Rubbermaid® Commercial Products

HYGEN™

DEFINING MICROFIBER: THE HYGEN™ DIFFERENCE

EXECUTIVE SUMMARY

The focus on effective environmental cleaning has never been as intense as it is in the wake of the COVID-19 global pandemic. In the post COVID era, facilities across the globe are increasingly looking for effective, efficient, and evidence-based cleaning solutions.

Microfiber cloths and mops have been identified as “essential tools in an infection-control program,”[3] because they provide superior microbe and organic matter removal compared to traditional textiles.[3-7] They have also been shown to have cost-saving and ergonomic benefits. These advantages are a direct result of microfiber’s design, including its incredibly fine size, large surface area, and electrostatic charge in use.[3-7] Each of these features translates into a highly effective cleaning tool with superior absorption and microbe removal.[3-7]

Not all microfiber is created equal. There are distinct differences in composition, size, and design amongst specific microfiber products that directly impact efficacy. Identifying quality microfiber necessitates an evaluation of its material composition, its split factor, and its product testing, including cleaning performance, durability, and microbial removal.

HYGEN™ microfiber is engineered to incorporate all of the evidence-based features that yield a highly effective and durable microfiber product. HYGEN™ is constructed from premium polymers, competitor tested, and proven to remove 99.7% or more of tested clinically relevant microorganisms. HYGEN’s™ unique, science-based design provides an added level of assurance against the many variables that can impact the cleaning and disinfection process, while also ensuring durability so that an investment in a product yields a long lifespan.

As environmental cleaning continues to be a global priority, it is imperative to use a cleaning tool like HYGEN™ microfiber, whose efficacy and efficiency have been demonstrated across a range of settings.

HYGEN’s™ unique, science-based design provides an added level of assurance against the many variables that can impact the cleaning and disinfection process while also ensuring durability so that an investment in a product yields a long lifespan.

As environmental cleaning continues to be a global priority, it is imperative to use a cleaning tool like HYGEN™ microfiber, whose efficacy and efficiency have been demonstrated across a range of settings.

INTRODUCTION

Over the past two decades, multiple clinical studies have demonstrated that the environment plays a significant role in the transmission of infection. Research has shown that not only do many pathogens, including viruses and multidrug-resistant bacteria, frequently contaminate the healthcare environment in particular, but also that they can survive in it for extended periods of time. This knowledge, set against the backdrop of the roughly 700,000 illnesses and 72,000 deaths that occur from healthcare-associated infections (HAI) each year and the emergence of SARS-CoV-2—the coronavirus responsible for COVID-19, has made cleaning and decontamination of the healthcare environment a global priority.[1-2]

Accordingly, considerable science-based efforts have been made to identify opportunities for improving environmental cleaning methods and practices. One of the key paradigm shifts in cleaning practices has been the transition from cotton cloths and string mops to microfiber textiles.[3] Several seminal studies in the early to mid-2000s demonstrated that not only were microfiber products more effective in removing microbes, dust, and other debris from surfaces, but also that they were more user-friendly and cost-effective.[3-6] Today, microfiber represents the standard of care for cleaning textiles, but it is important to note that not all microfiber is the same. In fact, there is wide variability among microfiber products and some of the fundamental differences have major implications for performance and outcomes.

Today, microfiber represents the standard of care for cleaning textiles, but it is important to note that not all microfiber is the same. In fact, there is wide variability among microfiber products and some of the fundamental differences have major implications for performance and outcomes.

WHAT IS MICROFIBER?

At its most basic, the term "microfiber" refers to a synthetic fiber measuring less than one denier, a unit of measurement for the linear weight or mass density of fibers, or more simply put, a measurement of the fiber thickness.[5-6] Technically, one denier is the equivalent of 1 gram per 9,000 meters,[7-8] but it is perhaps more helpful to think of a denier in relative terms: for example, the average human hair is approximately 20 denier. A microfiber, measuring in at less than one denier, is accordingly just that—a "micro" or very small fiber.

The vast majority of microfiber is made from synthetic polymer materials, most commonly polyesters, polyamides (e.g. nylon), or some combination of the two.[5-6,9] While in some products, such as clothing, natural fibers like cotton may be interwoven with the microfiber; in the cleaning industry, microfiber is almost exclusively synthetic. These synthetic polymers are what provide microfiber with some of its defining features, including tensile strength and durability, but it is the precise polymer make-up of microfiber products that determines the product's efficacy.[9]

HOW IS MICROFIBER MADE?

All microfiber begins with the process of extrusion—which in manufacturing is literally the process of shaping a substance by forcing it through a mold. The synthetic polymer(s) of the microfiber (e.g. polyester, polyester plus polyamide, etc.) is forced through an apparatus designed to create a product of a certain cross-sectional diameter. As the material moves through the apparatus, a process combining heat and spinning melds the polymers together to form one continuous fiber or filament.

A major point of differentiation for microfiber products is whether single or multiple synthetic polymers are extruded. If a single polymer (e.g. 100% polyester) is used, the microfiber is called an extruded or *monofilament* microfiber. If the extrusion process involves more than one polymer, polyester and a polyamide, the fiber produced is called an extruded *blend* fiber—for the obvious reason that two materials have been blended together. At this stage, blended fibers do not technically classify as *microfiber* because they are larger than one denier. However, unlike monofilament microfiber, extruded blend fibers can then undergo a second critical process called splitting which significantly reduces the size of the fibers—in some cases, to well below one denier.

Splitting occurs when chemical (alkaline) and mechanical forces are used to split the surface of the extruded blend microfiber, separating the polyester from the polyamide and creating microscopic wedges and crevices along the surface, the net effect of which is to dramatically increase the microfiber's total surface area.[6,9] The number of splits, or wedges and crevices along the surface can vary from one microfiber product to another, but the greater the number, the greater the surface area of the microfiber product and the smaller the size of the fibers.

HOW DOES MICROFIBER WORK?

Understanding how microfiber is made facilitates an understanding of how it works as a cleaning tool. On the most basic level, the efficacy of microfiber is a function of its fiber's very small size. A microfiber product in which individual microfibers are knit together is able to trap microscopic particles, microbes, and liquids within the intricate network of small fibers far more effectively than larger fibers. This small fiber size also allows the microfibers to penetrate and "clean" microscopic apertures in porous surfaces.[3]

A cleaning tool comprised of thousands of microfibers knit together also has the added benefit of a large collective surface area. This large surface not only allows for greater particle "capture" but also enhances a microfiber product's absorbency through capillary action. Capillary action is the process by which the stronger attraction between a water molecule and a surface (e.g. the highly absorbent polyamide in split microfiber) overcomes the attraction between two water molecules, thereby drawing the liquid up the surface.[10] The more surface area available for capillary action to occur, the greater the absorption of fluid—along with the microbes and particles contained within that fluid. This is why microfiber can absorb as much as six times its weight in water.[3-4]

Microfiber also generates a positive electrostatic field in use.[3,5,11] This is key because most dust, dirt, and bacteria have a net negative charge and thus are naturally attracted to the microfiber where they are then retained inside the microscopic crevices.[3-4,11-12] And because of the larger surface area of microfiber products, there is more space available to trap and retain the targeted microbes, dust, and debris.

Split microfiber has added functional benefits beyond those afforded by monofilament microfiber. To begin with, the polymers used in the blend each provide valuable qualities. Polyester is a durable polymer that provides optimized cleaning performance, while polyamide (e.g. nylon) further enhances microfiber's absorbency. Most importantly, however, the splitting process renders an already small fiber even smaller—considerably more so than a monofilament microfiber. This amplifies all the benefits related to microfiber's small size including the already considerable surface area so that the split microfibers have up to 40 times the surface area of a regular cotton fiber.[4]

Another effect of splitting is enhanced mechanical cleaning action. The sharp edges between the triangular wedges and crevices of the microfiber surface that are created by splitting help "grab" microbes, dust, and debris as the microfiber product is moved over a surface.[4,6,9] Importantly, this doesn't just apply to a smooth surface. The small size of the fibers along with the split edges allow them to "grab" material that might be found in microscopic abrasions, nooks, or crannies on a surface that are invisible to the naked eye but which can potentially serve as reservoirs for microbes.[3,5] By contrast, larger fibers are likely to pass over these microscopic spaces allowing the microbes to remain.[5]

DETAILS MATTER: HOW TO DISCERN QUALITY MICROFIBER

Clearly, not all microfiber is the same and the features that differentiate them directly impact the product's performance. Not surprisingly, studies published in peer-reviewed literature have demonstrated significant variability among different microfiber products in terms of absorbency, cleaning efficacy, and microbial removal.[9,13] Accordingly, there are a number of basic factors to be considered when choosing among microfiber options:

- **Material Composition:** Monofilament polyester microfiber delivers good cleaning performance, but polyester/polyamide blend microfiber delivers optimal cleaning *and* absorbency performance.
- **Split Factor:** Splitting increases surface area and optimizes capture of debris and microbes and absorption of liquids. The percentage of fibers that is split is critical, but if a blended fiber is not split, it is not a true microfiber (i.e. < one denier) and thus loses the performance value inherent in its small size. Does the microfiber have a high-split percentage?
- **Product Testing:** Are there in-use testing results for the product that compare performance to other microfiber products for a variety of functions, including among others:
  - **Cleaning Performance:** how effectively *and* efficiently does the product work?
  - **Durability:** How does the product hold up over time with repeated use and laundering? What is its lifespan?
  - **Microbial Removal:** Are there testing results demonstrating the percentage of microbes removed with the product? Do these results demonstrate removal of clinically relevant pathogens such as methicillin-resistant *Staphylococcus aureus, Clostridioides difficile, and Candida auris*?

MICROFIBER WET PADS

There are also product-specific features that should be considered. This is particularly true for mop pads which have a "face"—the surface of the pad that actually cleans the floor, an "inner layer"—the cushioning buffer layer between the frame and the floor, "backing"—the outer surface of the pad which impacts laundering durability and secure attachment to the mop frame, and "edging" which affects durability and pad structure. The composition and design of these different features can significantly impact performance:

- **Face Material:** Mop pads used for wet mopping need an optimal balance of polymers in their face material. This is because microfiber alone, when wet, has such a strong attraction to the floor surface, that it becomes difficult to move—a phenomenon called drag force. However, when larger polyester fibers are interwoven with the microfiber, they help reduce the drag force, or effort required to move the pad across the floor. Polypropylene fibers also reduce drag force but, more importantly, provide scrubbing power because of their stiffness. The most effective wet pads optimally combine these fibers to maximize performance.
- **Inner Layer:** The inner layer of a mop pad primarily serves as a supportive buffer between the mop frame and the floor, but also impacts how the fluid retained by the microfiber is released. The type of material used in the inner layer directly influences how well that process is accomplished. Polyester and polypropylene inner layers can help augment absorption and facilitate uniform fluid release. By contrast, foam, though cheaper, does not release liquid well, acting like a sponge that releases all the liquid when pressure is applied. Foam can also provide a potential breeding ground for bacteria[14] and deteriorate faster with laundering.[15]
- **Backing:** The main function of backing material is to serve as the attachment between the pad and the frame. This is key because secure attachment ensures coordinated movement of the frame and pad throughout the mopping process. Nylon and polyester are often used in backing because both are generally durable polymers; however, the critical role of the backing in ensuring secure attachment means even nuanced differences in durability matter. Polyester is more durable than nylon which means it is better able to withstand the harsh, but necessary, effects of bleach and high temperatures used in the laundering process.[16]
- **Edging:** Like backing, edging ensures that the mop face can do its job. That can only be accomplished if the pad maintains its shape through use and laundering and is able to be securely and uniformly attached to the frame. While stitched edges can curl, stretch, or abrade over time, taped edges retain the pad's original shape.

THE HYGEN™ DIFFERENCE

Rubbermaid® Commercial Products' HYGEN™ microfiber is rooted in science: science-based design, outcomes, and performance. The products are engineered to incorporate all of the evidence-based factors and features that yield the most durable and effective microfiber cleaning textiles. All HYGEN™ microfiber is:

Rubbermaid® Commercial Products' HYGEN™ microfiber is rooted in science: science-based design, outcomes, and performance.

- **Manufactured from Premium Polymers** for optimal cleaning and absorbency.
- **Competitor-Tested** by an accredited laboratory.
- **Proven to Remove 99.7% or More of Tested Microorganisms** by third-party laboratories, including *Clostridioides difficile, Pseudomonas aeruginosa*, methicillin-resistant *Staphylococcus aureus, Feline calicivirus, Candida auris, and OC43, a coronavirus belonging to the same genus as SARS-CoV-2.*

Additionally, all launderable HYGEN™ microfiber is:

- **16-Split**, in over 95% of fibers, for maximized surface area and optimal microbe and particle removal.
- **Highly Durable** owing to unique product construction and, in the case of wet pads, industry-leading backing design.

SCIENCE-BASED DESIGN

Efficacy

The goal of cleaning in any setting, but particularly in the healthcare setting, is to remove dirt, debris, and any microorganisms that may pose an infection risk. Numerous studies have shown that hand contact with contaminated surfaces plays a pivotal role in the transfer of pathogens between patients and healthcare workers.[17-19] Accordingly, in their Guidelines for Environmental Infection Control in Health-Care Facilities, the Centers for Disease Control and Prevention (CDC) state that "cleaning and disinfecting environmental surfaces as appropriate is fundamental in reducing their potential contribution to the incidence of healthcare-associated infections." [17] The COVID-19 pandemic, along with outbreaks of infectious diseases on cruise ships and in the food-processing industry, have demonstrated that these principles don't just apply to healthcare settings.[20-21]

The CDC identifies cleaning as the first step in the disinfection process because organic matter and debris interfere with the microbial inactivation of disinfectants.[17] Friction is a critical component of cleaning, whether it be surface cleaning or hand hygiene, because the mechanical action of scrubbing dislodges contaminants from surfaces, facilitating their removal.[17] This is at the heart of HYGEN™ design. In addition to having high performing, 16-split, 0.13 denier microfiber, HYGEN™ has a unique design that incorporates more microfiber into each product compared to standard microfiber, providing superior cleaning performance.

HYGEN's™ unique, microfiber-rich design also further enhances its ability to trap microbes. When used with water alone, HYGEN™ has been demonstrated in accredited laboratory testing to remove 99.7% or more of tested pathogens, including the Betacoronavirus, OC43, along with pathogens frequently associated with HAIs such as Clostridioides difficile, Candida auris, pseudomonas aeruginosa and methicillin-resistant Staphylococcus aureus. The efficacy of disinfectants is dependent on a number of variables, including contact time, product distribution over a surface, compatibility with surface material, and pathogen sensitivity.[19] A microfiber product that provides excellent microbial removal with water alone provides an added level of assurance against these variables by removing pathogens that may not otherwise be killed by disinfectant product, and by reducing overall bioburden on a surface, allowing greater disinfectant penetration.

When used with water alone, HYGEN™ has been demonstrated in accredited laboratory testing to remove 99.7% or more of tested pathogens, including the Betacoronavirus, OC43, along with pathogens frequently associated with HAIs such as Clostridioides difficile, Candida auris, pseudomonas aeruginosa and methicillin-resistant Staphylococcus aureus.

When it comes to mopping, there are dynamics and ergonomics beyond scrubbing and pathogen removal capability that require unique product features. HYGEN™ microfiber wet pads are designed to optimize all of these functions. The wet pads have a highly precise combination of knitted HYGEN™ microfiber, polyester, and propylene to facilitate pathogen removal and absorption, reduce drag force, and provide powerful scrubbing. Studies have shown that the ergonomics and fluid dynamics of microfiber mops result not only in decreased water usage but also fewer user-related injuries.[3]

Durability

A critical part of the efficacy of microfiber is ensuring that it can be properly cleaned and rid of microbial contamination during the laundering process. The CDC provides specific parameters for laundering healthcare textiles based on robust evidence.[17,22] These include the use of water of at least 160° Fahrenheit for a minimum of 25 minutes and chlorine bleach at a concentration of 50-150 parts per million.[17] However, the very properties that make heat and bleach effective in destroying microorganisms and cleaning textiles can also degrade the textiles over time, reducing their efficacy and lifespan. This has implications both for performance and for cost. Accordingly, durability is factored into every step of the manufacturing process from the polymers in HYGEN™ microfiber to the reinforced stitching of the fibers, to the durable polyester loop backing and the double-finished taped edges of the wet pads. Internal testing has shown HYGEN™ microfiber can withstand 200 laundering cycles with bleach as per the CDCs laundering parameters, and up to 500 laundering cycles without bleach.

SCIENCE-BASED OUTCOMES AND PERFORMANCE

Microbial Removal/Infection Control

The first published study evaluating the effectiveness of microfiber mops in removing bacteria from environmental surfaces was published in the *American Journal of Infection Control* in 2007.[4] In this seminal study, Rutala et al compared Rubbermaid® Commercial Product (RCP) microfiber mops (note: an earlier product that was not HYGEN™) to conventional cotton string mops.[4] Their results demonstrated that, *without* the use of a chemical disinfectant, the RCP microfiber mops achieved superior microbial removal (95%) compared to cotton string mops (68%).[4]

More recently, a study also published in the *American Journal of Infection Control*, has demonstrated that use of HYGEN™ microfiber provides excellent microbe removal.[23] Gillespie et al demonstrated that both durable and disposable HYGEN™ microfiber cloths had superior cleaning efficacy and microbial removal compared to detergent-impregnated disposable wipes and paper towels dampened with detergent.[23] Testing with fluorescent markers (used as a surrogate for dirt and debris) and UV-light (used to identify marker left behind after cleaning) demonstrated complete removal of fluorescent markers with both HYGEN™ durable and disposable cloths, while the other cloths left marker streaking.[23] Similarly, in microbiologic testing of surfaces inoculated with a vancomycin-resistant strain of *Enterococcus faecium*, both HYGEN™ products removed all of the bacteria while "heavy growth was still detected after detergent wipes and paper towels had been used." [23]

Return on Investment: Efficiency, Cost Savings

A study performed at the University of California, Davis, and available on the Environmental Protection Agency's (EPA) website, as of the writing of this paper, provided early evidence for resource savings with microfiber.[3] The study did not identify the microfiber brand evaluated, but their study demonstrated a number of key cost savings when using microfiber mops instead of conventional wet mops.[3] Chemical and water usage was lower when using microfiber mops as compared to using conventional wet mops.[3] Additionally, microfiber mops were considerably more efficient than conventional wet mops, thus allowing for reduced cleaning times[3]

HOSPITALS

At the 674-bed, Joint Commission International-accredited Hospital Israelita Albert Einstein in Brazil, administrators realized significant reductions in valuable resources when switching from their traditional cleaning protocols, which included disposable cloths and spray bottles, to HYGEN™ microfiber systems.[24] Daily and terminal patient room cleaning times were reduced by 19% and 27%, respectively.[24] By providing a change in process, product, and cleaning culture, they reported that their use of the Rubbermaid® HYGEN™ Microfiber System reduced their water use by 99% and total chemical consumption for daily cleaning was reduced by 47%.[24] Staff injury risk was also assessed utilizing the Rapid Entire Body Assessment (REBA) tool which collects ergonomic in-use data used to calculate a musculoskeletal injury risk score.[24] The HYGEN™ microfiber system earned a risk score of 3, indicating a "low ergonomic risk" to healthcare workers, while traditional cleaning methodologies generated a score of 9, indicating a "high ergonomic risk."[24]

Concerns about Environmental Services staff injury similarly prompted the 550-bed Royal Melbourne Hospital to evaluate the HYGEN™ system as an alternative to the traditional wringer mop and bucket system.[25] Using a workplace biometric analysis technology for EVS staff, they rolled out the HYGEN™ system in their intensive care and oncology units.[25] The results from their usage showed that compared with traditional wet mopping, the HYGEN™ microfiber system posed a 20% lower movement risk.[25] The cleaner spent 49% less time outside of the preferred overall movement range and 33% less time out of the preferred shoulder movement range with the HYGEN™ system.[25] Furthermore, electromyography (EMG)—a test that assesses the health of muscle and nerve activity—detected lower muscle activity for the lower back and shoulders, indicating a less work-intensive process for microfiber than conventional wet mopping.[25]

LONG-TERM CARE FACILITIES

A large long-term care facility (LTCF) system in Australia reported increased cleaning efficiency and efficacy when switching from traditional cleaning methods, including wet mopping, to the HYGEN™ microfiber system.[26] They were able to increase their cleaning frequency by 150 percent without any corresponding increase in labor costs while simultaneously reducing their water usage by 600 liters per day.[26] Their cleaning audits demonstrated over 95% of surfaces were appropriately cleaned with the microfiber system, which "outperformed the current and alternative methods." [26] Furthermore, they reported widespread staff buy-in to the new system and as of the time of the case study stated that they didn't have a work cover claim related to cleaning since they implemented the HYGEN™ system.[26]

Another multi-site LTCF system documented a 129% increase in cleaning efficiency after implementing HYGEN™ as part of a larger solution to improve efficiency and standards.[27] The number of rooms cleaned per 6-hour increments jumped from 14 to 32. Cleaning efficacy also improved dramatically.[27] Previous audits had demonstrated appropriate cleaning of high-touch surfaces occurred only 33% of the time.[27] After deployment of this effort, which included use of HYGEN™, audits revealed proper cleaning of these same surfaces occurred more than 88% of the time.[27]

CONCLUSION

In today's world, evidence-based cleaning is more critical than ever. The heightened awareness of hygiene and infection prevention has reinforced the need for science-driven cleaning solutions across all industries. Science informs cleaning best practices, advances healthcare protocols, and shapes the development of high-performance microfiber technology. It is also the standard by which cleaning outcomes should be measured. Not all microfiber is created equal—HYGEN™ microfiber is engineered with a singular focus: optimizing cleanliness, efficiency, and infection prevention through innovative, proven technology.

REFERENCES

1. Centers for Disease Control and Prevention. Healthcare-associated infections: data portal. Available from: https://www.cdc.gov/hai/data/portal/index.html
2. Centers for Disease Control and Prevention. Interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus disease 2019 (COVID-2019) in healthcare settings. Available from: https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html#infection_control
3. Environmental Protection Agency. Environmental Best Practices for Health Care Facilities: Using Microfiber Mops in Hospitals. 2002.
4. Rutala WA, Gergen MF, & Weber DJ. Microbiologic evaluation of microfiber mops for surface disinfection. Am J Infect Control 2007; 35(9): 569-573.
5. Wren MWD, Rollins MSM, Jeanes A, Hall TJ, Coen PG, Grant VA. Removing bacteria from hospital surfaces: a laboratory comparison of ultramicrofibre and standard cloths. J Hosp Infect 2008; 70(3): 265-271.
6. Nilsen SK, Dahl I, Jorgensen O, Schneider T. Micro-fibre and ultra-micro-fibre cloths, their physical characteristics, cleaning effect, abrasion on surfaces, friction, and wear resistance. Build Environ 2002; 37: 1373-1378.
7. Hari PK. Types and properties of fibres and yarns used in weaving. In: Ghandi KL, ed. Woven Textiles. Cambridg: Woodhead Publishing, 2012
8. Das A. Evaluation of Textile Materials Department Of Textile Technology Indian Institute of Technology- Delhi Lecture No-16 Evaluation of Linear Density of Textile Materials (contd.,). Available from: https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/116102049/lec16.pdf
9. Moore G, Griffith C. A laboratory evaluation of the decontamination properties of microfibre cloths. J Hosp Infect 2006; 64: 374-85.
10. United States Geological Survey. Capillary action and water. Available from: https://www.usgs.gov/special-topic/water-science-school/science/capillary-action-and-water?qt-science_center_objects=0#qt-science_center_objects. Accessed 2 April 2020.
11. California Department of Pesticide Regulation. Green cleaning, sanitizing, and disinfecting: a toolkit for early care and education—what's so great about microfiber? 2015. Available from: https://wspehsu.ucsf.edu/wp-content/uploads/2015/10/FactSheet_Microfiber.pdf. Accessed 31 March 2020.
12. Dickson JS, Koohmaraie M. Cell surface charge characteristics and their relationship to bacterial attachment to meat surfaces. Appl Environ Microbiol; 55 (4): 832-36.
13. Smith DL, Gillanders S, Holah JT, Gush C. Assessing the efficacy of different microfibre cloths at removing surface micro-organisms associated with healthcare-associated infections. J Hosp Infect 2011; 78(3): 182-6.
14. Jenkins RO, Sherburn RE. Growth and survival of bacteria implicated in sudden infant death syndrome on cot mattress materials. J Appl Microbiol 2005; 99(3): 573-9. Available from: 10.1111/j.1365-2672.2005.02620.x.
15. Lovett D, Eastop D. The degradation of polyester polyurethane: preliminary study of 1960s foam-laminated dresses. Studies in Conservation 2004; 49:sup2, 100-104, Available from: 10.1179/sic.2004.49.s2.022 Accessed 9 June 2020.
16. Cook JG. Chapter 2: Polyester Fibres. In: Cook JG, eds. Handbook of Textile Fibres. Woodhead Publishing; 2001: 358-359.
17. Centers for Disease Control and Prevention. Guidelines for Environmental Infection Control in Health-Care Facilities. 2003. Available from: https://www.cdc.gov/infectioncontrol/pdf/guidelines/environmental-guidelines-P.pdf. Accessed 3 April 2020.
18. Weinstein RA. Epidemiology and control of nosocomial infections in adult intensive care units. Am J Med 1991; 9(Supp3B): S179-S184.
19. Stiefel U, Cadnum JL, Eckstein BC, Guerrero DM, Tima MA, Donskey CJ. Contamination of hands with methicillin-resistant Staphylococcus aureus after contact with the skin of colonized patients. Infect Control Hosp Epidemiol 2011; 32: 185-7.
20. National Institutes of Health. New coronavirus stable for hours on surfaces. Available from: https://www.nih.gov/news-events/news-releases/new-coronavirus-stable-hours-surfaces. Accessed 9 April 2020.
21. Centers for Disease Control and Prevention. Norovirus: common settings for norovirus outbreaks. Available from: https://www.cdc.gov/norovirus/trends-outbreaks/outbreaks.html. Accessed 9 April 2020.
22. Sehulster LM. Healthcare laundry and textiles in the United States: review and commentary on contemporary infection prevention issues. Infect Control Hosp Epidemiol 2015; 36(9): 1073-88.
23. Gillespie E, Lovegrove A, Kotsanas D. Health care workers use disposable microfiber cloths for cleaning clinical equipment. Am J Infect Control 2015; 43: 308-11.
24. Rubbermaid® Commercial Products. Increased productivity and resource conservation at Albert Einstein Hospital: an analysis of the benefits of the Rubbermaid® Hygen™ microfiber system. Available from: https://www.rubbermaidcommercial.com/resource-center/84d2004bf28a2095230e8e14993d398d/HYGEN%C3%A2%E2%80%9E%C2%A2_Microfiber_Albert_Einstein_Hospital_Case_Study/
25. Rubbermaid® Commercial Products. The Royal Melbourne Hospital solves manual handling challenge with microfibre. Available from: https://www.rubbermaidcommercial.com/resource-center/818f4654ed39a1c147d1e51a00ffb4cb/Royal_Melbourne_Hospital_Case_Study/
26. Rubbermaid® Commercial Products. Amana Living improves cleaning standards and WHS outcomes with Rubbermaid® Commercial Products. Available from: https://www.rubbermaidcommercial.com/resource-center/43dd49b4fdb9bede653e94468ff8df1e/Amana_Living_Case_Study/
27. Rubbermaid® Commercial Products. Uniting Agewell implements Rubbermaid® Commercial Products to enhance their residents' experience. Available from: https://www.rubbermaidcommercial.com/resource-center/731c83db8d2ff01bdc000083fd3c3740/Uniting_AgeWell_Case_Study/