

# ANTIMICROBIAL ACTIVITY OF THE SHIELD FABRICS AGAINST COMMON PATHOGENS CAUSING HEALTHCARE-ASSOCIATED INFECTIONS IN THE U.S.

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## ABSTRACT (#2130)

**Background:** The U.S. CDC estimates that approximately 1 out of every 20 hospitalized patients contracts healthcare-associated infections (HAIs), of which the 10 most common pathogens account for 84% of any HAIs in the U.S. The Shield fabric (InPro Inc., Muskego, WI) is a stain resistant fabric that incorporates the Aegis Microbe Shield resistant technology to support the elimination of microorganisms. The aim of this study was to assess the antimicrobial activity of the Shield fabrics against clinical isolates common in causing HAIs in U.S. hospitals. **Materials and Methods:** Three Shield fabrics (Classic, Designer and Perspectives) were evaluated for their antimicrobial activities against a collection of clinical isolates from patients of a tertiary hospital by a quantitative method recommended by the ASTM International (E2149-10). The percent reduction and log<sub>10</sub> reduction of organisms by the Shield or control fabric were calculated by comparison to results from untreated controls. **Results:** 104 clinical isolates, representing the top 10 HAIs pathogens, various clinical sources and multidrug-resistant patterns, were evaluated in this study. Compared to untreated controls, the Shield Classic, Designer and Perspectives fabrics showed ≥3 log<sub>10</sub> reduction for 96.2%, 90.4% and 90.4% of the testing organisms, respectively. The average bacterial reductions were 5.33, 4.85 and 5.17 log<sub>10</sub> CFU/mL for the three Shield fabrics, respectively. Notably, all three Shield fabrics exhibited significant antimicrobial activity (≥3 log<sub>10</sub> CFU/mL reduction) against multidrug-resistant MRSA, VRE, ESBL- and KPC-producing Gram-negative organisms. **Conclusions:** The Shield fabric demonstrated significant antimicrobial activity against pathogens common in causing HAIs, including multidrug-resistant microorganisms, in U.S. hospital settings. It may play a role in infection control practice by preventing contamination and transmission of HAI microorganisms in hospital environments.

## INTRODUCTION

- **HAI Prevalence.** The Centers for Disease Prevention and Control (CDC) estimates that approximately 1 out of every 20 hospitalized patients contracts healthcare-associated infections (HAI)<sup>1</sup>.
- **HAI Common Pathogens.** Per CDC National Healthcare Safety Network (NHSN) data<sup>2</sup>, the 10 most common pathogens causing HAIs in the U.S. (accounting for 84% of any HAIs) are coagulase-negative staphylococci (15%), *Staphylococcus aureus* (15%), *Enterococcus* species (12%), *Candida* species (11%), *Escherichia coli* (10%), *Pseudomonas aeruginosa* (8%), *Klebsiella pneumoniae* (6%), *Enterobacter* species (5%), *Acinetobacter baumannii* (3%), and *Klebsiella oxytoca* (2%).
- **The Shield fabric** (InPro Inc., Muskego, WI) is an antibacterial and stain resistant fabric that incorporates the Aegis® Microbe Shield technology to support the elimination of microorganisms (Fig. 1)<sup>3</sup>. The Shield forms a covalent bond to a salane-based chemical to help prevent cross infection of bacterial and other microorganisms.

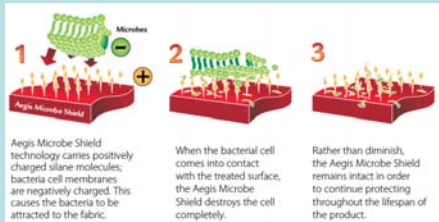


Fig. 1. Antimicrobial mechanisms of the Shield fabrics<sup>3</sup>.

## OBJECTIVE

To assess the antimicrobial activity of the Shield fabrics against the common pathogens causing HAIs in U.S. hospitals.

## MATERIALS AND METHODS

➤ **Clinical Isolates (n=104).** From a collection of patient isolates at a tertiary university hospital; representing the top 10 microorganisms causing HAIs in U.S. hospitals.

➤ **Fabric Materials.** Three Shield by Panaz fabrics (Classic, Designer and Perspectives) were obtained from InPro Inc. A fourth fabric from a different manufacturer was provided by the hospital Environmental Care Department and used as 'Fabric Control'.

➤ **Quantitative Assessment of Antimicrobial Activity.** Performed per ASTM Guidelines<sup>4</sup> with minor modification:

- For each quality control and testing isolate, five flasks each containing 50 ml of working dilution of the testing microbial inoculum were prepared.
- The three testing flasks were placed with 1.0 ± 0.1 g of Shield Classic, Designer or Perspectives fabric, respectively. The fourth flask was placed with 1 ± 0.1 g of control fabric and used as fabric control. The fifth flask contained only the working bacterial suspension without any fabric and used as untreated control.
- The percent reduction and log<sub>10</sub> reduction of microorganisms by testing or control fabric (A) were calculated by direct comparison to results from the untreated control (C):

$$\text{Reduction, \% (CFU)} = \frac{C - A}{C} \times 100$$

$$\text{Log}_{10} \text{ bacterial reduction} = \text{Log}_{10} (C) - \text{Log}_{10} (A)$$

Where A = CFU/mL for the flask containing one of the three testing fabrics or the control fabric, and C = CFU/mL for the flask containing only working dilution of bacterial inoculum without fabric after the specified contact time.



Fig. 2. Example of blood agar plates for colony counting. Top panel (left to right): 100 µl of diluted bacterial suspension, pre-incubation; 100 µl & 10 µl of diluted suspension from untreated control, respectively. Middle panel (left to right): 100 µl of diluted suspension from flasks with the Shield Classic, Designer and Perspectives fabrics, respectively. Low panel (left to right): 100 µl & 10 µl of diluted suspension from the flask with control fabric; a glass flask control.

## RESULTS

The bacterial counts (log<sub>10</sub> CFU/mL) of the top 10 pathogens examined (Figures 3 to 6).

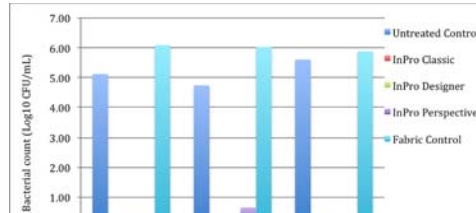


Fig. 3

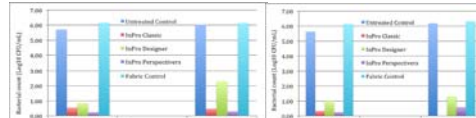


Fig. 4

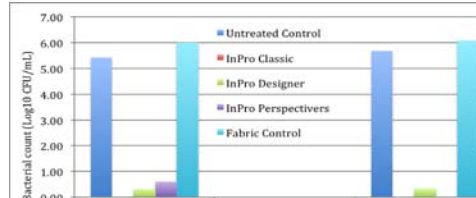


Fig. 5

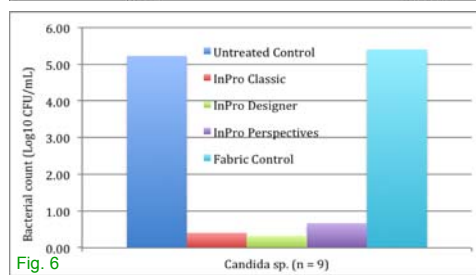


Fig. 6

## REFERENCES

1. CDC web site at <http://www.cdc.gov/HAI/burden.html>; accessed on 10/16/11.
2. Hidron A.L. et al. 2008. Infect Control Hosp Epidemiol 29:996-1011.
3. Shield brochure. 2012. InPro Inc.
4. American Society for Testing and Materials (ASTM) International. 2010. E2149-10.
5. American Association of Textile Chemists and Colorists. 2004. AATCC 147-2004.

TABLE 1. Percentage of bacterial reduction (CFU/mL) of the Shield fabrics compared to untreated control

Organism	No. of isolates	Untreated Control (CFU/mL)	Average bacterial reduction (% CFU/mL)		
			Shield™ Classic Fabric	Shield™ Designer Fabric	Shield™ Perspectives Fabric
CoNS*	10	6.5E+04	100.0	100.0	99.3
<i>Staphylococcus aureus</i>	10	2.0E+05	100.0	99.9	99.9
<i>Enterococcus</i> sp.	10	8.7E+05	100.0	100.0	100.0
<i>Escherichia coli</i>	11	7.0E+05	99.6	99.0	99.9
<i>Pseudomonas aeruginosa</i>	10	6.9E+05	100.0	99.9	99.9
<i>Klebsiella pneumoniae</i>	12	8.6E+05	99.9	99.7	100.0
<i>Enterobacter</i> sp.	12	2.1E+06	100.0	100.0	99.9
<i>Acinetobacter baumannii</i>	10	8.7E+05	100.0	99.9	100.0
<i>Klebsiella oxytoca</i>	10	1.5E+06	99.7	99.8	100.0
<i>Candida</i> sp.**	9	1.9E+05	99.8	100.0	99.9
Total	104	8.2E+05	99.9	99.8	99.9

TABLE 2. Bacterial reduction (log<sub>10</sub> CFU/mL) of the Shield fabrics compared to untreated control

Organism	No. of isolates	Untreated Control (log <sub>10</sub> CFU/mL)	Average bacterial reduction (log <sub>10</sub> CFU/mL)			
			Shield™ Classic Fabric	Shield™ Designer Fabric	Shield™ Perspectives Fabric	Fabric Control
CoNS*	10	4.72	4.72	4.72	4.08	-1.28
<i>Staphylococcus aureus</i>	10	5.11	5.11	4.78	4.81	-0.98
<i>Enterococcus</i> sp.	10	5.60	5.30	5.60	5.60	-0.27
<i>Escherichia coli</i>	11	5.64	5.29	4.64	5.36	-0.51
<i>Pseudomonas aeruginosa</i>	10	5.43	5.43	5.10	4.83	-0.56
<i>Klebsiella pneumoniae</i>	12	5.72	5.17	4.85	5.47	-0.44
<i>Enterobacter</i> sp.	12	6.19	4.86	5.58	-0.15	
<i>Acinetobacter baumannii</i>	10	5.68	5.68	5.33	5.68	-0.40
<i>Klebsiella oxytoca</i>	10	6.05	5.57	3.75	5.75	-1.10
<i>Candida</i> sp.**	9	5.23	4.83	4.69	4.56	-0.19
Total	104	5.54	5.33	4.85	5.17	-0.49

\* CoNS: Coagulase-negative *Staphylococcus* sp.; \*\* Includes *C. albicans* (n=4), *C. glabrata* (n=3) and *C. parapsilosis* (n=2).

TABLE 3. Antimicrobial activity of the Shield fabrics against multidrug-resistant (MDR) and non-MDR microorganisms

Organism group*	No. of isolates	Number of isolates (%) with ≥ 3 log <sub>10</sub> CFU/mL reduction		
		Shield™ Classic Fabric	Shield™ Designer Fabric	Shield™ Perspectives Fabric
MDR bacteria	42	40 (95.2)	37 (88.1)	40 (95.2)
Non-MDR bacteria	53	52 (97.8)	50 (93.0)	47 (86%)
P value		P = 0.58	P = 0.24	P = 0.30

\* The 9 yeast isolates were excluded.

## CONCLUSIONS

- The Shield fabrics demonstrated significant antimicrobial activity against common pathogens causing HAIs, including MDR microorganisms, in U.S. hospital settings.
- It may play a role in infection control practice by preventing contamination and transmission of HAI microorganisms in hospital environments.