasion of the fungus into the brain is not certain, but possible routes include via the lymphatic system or haematogenously, direct spread from adjacent lesions, or by accidental direct inoculation. Pulmonary entry has also been hypothesized and confirmed in animals.[1] The fungus is distributed worldwide, although infections are more common in warmer climates with high average humidity.[3,4] Occupations with regular exposure to dust, such as farming, are at increased risk.[4] To our knowledge, no nosocomially transmitted infections have been reported among patients or healthcare workers in clinical departments or laboratories. We found no guidelines describing the most appropriate infection control measures to be taken when caring for patients with *C. bantiana* infection. The current uncertainties about the modes of transmission of *C. bantiana* is probably one reason for the lack of guidance.

Most infections are confined to the central nervous system; in these cases, we suggest that contact isolation seems sufficient as an infection control measure. In cases of pulmonary infection with the tissue-invasive mycelial form, we suggest that contact isolation should suffice because the fungus is not believed to sporulate at body temperature in the lower airways.[5] However, for any case of phaeohyphomycosis (cutaneous, soft tissue, pulmonary or central nervous system infection) associated with an open wound, both contact and airborne precautions should be applied until definite closure of the wound. This level of precautions conforms with the US Centers for Disease Control and Prevention guideline for isolation precautions to be taken in cases of aspergillus soft tissue infections with copious drainage.[6] Pegues *et al*. previously reported a cluster of person-to-person airborne transmission of *Aspergillus* spp. in a transplant unit.[5]