Assessment of Laboratory Bench Cleaning Protocols with Surface Cultures

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Abstract

Background
Laboratory-acquired infections are a serious concern for the clinical microbiology laboratory worker. Laboratory workers have been reported to acquire shigellosis and salmonellosis from working in high-burden laboratories. Even the most minor breaches of protocol can result in infection as a very small infectious dose may be required. The likelihood of recovery of such organisms is highest for technologists culturing stool specimens. If routine biosafety principles are followed, contamination of bench surfaces should not occur with such organisms.

Objective
We evaluated routine bench cleaning practices in at a busy clinical microbiology laboratory to determine the risk to laboratory workers

Methods
The study was carried out at the clinical microbiology laboratory of the Aga Khan University in Karachi. The laboratory processes over 100 stool specimens per day, and has standardized protocols pertaining to biosafety and bench cleaning procedures. In an effort to establish effectiveness of cleaning procedures in the laboratory we observed bench contamination by monitoring the total microbial counts (Heterotrophic plate counts – HPCs) and culturing for *Shigella* and *Salmonella* species.

Results
30 samples were collected over 1 week. HPCs were higher at the end of the work day, demonstrating the waning of bleach cleaning effectiveness. Contamination with *Salmonella* or *Shigella* spp was not observed.

Conclusion
Adequate bench disinfection protocols were implemented in the study laboratory. Frequent audits of these cleaning practices instill confidence in laboratory workers that their work environment is safe.

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Owing to exhaustive test menus and prolonged work hours, modern clinical microbiology laboratories are overcrowded posing severe threat of laboratory acquired infections (LAIs) to workers. Data on laboratory-acquired infections are hard to acquire because infections don't have readily evident symptoms and incubation period and course of infection are not very well defined. The data for laboratory acquired infections have been largely voluntary as most of the laboratories may not share the report of incidents because of the fear of punishment and accountability.[1,2] One of the most common routes of exposure associated with laboratory work is ingestion of microorganisms occurs through bad laboratory practices transmission of organisms to the mouth from contaminated items and accidental splashes that fall into the mouth. Specimen processing during routine laboratory procedures often contaminates containers, bench tops, equipment, and causes generation of aerosols.[1]

Further details are mentioned in table 1. A study conducted by Pike *et al* identified 4,079 laboratory acquired infections from 1932 to 1978 out of which 17% were from clinical laboratories.[2] Similarly a survey by Bayer from 1979 to 2005 showed 1,141 laboratory acquired infections, 46% were acquired in diagnostic laboratory.

Laboratory-acquired infections occur due to a wide variety of organisms including bacteria, viruses, fungi, and parasites. The most common causes of LAI's causing agents include *Shigella* species, *Salmonella* species, *Brucella* species, *Neisseria meningitides and Mycobacterium tuberculosis*.[3] Different studies conducted over the period of time concluded following results in terms of most common infections among the laboratory workers table 2.[1,2,4,6]

Based on the rates of LAIs, *Shigella dysentriae* Type 1 and *Salmonella Typhi* are classified as pathogens belonging to Hazard Group 3 by the Advisory Committee on Dangerous Pathogens (ACDP) and must be processed in a Biosafety Level 3 (BSL 3) facility.[7] However, in high-burden laboratories, these organisms are dealt with under BSL-2 conditions on a regular basis, increasing the risk of acquisitions in laboratory workers. At the Aga Khan University clinical microbiology laboratory, work is performed in a BSL-2 facility but with stringent bench cleaning protocols and biosafety training of all laboratory

Table 1: Routes of exposure associated with laboratory acquired infections.

Route	Laboratory Practices
Ingestion and Contamination of skin and mucous membranes.	Pipetting from mouth Accidental splashes of hazardous material into mucous membrane (eyes, mouth and eyes) intact or non intact skin. Contaminated surface, equipment and articles Consumption of edible items in workplace
Inoculation	Injuries from sharp objects and needle stick Insect and animal bites and scratches
Inhalation	Numerous procedures that produce aerosols

[a] Adapted from reference 1

Table 2: Most common laboratory acquired infections

	Title	Findings	References
1	*Laboratory-associated infections: incidence, fatalities, causes, and prevention*	Over 64% of the laboratory acquired infections were caused by theSalmonella typhi, Franciscella tularensis ,Brucella species and Myobacterium Tuberculosis.	Pike *et al* 1979.[2]
2	*Incidence of tuberculosis, hepatitis, brucellosis, and shigellosis in British medical laboratory workers*	The most common infections among the laboratory workers were shigellosis, tuberculosis and hepatitis.	Harding *et al* 1976.[4]
3	*Infections acquired in clinical laboratories in Utah*	The most frequently occurring infections in Utah laboratories were hepatitis B, shigellosis, pharayngitis and tuberculosis. The incidence of infections was three times higher in smaller laboratories.	Jacobson *et al* [5]
4	*Epidemiology of laboratory associated infections*	The most reported cases were of Salmonella typhi, Brucella melitensis and chlamydia species.	Harding *et al* 1995. [6]

workers.

The main objective of our study was to assess stool bench cleaning procedures by observing for bench contamination with *Salmonella* and *Shigella* species, as these organisms are highly infectious and common causes of LAIs.

Methods

a. Site and biosafety procedures

The study was conducted at the clinical microbiology laboratory of Aga Khan University. The laboratory processes over 100 stool samples for microscopy and culture daily. The laboratory also has which has approved biosafety and bench cleaning

procedures as described in the BMBL 5th edition.[8] Briefly, benches are decontaminated and disinfected by 1% sodium hypochlorite (freshly prepared) before start of work, during the work if there is a small spill of any potentially infectious materials, after completing procedures, and at the end of the work shifts.

b. Study protocol

The stool processing and culture bench was divided into three equal parts A, B and C (figure 1) based on the workload. Three samples of swabs were taken from each portion of the stool bench for five consecutive days at the beginning and end of the day. These swabs were inoculated on nutrient agar, Xylose

Fig.1 Stool culture bench at Aga Khan University Microbiology Laboratory, Karachi, which was divided into A, B and C for sampling.

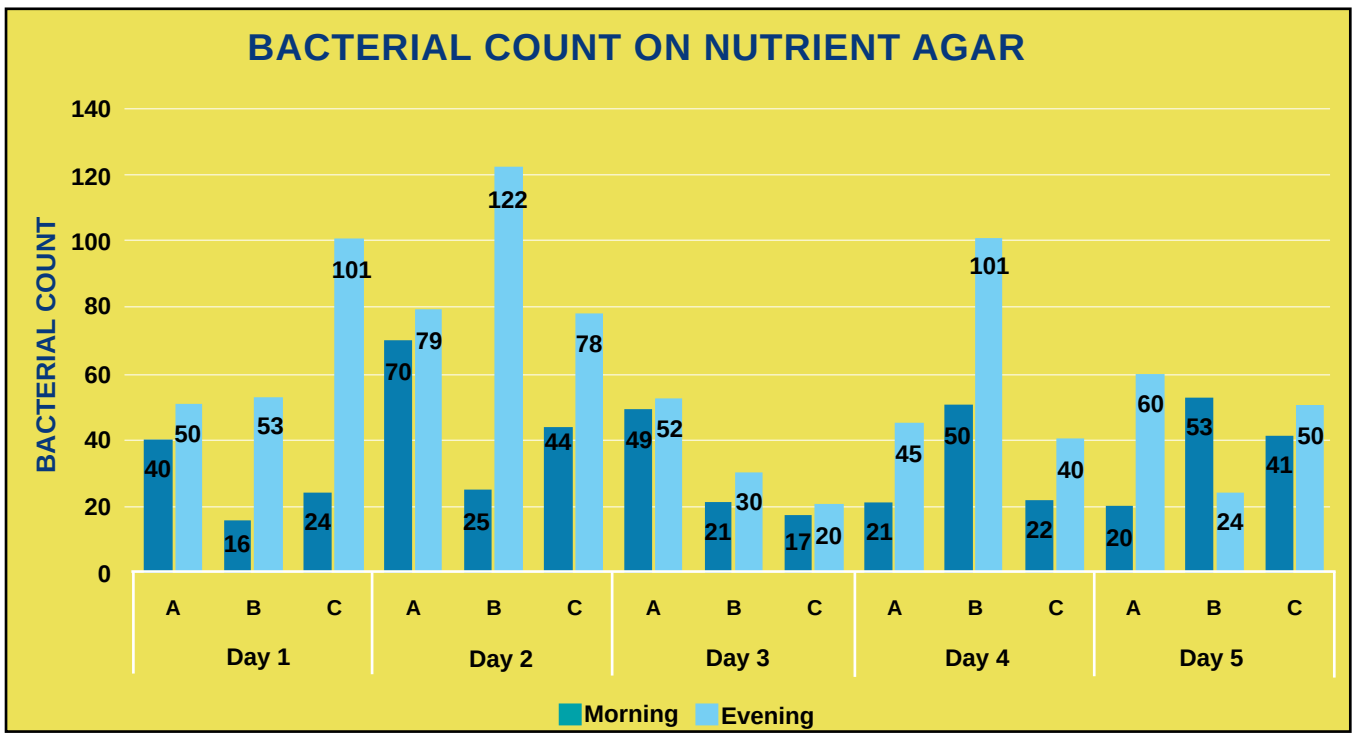

Fig 2. HPCs were higher at the completion of the work day, indicating the waning of bleach cleaning effectiveness However, no Salmonella or Shigella species were isolated.

Lysine Deoxycholate (XLD) agar and Salmonella Shigella (SS) agar. Growth was determined at 48 and 72 hours to determine Heterotrophic Plate Counts (HPCs) on the nutrient agar plate, and for any growth of non fermenters on XLD and SS agars. Any growth of non-fermenting gram negative organisms was identified further by biochemical and serological tests. Media quality control was performed as recommended by the American Society for Microbiology.[9]

Results

30 swabs were collected over 1 week at the start and end of each day from each part of the bench. Heterotrophic Plate Counts (HPCs), were high at the end of each day irrespective of the area of the bench sampled. Bacterial counts are plotted in figure 2 demonstrating the increase in counts at the end of the day. On average, counts were higher for part B of the bench. HPC for part B on day 5 at the end of the work day are lower. This represents an anomalous result and may have been obtained due to some small spill cleaning during the work process. *Salmonella* and *Shigella* spp were not isolated from any of the swabs.

Discussion

Our results show that bench cleaning protocols are being implemented and are effective for the laboratory bench studied. Results were communicated to laboratory manager and staff and were observed to increase efficiency in cleaning protocols. Therefore, results were likely to have increased confidence among staff in bench cleaning protocols employed.

The results projected the increase of HPCs at the end of the day indicating the weakening of the cleaning effect. However, results show that bench cleaning was being implemented regularly as low counts at the beginning of each work day demonstrate efficiency of disinfection at the end of each day.

A survey was conducted in approximately 22,000 medical laboratory in Great Britain showed enteric infections (salmonellosis and shigellosis) were the major cause of LAI's in microbiology laboratories.[4] Another survey conducted by Miller and Baron on the risk of a laboratory-acquired infection in microbiologists versus the general population of the same relative age and found that incidence of salmonellosis is 1.5 per 100000 microbiologists and incidence of shigellosis is 6.6 per 100000.[10] We cultured bench surfaces for these organisms on a bench which commonly cultures these pathogens and performs susceptibility testing. During the study period, 04 Salmonella and 01 Shigella spp isolates were cultured on the bench from samples. Since the study period was short, pathogen positivity remained low, and the incidence of LAIs due to *Salmonella* and *Shigella* is low globally, inferences regarding rate of acquisition of these LAIs in the study laboratory cannot be made. However, the absence of these pathogenic organisms from bench surface cultures is reassuring.

In conclusion, current disinfection protocols did not place workers at higher risk for acquisition of Shigellosis or Salmonellosis. Based on our observation that these results increased workers' appreciation of bench cleaning protocols, we recommend that such biosafety audits be carried out regularly by clinical microbiology laboratories to ensure biosafety compliance.

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