

# GROWTH INHIBITION OF MICROORGANISMS INVOLVED IN CATHETER-RELATED INFECTIONS BY AN ANTIMICROBIAL TRANSPARENT IV DRESSING CONTAINING CHLORHEXIDINE GLUCONATE (CHG)

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## PURPOSE

To evaluate the antimicrobial activity of the transparent dressing 3M™ Tegaderm™ CHG Chlorhexidine Gluconate IV Securement Dressing against microorganisms commonly associated with catheter-related (CR) infections using *in vitro* zone of inhibition.

## INTRODUCTION

Successful strategies for preventing CR-infections, and more specifically catheter-related bloodstream infections (CR-BSI), have demonstrated the benefits of implementing educational programs and bundles of interventions recommended in the guidelines. With those strategies, rates of CR-BSI in some cases declined in the last years. Notwithstanding, efforts are still needed since infections caused by vascular catheters remain an important source of morbidity and mortality for critically ill patients. In Europe, the incidence density of central venous CR-infections has been recently reported as ranging from 1 to 3.1 per 1000 patient days (2). Behind such figures, infection risks as high as 11% (corresponding to incidence densities of 7 to 9 episodes/1000 catheter days) have been pointed out in different European countries and high-risk hospital wards (3,4). It has been shown that, beyond the adherence to the guidelines, the use of antimicrobial medical devices for catheterization and catheter care significantly contributes to further reducing the incidence of catheter colonization by microorganisms and, as a consequence, the incidence of CR-BSI (5).

The skin flora is the main source of contamination and colonization of intra-vascular short-term catheters (Figure 1) via the extra-luminal route (6).

Recent European studies estimated that around 60% of the episodes of catheter colonization are caused by the coagulase-negative staphylococci and *Staphylococcus aureus*, (Figure 2A), and that 60% of all CR-BSI are caused by the same bacteria (Figure 2B).

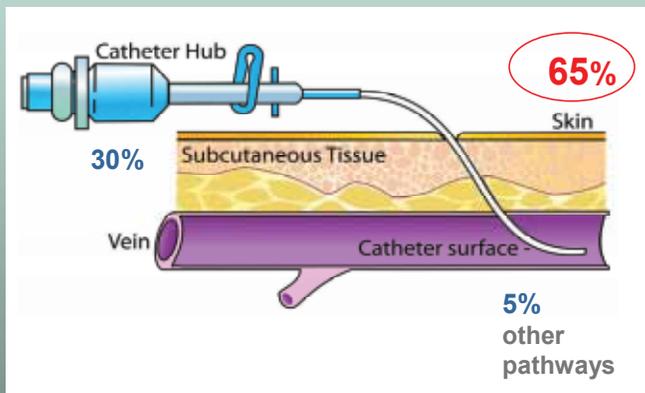


Figure 1. Sources of extraluminal catheter contamination

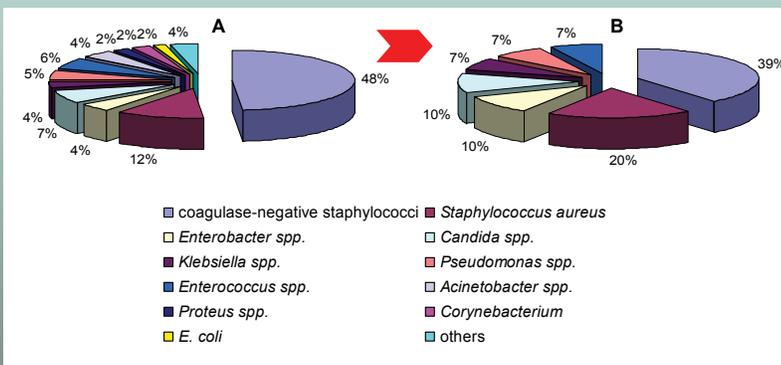
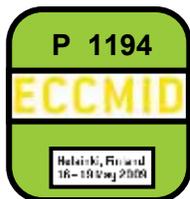


Figure 2. The most common microorganisms colonizing catheter-tips (A) and causing CR-BSI (B) in European countries belong to the skin flora (based on the studies ESGNI-005 and 006, refs. 7,8)

Although antiseptic agents are used to disinfect the skin prior to catheter insertion and therefore to reduce the risk of device colonization (9), the skin flora will rebound over time (10). By counteracting the skin re-colonization process during the whole catheterization period, medical devices, such as antimicrobial I.V. dressings, contribute to reducing the incidence of CR-BSI (3) and even approaching zero infections when the baseline of the infection rate is already low (11).

The new Tegaderm™ CHG is a one-step application I.V. securement dressing, which combines antimicrobial activity and transparency allowing continuous observation of the insertion sites and early recognition of signs of infections. This study is part of the efficacy evaluation of that novel dressing. Additional results from that evaluation have been presented elsewhere (10, 12, 13).



## ABSTRACT (updated)

### Introduction:

Infections associated with intravascular devices represent 10 to 20% of all nosocomial infections and are mostly caused by microorganisms belonging to the skin flora. Antiseptic agents are used to disinfect the skin prior to catheter insertion, to reduce the risk of device colonization by the skin microorganisms. Nevertheless, the skin flora will rebound over time and will be able to colonize from 2 to 71% of all the inserted vascular devices (1). Transparent IV dressings allowing continuous observation of the insertion sites and early recognition of signs of infections, and antimicrobial dressings, suppressing skin flora re-growth, are valuable elements for best practices in IV management. This study is part of the efficacy evaluation performed with a novel dressing, the 3M™ Tegaderm™ CHG Chlorhexidine Gluconate IV Securement Dressing, which combines both transparency and antimicrobial activity.

### Objective:

Demonstrate antimicrobial activity of Tegaderm™ CHG gel pad against microorganisms commonly associated with CR-infections by an *in vitro* assessment of growth inhibition.

### Methods:

1. **Zone of Inhibition:** Suspensions of microorganisms (approximately  $10^8$  cfu / mL) were prepared in sterile Butterfield's phosphate buffered water from overnight growth plates. Mueller-Hinton (MH) agar plates were inoculated with the test microorganisms. Die-cut 24 mm disks from Tegaderm™ CHG dressings were placed onto the agar surface. Duplicate samples were prepared for each microorganism and incubated overnight incubation at  $35 \pm 2^\circ\text{C}$ . The diameter of the zone of inhibition was measured.
2. **Aged Zone of Inhibition:** The experiment described above was performed with Tegaderm™ CHG dressings that were subject to standard ICH aging conditions ( $25^\circ\text{C}/60\%$  humidity &  $30^\circ\text{C}/65\%$  humidity) for 22 months. Tegaderm™ CHG dressings that were not aged served as the control to determine the ability of the aged Tegaderm™ CHG to retain its antimicrobial properties.

### Results:

Antimicrobial activity of the Tegaderm™ CHG gel pad was tested against a panel of 37 microorganisms, comprised of 21 gram positive and 14 gram negative bacteria, and 2 yeasts. Tegaderm™ CHG susceptibility was observed for all the microorganisms tested among those multiple strains of coagulase-negative staphylococci and *Staphylococcus aureus* – including those methicillin-resistant strains – and vancomycin-resistant enterococci (Table 1, 2 and 3; figures 5, 6 and 7). Aged Tegaderm™ CHG, also generated clear zones of growth inhibition for the microorganisms tested.

### Conclusions:

The Tegaderm™ CHG dressing demonstrated broad-spectrum antimicrobial activity against all 37 strains of microorganisms tested. Tegaderm™ CHG retains its antimicrobial properties as demonstrated by the aged dressings ability to produce similar zones of inhibition compared to unaged dressings.

## MATERIAL AND METHODS

### Features of the CHG-Impregnated Dressing



Figure 3.  
The Tegaderm™ CHG antimicrobial i.v. securement dressing

Tegaderm™ CHG integrates an adhesive, antimicrobial CHG-impregnated gel pad onto a moisture vapor permeable transparent dressing.

This feature allows a single-step yet easy application directly over the insertion site following catheter insertion or during follow-up site care. The gel rapidly softens on skin and molds around the catheter, ensuring intimate contact of the CHG-impregnated surface along the entire insertion site (Figure 3).

The integrated gel pad by adhering and enveloping the catheter, potentially minimizes pistoning movement of the catheter into the skin. Pistoning movement of the catheter can facilitate entry of microorganisms into the insertion tract (14). The gel also absorbs up to eight times its weight in fluid, preventing accumulation of moisture on the site.

### Zones of Inhibition around the Tegaderm™ CHG gel pad

- Suspensions of microorganisms (approximately  $10^8$  cfu / mL) were prepared in sterile Butterfield's phosphate buffered water from overnight growth plates.
- Mueller-Hinton (MH) agar plates were uniformly inoculated with the test microorganisms (tables 1, 2 and 3).
- Die-cut 24 mm gel disks from Tegaderm™ CHG dressings were placed onto the agar surface.
- Duplicate samples were prepared for each microorganism.
- After overnight incubation at  $35 \pm 2^\circ\text{C}$ , the diameter of the zone of inhibition (w) was measured (figure 4).

### Zone of Inhibition around aged Tegaderm™ CHG gel pad

- The experiment described above was performed with Tegaderm™ CHG dressings that were subject to standard ICH aging conditions ( $25^\circ\text{C}/60\%$  humidity &  $30^\circ\text{C}/65\%$  humidity) for 22 months.
- Tegaderm™ CHG dressings that were not aged served as the control to determine the ability of the aged Tegaderm™ CHG to retain its antimicrobial properties.



Figure 4.  
Measurement of the diameter of the zone of inhibition

## DISCUSSION AND CONCLUSIONS

- The Tegaderm™ CHG gel pad produced a circular zone of inhibition in which the amount of antimicrobial exceeded inhibitory concentrations for each of the microorganisms tested.
- The broad spectrum activity of the Tegaderm™ CHG gel pad was demonstrated by the ability to produce this effect against gram positive, gram negative, and yeast microorganisms.
- Tegaderm™ CHG retains its antimicrobial properties as demonstrated by the aged dressings ability to produce similar zones of inhibition compared to unaged dressings.
- Antimicrobial activity was observed against all major genre of microorganisms that cause CR-BSI or commonly colonize catheter tips (Figure 2) including: methicillin-resistant staphylococci (MRSA and MRSE), coagulase-negative staphylococci (CNS), vancomycin-resistant enterococci (VRE), and *Staphylococcus aureus*
- The antimicrobial efficacy of Tegaderm™ CHG documented in the present study complements the results of *in vitro* time-kill assays and studies on healthy volunteers demonstrating skin flora killing and suppression of regrowth after prepping (10, 13).

# RESULTS

- The Tegaderm™ CHG gel pad was tested for antimicrobial activity against 37 microorganisms, including 21 gram positive and 14 gram negative bacteria, and 2 yeasts.
- Tegaderm™ CHG, that was subject to standard ICH aging conditions for 22 months, was tested for antimicrobial activity against a gram positive, gram negative, and a yeast microorganism.
- Tegaderm™ CHG, aged and new, generated clear zones of growth inhibition for all the microorganisms tested.
- Table 1, 2, and 3 lists all of the microorganisms tested and their corresponding zone of inhibition diameters.
- The spider web figures 5, 6, and 7 represent the zone of inhibition diameter produced by the Tegaderm™ CHG gel pad for each microorganism tested.

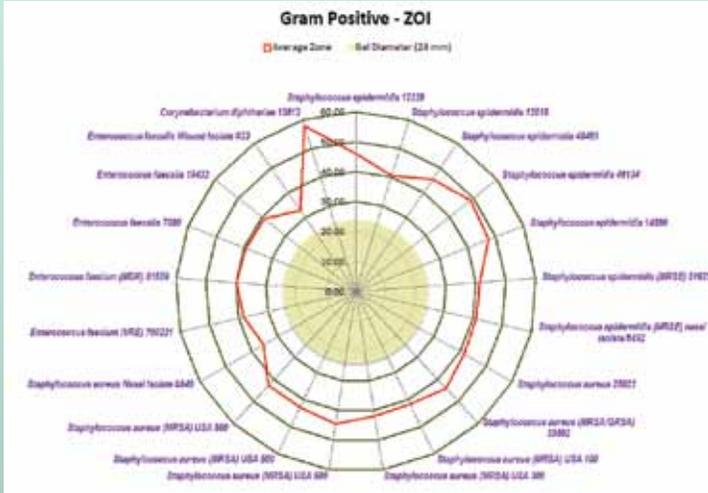


Figure 5. Graphical representation of the zones of inhibition for Gram Positive bacteria

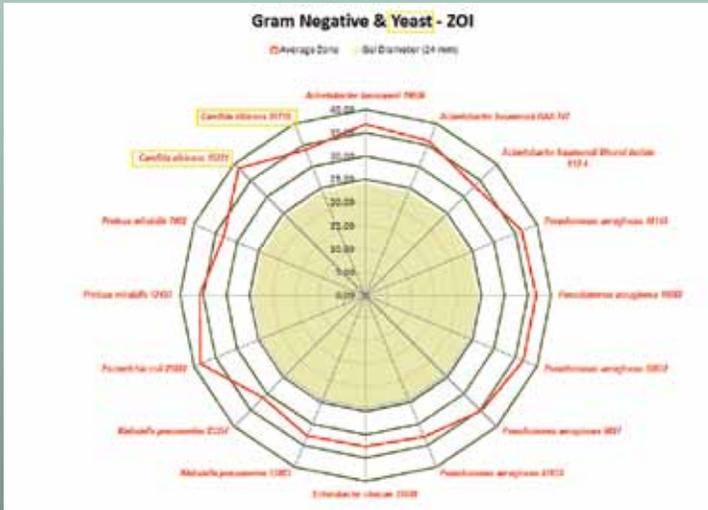


Figure 6. Graphical representation of the zones of inhibition for Gram Negative bacteria and Yeast

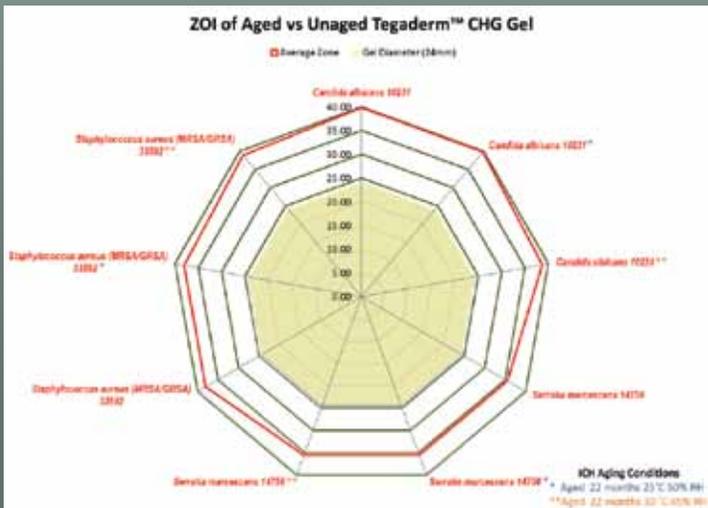


Figure 7. Graphical representation of the zones of inhibition with aged Tegaderm™ CHG Dressing

Table 1. Gram Positive microorganisms strains tested with corresponding average zone of inhibition (mm)

Gram Positive	ATCC	Average Zone diameter (mm)
<i>Staphylococcus epidermidis</i>	12228	46.04
<i>Staphylococcus epidermidis</i>	13518	40.38
<i>Staphylococcus epidermidis</i>	49461	45.28
<i>Staphylococcus epidermidis</i>	49134	48.87
<i>Staphylococcus epidermidis</i>	14990	47.55
<i>Staphylococcus epidermidis</i> (MRSE)	51625	41.45
<i>Staphylococcus epidermidis</i> (MRSE) nasal isolate #492		41.2
<i>Staphylococcus aureus</i>	25923	41.70
<i>Staphylococcus aureus</i> (MRSA/GRSA)	33592	44.15
<i>Staphylococcus aureus</i> (MRSA) USA 100		41.70
<i>Staphylococcus aureus</i> (MRSA) USA 300		42.08
<i>Staphylococcus aureus</i> (MRSA) USA 600		44.72
<i>Staphylococcus aureus</i> (MRSA) USA 500		42.83
<i>Staphylococcus aureus</i> (MRSA) USA 800		42.64
<i>Staphylococcus aureus</i> Nasal Isolate #849		35.40
<i>Enterococcus faecium</i> (VRE)	70022	1
<i>Enterococcus faecium</i> (MDR)	51559	38.20
<i>Enterococcus faecalis</i>	7080	39.80
<i>Enterococcus faecalis</i>	19433	39.25
<i>Enterococcus faecalis</i> Wound Isolate #23		38.87
		32.60
<i>Corynebacterium diphtheriae</i>	13812	57.74

Table 2. Gram Negative bacteria and Yeast strains tested with corresponding average zone of inhibition (mm)

Gram Negative	ATCC	Average Zone diameter (mm)
<i>Acinetobacter baumannii</i>	19606	36.79
<i>Acinetobacter baumannii</i>	BAA-747	35.85
<i>Acinetobacter baumannii</i> Wound Isolate #12-4		33.20
<i>Pseudomonas aeruginosa</i>	10145	36.42
<i>Pseudomonas aeruginosa</i>	10662	36.79
<i>Pseudomonas aeruginosa</i>	35032	36.79
<i>Pseudomonas aeruginosa</i>	9027	35.28
<i>Pseudomonas aeruginosa</i>	27853	33.00
<i>Enterobacter cloacae</i>	35549	32.60
<i>Klebsiella pneumoniae</i>	13883	32.80
<i>Klebsiella pneumoniae</i>	23357	31.20
<i>Escherichia coli</i>	25922	38.49
<i>Proteus mirabilis</i>	12453	35.66
<i>Proteus mirabilis</i>	7002	33.02
Yeast	ATCC	Average Zone diameter (mm)
<i>Candida albicans</i>	10231	38.60
<i>Candida albicans</i>	58716	33.80

Table 3. Strains of microorganisms tested with aged Tegaderm™ CHG Dressing with corresponding average zone of inhibition

Microorganism	ATCC	Average Zone diameter (mm)		
		Aged 22 months @ 25°C/60% humidity	Aged 22 months @ 30°C/65% humidity	Unaged Control
<i>Staphylococcus aureus</i> (MRSA/GRSA)	33592	39.26	38.88	37.95
<i>Serratia marcescens</i>	14756	35.32	35.515	35.515
<i>Candida albicans</i>	10231	38.31	38.69	39.83

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