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Cleanliness audit of clinical surfaces and equipment: who cleans what?☆

R.E. Anderson [a], V. Young [a], M. Stewart [b], C. Robertson [c], S.J. Dancer [b,*]

[a] Department of Surgery, Hairmyres Hospital, East Kilbride, Lanarkshire, UK
[b] Department of Microbiology, Hairmyres Hospital, East Kilbride, Lanarkshire, UK
[c] Department of Statistics & Modelling Science, University of Strathclyde, Glasgow, UK

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SUMMARY

Current guidelines recommend regular cleaning of clinical equipment. We monitored items on a surgical ward for predominant user, hand-touch frequency, cleaning responsibilities and measurement of organic soil. Equipment was assessed in triplicate against a cleanliness benchmark of 100 relative light units (RLU) using the Hygiena® ATP system. There were 44 items, of which 21 were cleaned by clinical support workers (CSWs), five by domestic staff; three by nurses, three by doctors, and 12 with no designated cleaning responsibility. Geometric mean RLUs ranged from 60 to 550/100 cm^2 for small items such as hand-gel containers, bed control, blood pressure cuff and clinical notes; with similar values of 80–540/100 cm^2 RLU for larger items such as electrocardiogram machine, defibrillator, trolleys and tables. Overall geometric mean was 249/100 cm^2 RLU for all surfaces, with 84% (37 of 44) items exceeding the 100 RLU benchmark. Of 27 items cleaned by clinical staff, 24 (89%) failed the benchmark. Of 12 sites with no cleaning specification, 11 (92%) failed the benchmark. Three of seven 'clean' sites (<100/100 cm^2 RLU) were cleaned by domestic staff. Average $\log_{10}$ RLU of surfaces cleaned by domestics were 64% lower compared with surfaces cleaned by CSWs (95% confidence interval: 35%, 80%; $P = 0.019$). In conclusion, clinical equipment frequently demonstrates high levels of organic soil, whether or not items have assigned cleaning responsibility. These findings suggest that cleaning practices for clinical equipment may require review, along with education of staff with specific cleaning responsibilities.

Introduction

Hospital cleaning is generating increased interest as an effective component in the control of hospital-acquired infection.[1,2] It is thought that contaminated hand-touch sites on surfaces or equipment in patient care areas present an infection risk to patients.[1–4] UK healthcare facilities have domestic specifications for environmental cleaning endorsed by local, national and National Health Service (NHS) policies.[5,6] These specifications encompass general surfaces, equipment and furniture in UK hospitals, but do not necessarily include all items of clinical equipment routinely used on wards. Cleaning of these items is usually a nursing responsibility, although some pieces of equipment may be cleaned by doctors or specialist cleaning teams.[7] Following concerns that equipment was not being cleaned properly, it was decided to audit appliances on a general surgical ward for frequency of use, predominant user and levels of organic soil using ATP bioluminescence while investigating designated cleaning responsibilities.[7–9]

Methods

We sampled the clinical equipment in a 24-bedded general mixed surgical ward in a district general hospital. A list of clinical equipment used daily on the wards was compiled. Data included the predominant user [e.g. staff nurse; clinical support worker (CSW); doctor; occupational therapist; physiotherapist], hand-touch frequency and the person designated responsible for cleaning it. To quantify predominant user and hand-touch frequency, we observed members of staff on the ward using the various items of clinical equipment. Each site was graded from 0 (no contact in >3 h); + (one contact/3 h); ++ (one contact/h); to +++ (multiple contacts/h).

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* Corresponding author. Address: Department of Microbiology, Hairmyres Hospital, East Kilbride G75 8RG, UK. Tel.: +44 1355 585000; fax: +44 1355 584350.
E-mail address: stephanie.dancer@lanarkshire.scot.nhs.uk (S.J. Dancer).

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ATP monitoring

There are several methods for assessing environmental cleanliness, one of which is the adenosine triphosphate (ATP) bioluminescence assay.[9] ATP detection on surfaces has been used for years by the food industry to provide an estimate of organic soil, which includes food residues as well as human and microbial cells. ATP measurement has already been investigated as a scientific tool to assess hospital cleanliness using benchmark values in relative light units (RLU).[8,10–12]

The system chosen for this audit was the SystemSure Plus system (Hygiena® Int. Ltd, Watford, UK).

The Hygiena luminometer self-calibrates at start-up, with additional calibration carried out using positive and negative calibration rods. The positive rod ensures that the luminometer is measuring a known light output value, whereas the negative rod detects whether background light is entering the instrument. At different temperatures the luminometer can yield slightly varied ATP readings. To minimise error, the device was stored in the same location throughout the sampling period and all readings were generated on the chosen sampling ward.

Swabs required for this system were received in sealed batches of 25 and stored at the recommended temperature of 2–8 °C. Before sampling, two swabs from each sealed batch of 25 were tested by the positive control kit. Each kit contained sealed glass vials containing lyophilised ATP and sugars to produce a predictable positive result of >100 RLU. Any batches not producing the recommended result were discarded.

Sampling process

Hand-touch sites on each individual piece of equipment were sampled in triplicate. Where possible, three separate identical items were screened on the same day, e.g. three different drip stands on the ward. For items that did not exist in multiples on the ward, e.g. ECG machine, the same item was tested on three separate consecutive days. Samples were taken from 10 cm × 10 cm areas, unless this was impossible owing to the scale of the item (e.g. visitors' bell). These items were then sampled over the entire surface. The cap of the swab containing the luciferase/luciferin reagent was snapped twice, allowing the reagent to enter the reaction tube for brief agitation. Light is emitted in direct proportion to the amount of ATP present and measured in RLU. The higher the reading, the greater the level of ATP present, representing a tangible measurement of organic soil.[9]

Choice of level indicating acceptable cleanliness

Previous studies have compared ATP levels against aerobic colony counts from a variety of clinical sites in order to define benchmark levels.[10–12] These levels depend upon the ATP system used. For the purposes of this study, we used a benchmark of 100 RLU to indicate acceptable cleanliness as defined by Mulvey *et al.*, who sampled a variety of hand-touch sites in the clinical environment using identical equipment.[13] Using the same system, this study suggested a loose relationship between ATP values and microbial growth categories. If non-selective microbiological screening recovered >2.5 cfu/cm^2 from a surface, then there was a 60% chance that the immediate adjacent surface would deliver an ATP value >100 RLU.[13] Since it is possible that there is a link between hygiene failures using microbiological benchmarks and increased risk of hospital infection, we chose this ATP benchmark and assumed 'hygiene failure' if the surface tested exceeded 100 RLU.[13,14]

Since this was an environmental audit, ethical permission was not sought; the project was discussed and agreed with ward-based consultants, domestic supervisor, infection control staff and senior nurses on the study ward.

Statistical methods

In the statistical analysis a log transformation of the RLU values was taken, as the original distribution of RLU is very skew with a long tail to the high values. As a consequence the geometric mean is used as a summary measure of RLU per surface. For a log normal distribution the geometric mean corresponds to the median. Analysis of variance models on $\log_{10}$ geometric mean RLU were used to estimate the effects of cleaning responsibility, hand-touch frequency and material against RLU levels. Although this is a repeated measures design, there were no recorded variables which differed within surface and it was appropriate to summarise the RLU value from each surface using the geometric mean.

Results

Forty-four items or surfaces on clinical equipment were identified within surgical patient care areas, with 21 cleaned by CSWs; five by domestic staff; three by staff nurses; three by doctors; and 12 with no designated cleaning responsibility at all (Table I). The predominant users of most of the appliances were nurses and CSWs, followed by the doctors. Physiotherapists and occupational therapists tended to handle items linked with their duties as well as more general items in order to allow access to patients. All staff touched ID badges, alcohol gel containers, taps and pens. As expected, these items were among the most frequently handled, along with surfaces close to the patients' beds, BP cuff, stethoscope, notes, computers, phones, tourniquets, thermometer, tables, drug trolley and saturation probe.

Geometric mean RLU values ranged from 58 for hand-gel containers, 63 for computers, 72 for commodes and pens; to 447 for fans, 514 for patient console, 541 for sitting scales and 553 for the saturation probe. Smaller discrete pieces of equipment, which were sampled in their entirety, demonstrated a wide range of ATP values (58–553/100 cm^2), with a similar range seen from 100 cm^2 areas on larger pieces of equipment (77–541/100 cm^2). The overall geometric mean was 249 RLU (range: 58–553 RLU) for all 44 surfaces tested.

How many sites failed the ATP benchmark?

For all sites tested, ATP levels occasionally varied considerably. Our results showed that most of the clinical equipment sampled produced geometric mean ATP levels of >100 RLU. As defined previously, organic soil with ATP levels >100 RLU using the Hygiena system does not meet the recommended criteria for cleanliness.[13] Overall, 84% of items (37 of 44 sites sampled) surpassed 100 RLU and were designated hygiene failures. Of 27 items supposedly cleaned by clinical staff, 24 (89%) failed the benchmark. Of 12 sites with no cleaning specification, 11 (92%) failed the benchmark. Three of five surfaces assigned to domestic services passed the standard, since they gave geometric mean RLU scores of <100; these, along with the other four sites returning a score of <100 RLU, were composed of synthetic materials (bed control; commode; ECG machine; hand gel container; computer; light switches; and pens). Average $\log_{10}$ RLU of surfaces cleaned by domestic staff were 64% lower compared with surfaces cleaned by CSWs (95% confidence interval: 35–80%; $P = 0.019$). There was no evidence of any association between average $\log_{10}$ RLU score and material type ($P = 0.91$).

Is there a relationship between frequently handled items and ATP score?

Each item or surface was scored according to hand-touch frequency as detailed in Methods (Table I). Geometric mean RLU values for each item were assigned to each category of hand-touch

Table I
Table to show clinical equipment, cleaning responsibilities, staff handling frequencies and levels of organic soil on a surgical ward

Ward item or surface	Material	Who cleans this?	Nurses and CSW[a]	Medic[a]	Physiotherapist[a]	Occupational therapist[a]	Hand-touch frequency[a]	ATP 1[b]	ATP 2[b]	ATP 3[b]	ATP geometric mean[b]
Bed control	Synthetic	DS	+++	++	+	+	+++	32	106	160	82[c]
Bed rails	Metal	DS	+++	++	+	+	+++	97	26	621	116
Blood glucose monitoring kit	Synthetic	CSW	+++	+	0	0	++	162	1294	435	450
Blood pressure cuff	Fabric	CSW	+++	+	0	0	+++	165	90	151	131
Clinical notes	Synthetic	None	+	+++	+	+	+++	153	146	95	129
Clipboard	Synthetic	Medic	0	+++	0	0	+++	327	247	188	248
Commode	Synthetic	CSW	+++	0	0	0	++	80	143	33	72[c]
Defibrillator trolley	Synthetic	CSW	++	+++	0	0	+	196	144	176	171
Doctor's phone	Synthetic	Medic	0	+++	0	0	+++	382	411	525	435
Drip stand	Metal	CSW	+++	+	0	0	++	350	264	339	315
Drug fridge	Metal	SN	+++	+	0	0	++	161	225	132	168
Drug trolley	Metal/synthetic	SN	+++	+	0	0	+++	598	218	499	402
ECG machine	Metal/synthetic	SN	++	++	0	0	++	124	98	37	77[c]
Fans	Synthetic	CSW	++	0	0	0	+	371	446	541	447
Hand gel container	Synthetic	DS	+++	+++	++	++	+++	85	49	47	58[c]
Hoist	Fabric/synthetic	CSW	+	0	+++	+++	++	106	440	270	233
Hole-punch	Metal/synthetic	None	++	++	+	+	++	119	155	267	170
Identification badges	Synthetic	None	+++	+++	+++	+++	++	262	243	618	340
Keyboards and mice	Synthetic	CSW	+++	+++	+	+	+++	83	59	50	63[c]
Light switches	Synthetic	DS	+++	+	+	+	+	63	130	52	75[c]
Lockers	Metal	CSW	+++	0	0	0	+	397	144	66	156
Notes trolley	Metal	None	+++	+++	+	+	++	152	484	137	216
Nursing notes	Synthetic	CSW	+++	++	+	+	+++	147	159	120	141
Observation screen stand	Synthetic	CSW	+++	+	0	0	+	139	238	181	182
Observation screen	Metal/synthetic	CSW	+++	++	0	0	++	124	73	266	134
O_2 wall mount	Metal/synthetic	CSW	+++	+	0	0	++	327	146	102	169
Patient console	Synthetic	CSW	++	+	+	+	++	408	650	513	514
Pens	Synthetic	None	+++	+++	+++	+++	+++	113	33	101	72[c]
Physiotherapy aid	Synthetic	None	0	0	+++	+	++	174	116	119	134
Pod button	Synthetic	None	++	0	0	0	++	277	321	287	294
Pod keypad	Synthetic	None	++	0	0	0	++	398	153	153	210
Pod lid	Metal	None	++	0	0	0	++	272	113	172	174
Saturation probe	Synthetic	CSW	+++	++	++	0	+++	857	372	530	553
Sitting scales	Metal/synthetic	CSW	+++	0	0	0	++	599	680	389	541
Standing scales	Metal/synthetic	CSW	+++	0	0	0	++	563	572	292	455
Stapler	Metal	None	++	+	+	+	+	329	452	213	316
Stethoscope	Synthetic	Medic	0	+++	++	0	+++	317	100	348	223
Syringe driver	Synthetic	CSW	+++	+	0	0	+	514	113	421	290
Table	Metal/synthetic	CSW	+++	++	++	++	+++	1115	175	351	409
Tap	Metal	DS	+++	+++	+++	+++	+++	573	107	39	134
Thermometer	Synthetic	CSW	+++	+	0	0	+++	269	395	410	352
Tourniquet	Fabric	None	+	+++	0	0	+++	309	534	273	356
Visiting time bell	Metal	None	++	0	0	0	+	652	302	301	390
Ward phone	Synthetic	CSW	+++	+++	+	+	+++	323	444	320	358

CSW, clinical support worker; DS, domestic staff; ECG, electrocardiogram.
[a] Predominant user and hand-touch frequency: 0 (no contact >3 h); + (one contact/3 h); ++ (one contact/h); +++ (multiple contacts/h).
[b] ATP results in relative light units (RLU).
[c] Signifies hygiene pass (<100 RLU).

frequency and compared against the others, including overall mean RLU, range of RLU values and number of sites exceeding the 100 RLU benchmark. There was no significant difference between the average $\log_{10}$ RLU score and hand-touch frequency ($P = 0.71$).

Discussion

This audit has demonstrated high levels of organic soil on frequently used items of clinical equipment in a surgical ward. Using a previously defined benchmark of 100 RLU, we found that 84% of items sampled failed the standard. This is similar to a review reporting a pooled mean of 86.8% contamination of healthcare equipment, although the studies included used microbiological rather than ATP sampling methods.[15]

There was no relationship between mean RLU values and how often items were handled; similarly, there was no association between which group of staff used specific items and mean RLU values; or between handling scores and which categories of staff were responsible for cleaning specific items, other than the few sites cleaned by domestic staff. The number of sites cleaned by domestics was small but our snapshot audit suggests that items featured within the domestic specification are more likely to pass the cleanliness benchmark than items assigned to clinical staff.[14] There are several reasons for the poor cleaning of clinical equipment but one of the most obvious would be work pressures.[14] On a busy ward, patients' needs are the main priority, and if a piece of equipment or surface is not visibly dirty, it may not receive any cleaning attention.

This type of audit suffers from lack of control data, in that despite attempts to validate the findings using standardised measurement and handling frequency, we cannot assume that levels of soil are solely due to the person cleaning the item; 'dirty' equipment might be due to heavy use or cleaning method; construction material or intricate (difficult to clean) design; or perhaps contamination from the air or from storage practices. Neither the material composition of the item nor the frequency of usage made any difference. Touch frequency might confound any cleaning attempts – depending upon how often the item is cleaned and when it is cleaned in relation to use. Devising a study to examine this would be almost impossible on a busy ward. Even a before-and-after study would have been difficult, because when staff did clean items, varying methods were used at different times. A before-and-after study would also have been subject to Hawthorne bias. We did not broadcast the audit, and although senior staff knew, they were not told when it was going to take place. Thus we chose to organise an audit snapshot of the daily situation on a busy working ward.

There were one or two surprises – for instance, commodes and computer keyboards, often reported as contaminated, passed the ATP benchmark (72 and 63 RLU, respectively). On further investigation, we were told that the infection control nurses regularly conducted a cleanliness audit of commodes, and that the computers had 'self-cleaning' keyboards. By contrast, ID badges carried a high level of soil, as did the patient console (340 and 514 RLU, respectively). High ATP values from blood glucose monitoring kit and saturation probe may indicate blood spillage, which was visually apparent on several occasions. Both sets of scales for weighing patients were visibly soiled. Even the ward bell was not exempt from contamination (nearly 400 RLU). Although this item is handled only to warn visitors that visiting time is over, it had never been cleaned according to ward staff.

Now that many nurses and CSWs are doing the tasks once performed by doctors, there is a possibility that certain cleaning duties have got lost among the shifting of professional responsibilities.[7,8] Perhaps nurses feel that basic cleaning is not an appropriate use of their time.[16] Domestic staff work to original specifications that may lack detail on all the items found on a ward and they are not usually responsible for cleaning clinical equipment, including electrical items.[5,6] Thus, frequently used equipment on a ward is at risk of accumulating organic soil, including potential microbial pathogens. Given that only a few colony-forming units of *Staphylococcus aureus* or spores of *Clostridium difficile* can initiate infection, such contamination illustrates a continuing risk to patients.[17,18]

In conclusion, this audit suggests that many items of clinical equipment in patient care areas are not receiving appropriate cleaning attention. Since this represents an infection risk to patients, we recommend a review of cleaning responsibilities for all staff, along with a relevant and regular educational programme.[8] There may be benefit in transferring cleaning responsibilities of certain items to domestic service personnel.

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Conflict of interest statement

None declared.

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