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Microbiological evaluation of hospital textiles and textiles from the food-processing industry

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ABSTRACT:
Industrial laundries have a goal of maintaining and constantly improving the quality of their services. The main aim of laundering hospital textiles and textiles from the food-processing industry is to remove soiling and microorganisms from infected and dirty textiles and achieving clean, fresh and disinfected textiles ready for use. Although laundering itself is most important in achieving this state, the overall hygiene level in the laundry is also important in preventing recontamination of textiles. Regular sanitary-microbiological analyses of laundries and implementation of correction measures have proved efficient in achieving the goal of clean and disinfected textiles. In this study the hygienic state of two industrial laundries in Slovenia before and after implementing sanitary measures was evaluated by surface sampling using agar plates as well as determining the disinfection effect of the laundering procedures using indicator bacteria: *Staphylococcus aureus*, *Enterococus faecium* and *Candida albicans*. The first laundry washed hospital textiles and the second washed textiles from the food-processing industry. It was observed that both laundries with no regular cleaning and disinfecting measures did not reach a sufficient hygiene level, but after implementing sanitary measures a sufficient hygiene level was reached.

KEY WORDS:
Laundry hygiene, Sanitary measures, Disinfection, Hospital textiles, Food-processing industry

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INTRODUCTION

The main aim of washing laundry is to remove soils and microorganisms from infected and dirty textiles and achieve clean, fresh and disinfected textiles ready for use [1]. Textiles undergo laundering processes which include: soil removal with special laundering agents; bleaching; disinfecting; and finally neutralizing and rinsing. It is important to maintain hygiene and quality of textile cleaning by successfully taking advantage of the beneficial interactions occurring between well-chosen detergent ingredients, using a professional and responsible way to deliver superior performance with a minimum amount of active ingredients and choosing the most optimal laundering procedure. When these factors are taken into consideration, the product cost and the quantity of materials released into the environment is reduced and at the same time an appropriate quality and hygiene level is maintained [2]. Because textiles from hospitals and the food-processing industry may contain many kinds of pathogenic bacteria, fungi and viruses, it is essential that these laundering processes have not only a cleaning effect, but also an anti-microbial effect [3]. There have been reports of hospital textiles being the source of infections with *Streptococcus* [4], *Enterococcus* [5], *Bacillus cereus* [6], *Staphylococcus* [7] and coliforms [8]. There have also been documented reports of laundry staff and staff in the hospital wards being infected with scabies [9], fungi [10], salmonella [11], gastroenteritis viruses [12] and hepatitis A viruses [13] after treating dirty laundry. Therefore inappropriately laundered textiles are a possible vehicle for nosocominal infections [14] and laundering must be taken seriously especially during outbreaks that seem to have no apparent cause. Protective clothing of workers in the food-processing industry is also an important barrier for protection of meat and meat products as well as for the protection of workers against contamination with microorganisms [15].

Textiles from hospitals and food-processing industry may contain many kinds of pathogenic bacteria, fungi and viruses, it is essential that these laundering process have not only a cleaning effect, but also an antimicrobial effect.

Systems for evaluating hygiene in laundries

HACCP

The HACCP system can be applied by all sectors of the food industry and is based on establishing, documenting and maintaining a system of ensuring that all known potential hazards are identified, and that all relevant hazards are controlled in such a manner that a company's products do not harm the consumer. A critical control point (CCP) is a point, procedure or stage in the food chain at which control can be applied, and is essential to prevent or eliminate any food safety hazard or reduce it to an acceptable level [16]. It was accepted that textiles used in the food industry (i.e. working clothes, towels etc.) are classified as one of these CCPs. It is important that the hygiene level of these textiles meets certain requirements for further use in the food sector, thus preventing contamination in the food chain from the pathogens of inappropriately disinfected textiles. Integrated hygiene and food safety management systems in food production can assure improvements in food safety performance, but require a high level of commitment, and full functional involvement [15]. The HACCP principles can be appropriately applied in laundries for textiles from the food-processing industry in order to improve the quality and especially the hygiene of laundered textiles.

RABC

The RABC (Risk analysis and biocontamination control) system is an approved standard based on RABC principles, for laundry processed textiles [17]. This document provides a management system that uses the principles of a risk analysis and biocontamination control system based on preventive measures. This enables laundries to continuously assure the microbiological quality of laundered textiles, especially for textiles used in specific sectors, such as pharmaceuticals, medical instruments, food, healthcare and cosmetics. A control point (CP) is any point or step in a process at which control is applied, in order to contain, eliminate or reduce biocontamination risk [15]. The RABC principles should therefore be applied in laundries for hospital textiles in order to improve the quality and especially the hygiene of these laundered textiles.

Directives of the Robert-Koch Institute

According to the regulations of the Robert-Koch Institute in Germany [18] the disinfection effect of a laundering procedure can be thermal, chemical or chemo-thermal. The laundering procedure has the effect of thermal disinfection under two conditions with bath ratios between 1 : 4 and 1 : 5: (i) disinfection temperature: 85 °C, treatment time: 15 min; or (ii) disinfection temperature: 90 °C, treatment time: 10 min. The Robert-Koch Institute issues an up-to-date list of approved disinfecting procedures for the appropriate chemo-thermal disinfection procedures having a common bath ratio of 1 : 5, treatment time between 10 min to 15 min, and disinfection temperature between 60 °C and 70 °C. The listed laundering procedures contain different substances as active compounds such as: per-compounds, phenol derivates, and chlorine compounds [18,19]. According to the regulations of the Robert-Koch Institute the laundering procedures for hospital textiles must fulfil two regularly controlled conditions. Firstly: regular control of the disinfection effect of the laundering procedure using bioindicators: *Staphylococus aureus*, ATCC 6538 in *Enterococus faecium*, ATCC 6057. Cotton pieces with an area of 1 cm^2 contaminated with a suspension of microorganisms and defibrinated sheep blood are used as substrates and are put in a randomly chosen laundering procedure for hospital textiles. The disinfection effect is confirmed if no bioindicator bacteria survive. Secondly: hospital textiles mustn't contain any pathogenic microorganisms. Regular control of ironed, folded hospital textiles is conducted by surface sampling using RODAC-agar plates. After incubation of the agar plates for (20±4) hours at (37±1) °C nine out of ten samples must not contain more than 2 cfu/10 cm^2.

Guidelines according to the RAL-GZ 992 criteria

RAL, the German Institute for Quality Assurance and Certification issued directions for the laundering hygiene for hospital textiles RAL-GZ 992/2 and for textiles from the food-processing industry RAL-GZ 992/3 [20]. In these directions, valid as important recommendations for laundries in the European Union, the proper transporting, storage time and

Table 1.
Values of control points for laundries according to the RAL-GZ 992 recommendations

CP	Criterion for hospital textiles	Criterion for textiles from the food-processing industry
Washing procedure	No growth of bioindicators[a]	No growth of bioindicators
Ironed and folded textiles[b]	< 20 cfu/dm^2 [c] (in 9 out of 10 samples)	< 50 cfu/dm^2 (in 9 out of 10 samples)
Damp textiles	< 30 cfu/dm^2	< 100 cfu/dm^2
Technical waters	< 100 cfu/mL[d]	< 100 cfu/mL
Technical equipment, storage shelves/transport, hand hygiene	< 100 cfu/dm^2	< 100 cfu/dm^2

[a] biondicators: *Staphylococus aureus*, ATCC 6538 and *Enterococus faecium*, ATCC 6057

[b] The RODAC-agar plates used for surface sampling of ironed and folded textiles should not contain pathogenic and potentially pathogenic microorganisms such as: *Escherichia coli, Enterobacter cloaque* etc.

[c] cfu/dm^2: number of colonies (bacteria, fungi) formed on RODAC-agar plates after being incubated for (48±4) hours at 37 °C calculated to an area of 1 dm^2

[d] cfu/mL: number of colonies (bacteria, fungi) formed in 1 mL water samples after being incubated for (24±4) hours at 37°C or in 1 mL water samples after being incubated for (72±4) hours at 22°C.

sorting of unclean textiles is specified, instructions for the preparation of technical water and washing procedures, the ironing and folding of clean textiles. This is in addition to instructions for regular cleaning and disinfecting measures for all working areas, surfaces, technical equipment, storage shelves, transportation devices, and recommended regular education of workers concerning appropriate hand hygiene. The Research Institute Hohenstein, Germany authorized by RAL, issues Certificates according to RAL-GZ 992, which includes RABC and HACCP principles. Retaining the Certificate depends on unannounced annual inspections of the laundering and disinfecting quality and the hygiene levels in the laundries, according to standard methods and in comparison with chosen limited values. According to these guidelines there are several CPs in laundries (Table 1) that are essential to control, in order to reduce bacterial contamination. The main bactericidal effects appropriate for laundry decontamination are chemo-thermal, thermal and physical as a result of cleaning and disinfecting or washing.

Review of previous research on the hygiene of laundered textiles

Most published reports of the disinfection laundering effect [21,22] use the limit value of the English guidelines for the disinfection measures of hospital laundries when handling dirty and infected textiles [23]. According to these guidelines the laundering programs should contain a disinfection phase that lasts 10 min at 65 °C or 3 min at 71 °C. On the other hand in some investigations the 'excessive' use of high laundering temperatures of hospital textiles is reported [24]. There have also been some reported investigations using the RAL-GZ 992 principles that include RABC principles for hospital textiles and HACCP principles for textiles from the food-processing industry. A laundry that washes hospi-

tal textiles was investigated before and after implementing sanitary measures [1] where it was found that the hygiene level of the laundry is improved after implementing regular sanitary measures. Also, a laundry that washes textiles from the food processing industry without any comparison before and after implementing sanitary measures was investigated [15] and a comparison was done on the systems for determining the hygiene level in industrial laundries in Slovenia, Norway and Denmark [25]. In this research we studied the comparison of the hygienic state of two laundries before and after implementing sanitary measures. Before implementing regular sanitary measures, which included the RAL-GZ 992 principles for textiles from the food-processing industry and hospital textiles, neither laundry had a systematic hygiene plan, only irregular cleaning and disinfecting actions. Both laundries then implemented regular cleaning and disinfecting measures targeting all the control points according to the RAL-GZ 992 criteria. So far to the best of our knowledge no research has been published where a laundry that washes textiles from the food-processing industry has been investigated before and after implementing sanitary measures.

METHODS

Assessment of the disinfection effect of the laundering procedures

Enterococcus faecium Staphylococcus aureus and *Candida albicans* were used as bioindicators and inoculated into defibrinated sheep blood in order to determine the efficiency of chemo-thermal or thermal [19] disinfection during the investigated laundering procedures. *Enterococcus faecium,* and *Staphylococcus aureus* are standard bioindicators used in European tests for determining basic bactericidal disinfectant efficiency with the aim of achieving a reduction of 100,000 cfu/mL for bacteria and 10,000 cfu/mL for fungi according to RKI regulations [18]. This method of bioindicator preparation has been described previously [1,14,15]. Briefly, a mixed suspension of 13 mL of microorganisms with approximately 10^9 cfu of bacteria or fungi together with 100 mL defibrinated sheep blood were added into previously sterilized

Petri dishes and cotton pieces with an area of 1 cm^2 were dipped in the suspension for 10 min. The procedure was repeated for each microorganism. The cotton pieces were taken out and dried overnight in laminar flow. The final concentration of bacteria or fungi was between 100,000 and 500,000 bacteria/mL (or between 10,000 and 500,000 fungi/mL) assessed by serial dilutions and plating on tryptic agar. The bioindicators were then incorporated into the laundering procedure (washing, rinsing and wringing phases), then taken out and brought to the lab: They were put into 40 mL of tryptic soy broth (TSB) for 4 days at 36 °C (Incubator, Wtb Binder) after which 1 mL of the homogenized suspension was spread onto the following agars: kanamycin esculin azide agar for *Enterococcus faecium*, and Baird-Parker agar for *Staphylococcus aureus* incubated for 24 hours at 37 °C and Nickerson agar for *Candida albicans* incubated for 72 hours at 37 °C. Chemo-thermal disinfection was successful when no growth of colonies in any agars was

detected, thus achieving the necessary reduction of 100,000 cfu/mL for bacteria and 10,000 cfu/mL for fungi.

Assessment of technical water samples

Two hundred micro-litres of each water sample were placed on trypcase soy agar. Two samples were prepared for each main sample – one for incubation at 22 °C for 72 h, the other for incubation at 37 °C for 24 h and cfu was determined, then identification by general microbiological methods, as noted below.

Assessment of plate counting agar samples

The count agar plates containing RODAC agar were incubated at 37 °C for 48 h. After the incubation period, the cfu was determined and identification of the formed colonies was conducted by general microbiological methods, as noted below.

General microbiological methods for identification

All formed colonies were analyzed using the following general and specific microbiological methods [1,15]. Any presence of isolates from the family of *Enterobacteriaceae* was confirmed by Gram's stain, catalase activity, oxidase activity and by growth on Endo agar, VRB-agar and VRBD-agar. Conformation of *Pseudomonas aeruginosa* was characterized by Gram's stain, catalase activity, oxidase activity and by growth on cetrimid agar. Any presence of *Stapylococcus* sp. water isolates was confirmed by Gram's stain, catalase activity, oxidase activity, coagulase activity, as well as growth on Baird-Parker agar and Columbia blood agar. *Enterococcus* sp. isolates were characterized by Gram's stain, catalase activity, oxidase activity, pyrase activity and by growth on bile esculin azide agar and Columbia blood agar. Conformation of *Micrococcus* sp. isolates was confirmed by Gram's stain, catalase activity, oxidase activity and by the absence of growth on OF-medium under anaerobic conditions. *Corynebacterium* sp. isolates were characterized by Gram's stain, catalase activity, oxidase activity and by microscopy. Gram positive aerobic spore forming bacilli were confirmed by Gram's stain, catalase activity and by growth on TSA-agar after thermal treatment of samples (10 min, 75 °C). Presence of yeasts and fungi were characterized by visual observation of hypheae or the presence of yeast cells.

RESULTS AND DISCUSSION

Disinfection effect of the laundering procedures

The randomly chosen laundering procedure (Table 2) for hospital linen in laundry A proved to be ineffective since the bioindicator *Enterococcus faecium*, survived the laundering procedure. The manufacturer of the laundries' detergents and disinfecting agent was notified and the laundering procedures were adjusted accordingly. The procedure proved to be inappropriate since the temperature of 85 °C for at least 15 min (as is the thermal disinfection effect according to the guidelines of the Robert-Koch Institute) was not achieved. Therefore the sanitation meas-

Table 2.
Results of the disinfection effect of laundering procedures before and after implementing sanitary measures

CP		Laundry A (hospital)		Laundry B (food-processing industry)	
		No system for sanitary measures	Implemented sanitary measures	No system for sanitary measures	Implemented sanitary measures
Washing process	Growth	*Enterococcus faecium*	No growth of bioindicators	No growth of bioindicators	No growth of bioindicators
	Evaluation	No disinfection effect	Disinfection effect	Disinfection effect	Disinfection effect

ures included an excessive change of all laundering programs which was conducted with the laundry manager together with the manufacturer of the laundries' detergents and disinfecting agent prepared new washing programs according to the list of the Robert-Koch institute [18,19] using different agents that assure chemo-thermal laundering effects. After these implementations no bioindicators survived. In laundry B no bioindicators survived the laundering procedures since a thermal disinfection was assured. This investigation also proves that *Enterococcus faecium* was the most thermo-tolerant chosen bioindicator, since *Staphylococcus aureus* and *Candida albicans* did not survive any laundering procedure [1,14].

Sanitary evaluation of ironed and folded textiles and damp

The results (Table 3) show that the number of colony forming units of bacteria taken from the surface samples of the ten ironed and folded textiles in both laundries, before any sanitation measures were implemented, exceeded the tolerance limit described by RAL-GZ 992 in 4 of the 10 samples for laundry A and 5 of 10 samples in laundry B. The main microorganisms found were: (i) coagulase negative staphylococci and representatives of the genus *Corynebacterium* and *Micrococcus*; these are typical skin bacteria. Representatives of the genus *Bacillus*, the first indicator of insufficient overall hygiene, and *Enterococcus*, a faecal indicator, was also found. The origin of enteroccoci on the ironed and folded textiles could have been from the unprofessional movement of workers from the unclean area containing dirty and contaminated textiles to the clean area, without changing their protective clothing, and conducting proper hand hygiene. The management of both laundries were advised to prepare and execute a protocol for regular radical sanitation measures for all working areas, surfaces, technical equipment, storing shelves and transport devices; and to raise employees' awareness levels of good practice with regard to effective hand hygiene. After these sanitation measures were taken, the microbiological control of ten ironed and folded textiles was repeated and the number of colony forming units of present bacteria for all samples was found to be within the permissible tolerance limit regulated by RAL-GZ 992/2 criteria and the Robert-Koch Institute for both laundries proving that the implemented sanitary measures were efficient. Although the laundering procedure in laundry B proved to have a disinfection effect, the overall handling of the washed laundry (drying, sorting,

Table 3.
Results of the sanitary evaluation of textiles before and after implementing sanitary measures

CP		Laundry A (hospital)		Laundry B (food-processing industry)	
		No system for sanitary measures	Implemented sanitary measures	No system for sanitary measures	Implemented sanitary measures
Ironed textiles	Growth	*Corynebacterium sp.*, *Micrococcus sp.*, CNS[a]	CNS	*Enterococcus sp.*, *Micrococcus sp.*, *Bacillus sp.*, CNS	*Micrococcus sp.*, CNS
	Evaluation	> 20 cfu/dm² in 4 out of 10 samples	> 20 cfu/dm² in 1 out of 10 samples	> 50 cfu/dm² in 5 out of 10 samples	< 50 cfu/dm² in all 10 samples
Damp textiles	Growth	*Corynebacterium sp.*, CNS	*Corynebacterium sp.*, CNS	CNS	CNS
	Evaluation	> 30 cfu/dm² in both samples	< 30 cfu/dm² in both samples	> 100 cfu/dm² in both samples	< 100 cfu/dm² in both samples

[a] CNS: coagulase negative staphylococci

ironing, folding, and packing) proved to cause recontamination with microorganisms due to insufficient division of the clean and unclean area as well as inappropriate handling of the textiles due to manual work and ineffective and hygiene. The surface sampling of damp textiles showed similar results as mainly coagulase negative staphylococci were found showing inappropriate handling of the textiles.

Sanitary evaluation of technical waters

Table 4 shows that the hygienic level of the initial water for laundering was satisfactory, and that contamination of the laundering water occurred in subsequent phases of the laundering procedure (water softening, washing, rinsing etc.). The softened water in laundry A before sanitary measures proved to exceed the recommended value. It was shown that the ion exchanger in the softening plant was infected with biofilm. Therefore, sanitation measures included replacing a ion exchanger and radical cleaning and disinfecting of the water softening device. After replacing the ion exchanger the results were within the tolerance values. The results for the rinsing water from both laundries exceeded the recommended value and confirmed the presence of *Pseudomonas aeruginosa*, an autochthonic water microorganism. Although the laundering procedure B proved to have a disinfection effect it is not uncommon to find a large number of autochthonic water microorganisms on the water extract press as the environment is warm, humid with nutrient. Therefore, the water extract press is a very important control point that needs regular cleaning and disinfecting measures. The rinsing water of the laundering procedure A before sanitary measures also found a representative of the representatives of the family *Enterobacteriaceae* confirming an overall insufficient disinfection effect for the laundering procedure before sanitary measures. Sanitation measures include radical cleaning and disinfecting of the water extract press and preparing a protocol for regular execution of the cleaning program.

Table 4.
Results of the sanitary evaluation of technical waters before and after implementing sanitary measures

CP		Laundry A (hospital)		Laundry B (food-processing industry)	
		No system for sanitary measures	Implemented sanitary measures	No system for sanitary measures	Implemented sanitary measures
Tap water	Growth	MAM[a]	MAM	MAM	MAM
	Evaluation	< 10 cfu/mL at both incubation temperatures	< 10 cfu/mL at both incubation temperatures	< 10 cfu/mL at both incubation temperatures	< 10 cfu/mL at both incubation temperatures
Softened water	Growth	*Bacillus sp.,* MAM	MAM	MAM	MAM
	Evaluation	> 100 cfu/mL at both incubation temperatures	< 100 cfu/mL at both incubation temperatures	< 100 cfu/mL at both incubation temperatures	< 100 cfu/mL at both incubation temperatures
Rinsing water	Growth	*Pseudomonas aeruginosa*, CNS, *Enterobacteriaceae*	*Pseudomonas aeruginosa,* MAM	*Pseudomonas aeruginosa*, CNS, MAM	MAM, CNS
	Evaluation	> 100 cfu/mL at both incubation temperatures	< 100 cfu/mL at both incubation temperatures	> 100 cfu/mL at both incubation temperatures	< 100 cfu/mL at both incubation temperatures

[b] MAM: mesophylic, autochthonic microorganisms;

Table 5.
Results of the sanitary evaluation of technical equipment, storing selves, hand hygiene before and after implementing sanitary measures

CP		Laundry A (hospital)		Laundry B (food-processing industry)	
		No system for sanitary measures	Implemented sanitary measures	No system for sanitary measures	Implemented sanitary measures
Technical equipment	Growth	*Corynebacterium sp., Pseudomonas aeruginosa*, CNS	*Micrococcus sp.*, CNS	*Micrococcus sp.*, *Enterobacter sp.*, moulds, CNS	*Micrococcus sp.*, *Corynebacterium sp.,* CNS
	Evaluation	> 100 cfu/ dm^2 in 4 out of 5 samples	< 100 cfu/ dm^2 in all 5 samples	> 100 cfu/ dm^2 in all 5 samples	< 100 cfu/ dm^2 in all 5 samples
Storing shelves/ transport	Growth	*Bacillus sp., Enterococcus sp.*, moulds, CNS	*Micrococcus sp.*, CNS	*Bacillus sp.,* CNS	*Micrococcus sp.*, CNS
	Evaluation	> 100 cfu/ dm^2 in all 4 samples	> 100 cfu/ dm^2 in 1 out of 4 samples	> 100 cfu/ dm^2 in 1 out of 4 samples	< 100 cfu/ dm^2 in all 4 samples
Hand hygiene	Growth	*Micrococcus sp.*, CNS	CNS	CNS	CNS
	Evaluation	> 100 cfu/ dm^2 in all 3 samples	> 100 cfu/ dm^2 in 1 out of 3 samples	> 100 cfu/ dm^2 in 2 out of 3 samples	< 100 cfu/ dm^2 in all 3 samples

Sanitary evaluation of technical equipment, storing shelves, transport and hand hygiene

Assessment of the hygienic state of all working areas, surfaces, technical equipment, storing shelves, transport vehicles etc. before and after implementing sanitary measures indicate that the overall regular cleaning and disinfecting measures are necessary to maintain an appropriate hygiene level of the washed textiles and that despite the appropriate disinfecting effect of the laundering procedure, the recontamination of laundered textiles is inevitable if further handling (sorting, ironing, folding etc.) isn't conducted under professional conditions. The most common micro organisms found were representatives of micrococci and staphylococci that are typical skin germs. Their frequent presence indicates poor hand hygiene of workers, high air contamination, unsuitable separation between clean and unclean working areas etc. The representative of the genus *Bacillus*, which is the first indicator of inappropriate hygiene in laundries, were very common as well as moulds thus indicating that the working area is also contaminated with fungi due to insufficient cleaning and disinfecting measures of all working areas, surfaces, technical equipment, storing shelves, transport vehicles etc.

CONCLUSION

Achieving a satisfactory hygiene level in a laundry is mainly dependent on the effect of the anti-microbial laundering process. While it is not possible to ensure the absence of microorganisms in the unclean area – owing to the fact that the unclean hospital textiles contain excrements such as blood, urine and other body fluids which are contaminated with microorganisms – it is essential for good laundry hygiene that the laundering procedure is effective in eliminating these microorganisms. Specifically, if the laundering procedure has an insufficient anti-microbial effect, microorganisms are spread widely within the clean area of the laundry. This critical control point also presents the greatest challenge for implementing effective control measures because it is necessary to optimize the anti-microbial effect of the complex laundering procedure. Besides the laundering procedure, it is also necessary to introduce regular cleaning and disinfecting measures in the interior of the continuous batch washer as well as all the other technical equipment (press extractor, dryer, conveyer belts etc.). In this way it will be possible to minimize the growth of microorganisms in order to ensure the anti-microbial effects of the laundering process.

Regular cleaning and disinfecting measures of the working areas, technical equipment and storing shelves as well as regular education of employees with regard to good practice in hand hygiene are very important measures in maintaining appropriate hygiene levels in laundries. It is also very important to minimize cross-contamination of clean textiles resulting from poor hand hygiene at the post-washing handling stage: once again, ensuring employees' awareness of such issues, and of the appropriate mitigating measures, is most important.

The findings of this research have shown that by optimizing laundering procedures and then implementing regular cleaning and disinfecting meas-

ures in the clean area of the laundry together with regular external controls, it is possible for a laundry to operate at an efficient level of hygiene.

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