how to prevent catheter-related infections

…..some things to think about!

Marcia Ryder PhD, MS, RN, FNAP

WoCoVA

MEET THE EXPERTS

“the big picture”

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

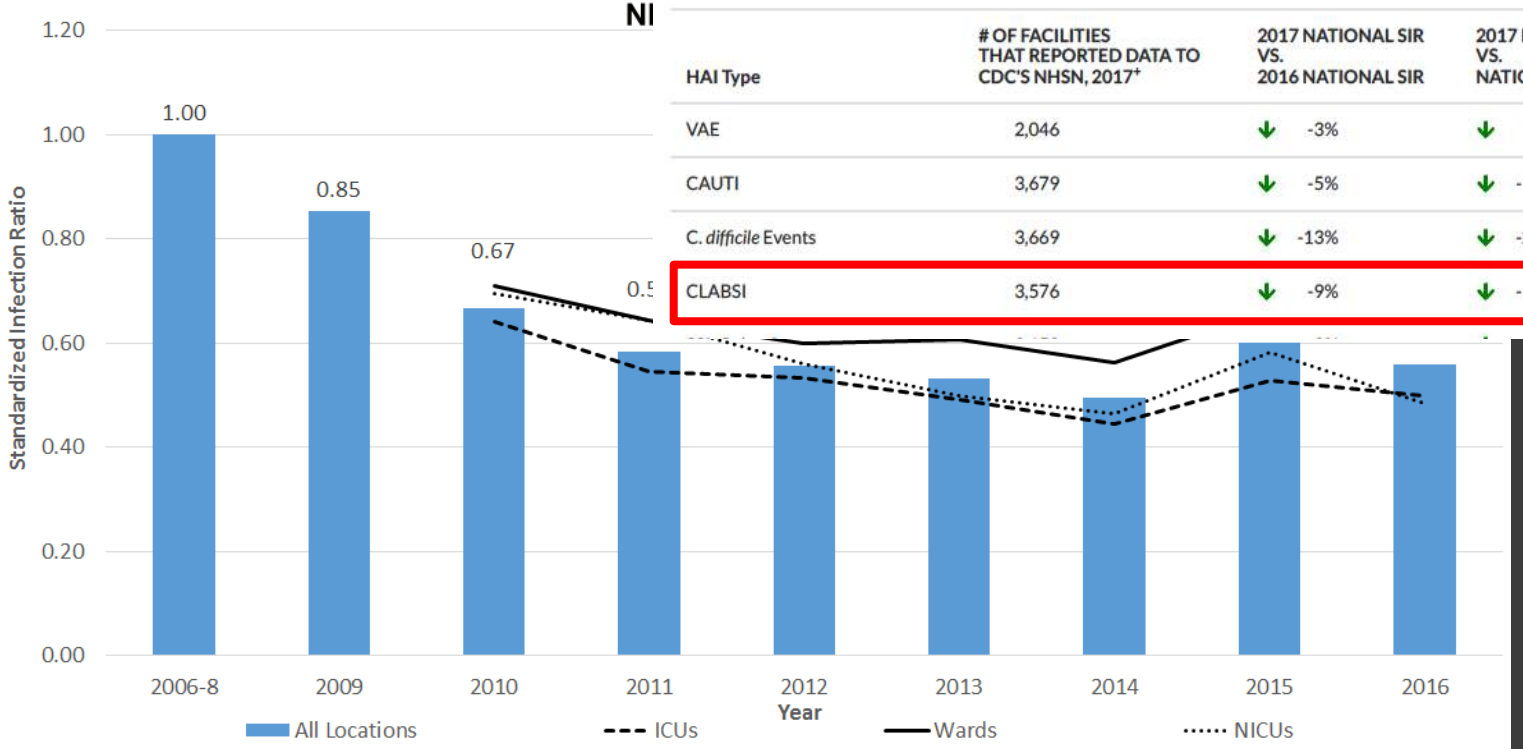
Data Summary of HAIs in the US: Assessing Progress 2006-2016

National Data for Acute Care Hospitals, Year 2017

National Data by HAI Type

HAI Type	# OF FACILITIES THAT REPORTED DATA TO CDC'S NHSN, 2017†	2017 NATIONAL SIR VS. 2016 NATIONAL SIR	2017 NATIONAL SIR VS. NATIONAL BASELINE	2017 NATIONAL SIR
VAE	2,046	↓ -3%	↓ -5%	0.95
CAUTI	3,679	↓ -5%	↓ -12%	0.88
C. *difficile* Events	3,669	↓ -13%	↓ -20%	0.80
CLABSI	3,576	↓ -9%	↓ -19%	0.81

Figure 1. Changes over time in CLA… NI…

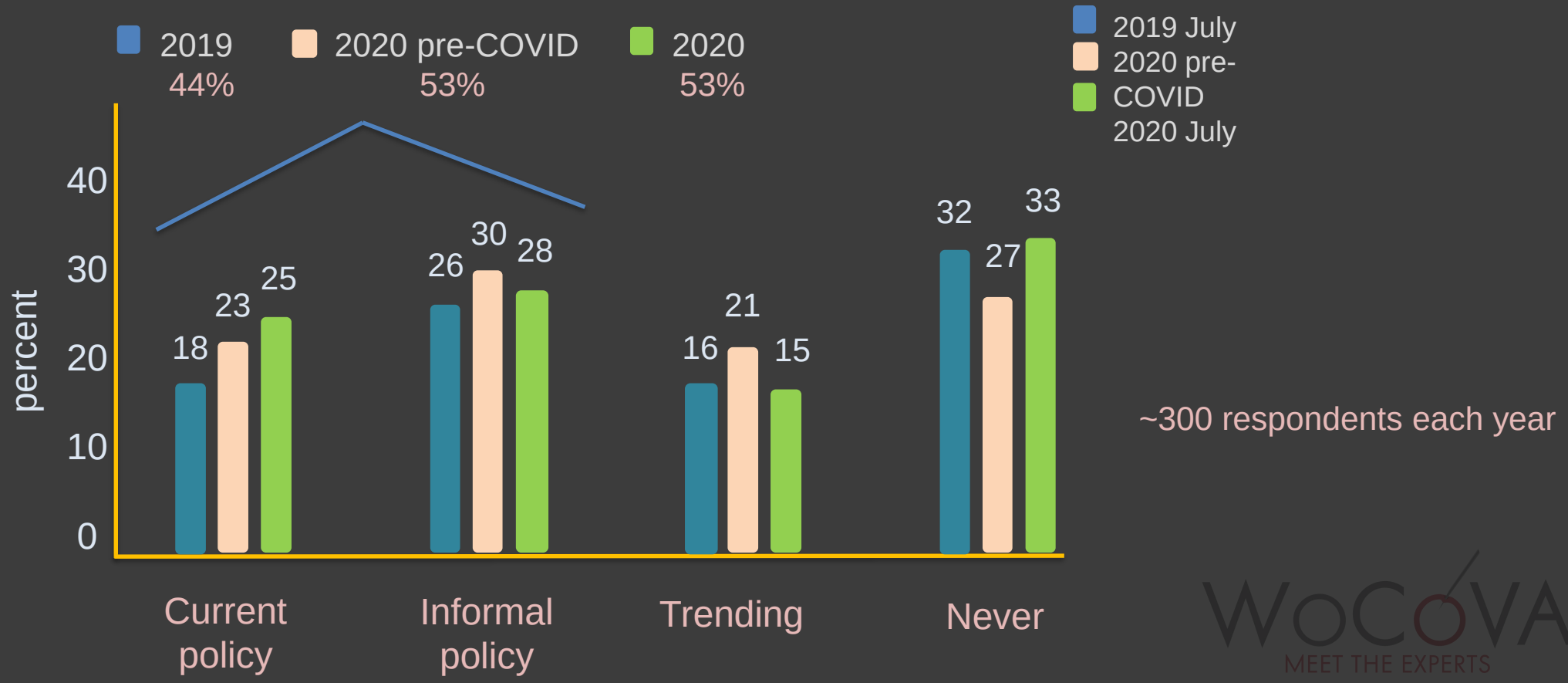


- Hospitals have made significant progress in preventing CLABSIs–nationally, there has been a roughly 50% drop in CLABSIs between 2008 and 2016. (Figures 1 and 2)

could avoidance of the use of CVCs account for some of this success?

2019-2020 AVA member survey: PVAD use

Does your administration require/request your team to place peripheral catheters (SPC/midlines) in place of PICCs/CICC for the purpose of CLABSI reduction?



~300 respondents each year

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Contents lists available at ScienceDirect

International Journal of Antimicrobial Agents

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Peripheral venous catheters: an under-evaluated problem

Walter Zingg *, Didier Pittet

Clinical Infectious Diseases

INVITED ARTICLE

HEALTHCARE EPIDEMIOLOGY: Robert Weinstein, Section Editor

ipheral Venous Catheter–Related fections: A Systematic Review

Peripheral Venous Catheter-Related *Staphylococcus aureus* Bacteremia

T. Tony Trinh, MD;[1] Philip A. Chan, MD;[1,4] Omega E
Nancy Burdick, RN;[2] Julie A. Jefferson,

Peripheral intravenous catheter-associated *Staphylococcus aureus* bacteraemia: more than 5 years of pr tertiary health serv

Open Forum Infectious Diseases

BRIEF REPORT

Peripheral Intravenous Catheter Placement Is an Underrecognized Source of *Staphylococcus aureus* Bloodstream Infection

Eloise D. Austin,[1] Sean B. Sullivan,[1] Susan Whittier,[2] Franklin D. Lowy,[1,2] and Anne-Catrin Uhlemann[1]

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevierhealth.com/journals/jhin

Nationwide study on peripheral-venous-catheter-associated-bloodstream infections in internal medicine departments

M. Guembe [a,d,*], M.J. Pérez-Granda [c,d,f], J.A. Capdevila [e,g], J. Barberán [e,h], B. Pinilla [e,i], P. Martín-Rabadán [a,b,c,d], E. Bouza [a,b,c,d,e] on behalf of the NUVE Study Group

Brief Report

A comparison of the incidence of midline catheter–associated bloodstream infections to that of central line–associated bloodstream infections in 5 acute care hospitals

Nancy J. Hogle MPH, RN, CIC [a,*], Krystal M. Balzer MSN, RN, CIC [a], Barbara G. Ross MS, RN, CIC, FAPIC [a], Lorelle Wuerz PhD, RN, VA-BC, NEA-BC [b], William G. Greendyke MD [a,c], E. Yoko Furuya MD, MS [a,c], Matthew S. Simon MD, MS [a,d], David P. Calfee MD, MS [a,d]

AJIC American Journal of Infection Control

ELSEVIER

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Hospital-acquired *Staphylococcus aureus* primary bloodstream infection: A comparison of events that do and do not meet the central line–associated bloodstream infection definition

Christopher S. Kovacs MD [a,*], Cynthia Fatica RN, BSN, CIC [b], Robert Butler MS [c], Steven M. Gordon [a], Thomas G. Fraser MD [a,b]

Víctor Daniel Rosenthal MD, CIC, MSc [a,*], Debkishore Gupta MD [b], Prasad Rajhans MD [c], Sheila Nainan Myatra MD [d], S. Muralidharan MD [e], Yatin Mehta MD [f], Mohit Kharbanda MD [g], Camilla Rodrigues MD [h], Arpita Dwivedy MD [i], Sweta Shah MD [j], Aruna Poojary MD [k], Subhash Kumar Todi MD [l], Supriya Chabukswar MD [m], Mahuya Bhattacharyya MD [n], Bala Ramachandran MD [o], Nagarajan Ramakrishnan MD [p], Sujit Kar Purkayasta MD [q], Asmita Sagar Sakle MD [r], Siva Kumar MD [s], Anup R. Warrier MD [t], Maithili Satish Kavathekar MD [u], Samir Sahu MD [v], Aisha Mubarak MD [w], Nikhil Modi MD [x], Namita Jaggi MD [y], Nadimpalli Gita MD [z], Shakti Bedanta Mishra MD [aa], Suneeta Sahu MD [bb], Burhan Jawadwala MD [cc], Dolatsinh Zala MD [dd], Tenzin Zompa MD [ee], Purva Mathur MD [ff], Suhas Nirkhiwale MD [gg], Sonali Vadi MD [hh], Sanjeev Singh MD [ii], Manoj Agarwal MD [ij], Nagamani Sen MD [kk], Anil Karlekar MD [ll], D.P. Punia MD [mm], Suresh Kumar MD [nn],

Major Article

Safety and utilization of peripherally inserted central catheters versus midline catheters at a large academic medical center

Tianyuan Xu MPH [a], Lawrence Kingsley DrPH [a], Susan DiNucci RN, CIC [b], Gwen Messer MT [b], Jong-Hyeon Jeong PhD [c,d], Brian Morgan RN [e], Kathleen Shutt MS [f], Mohamed H. Yassin MD, PhD, CIC [b,f,*]

About the Survey: Al

preventionist members O

responses from 1,083 infe

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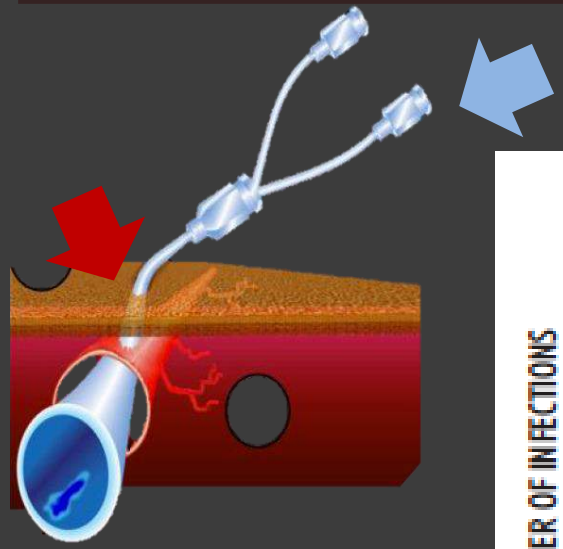
Healthcare-Associated Infections

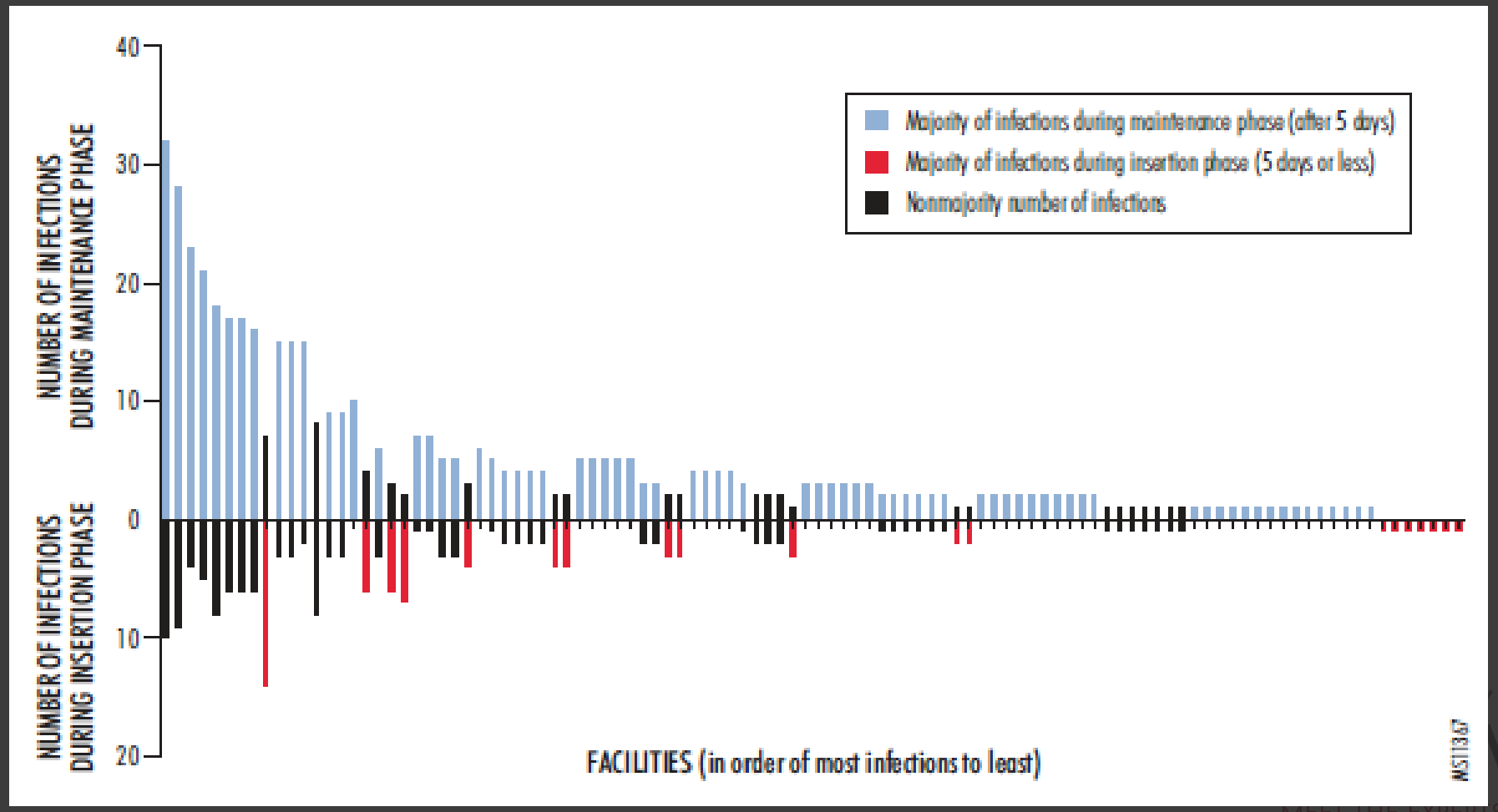
Which types of healthcare-associated infections have increased since the pandemic started?

- CLABSI: **27.8%**
- CAUTI: **21.4%**
- VAPS or VAEs: **17.6%**
- SSIs: **8.0%**
- MDROs: **5.4%**

Central-Line-Associated Bloodstream Infection: Comprehensive, Data-Driven Prevention

James Davis, MSN, RN, CCRN, CIC
Senior Infection Prevention Analyst
Pennsylvania Patient Safety Authority





Davis J. Penna Patient Safety Advisory. 2011;8(3)100-4.

complex, dynamic structures

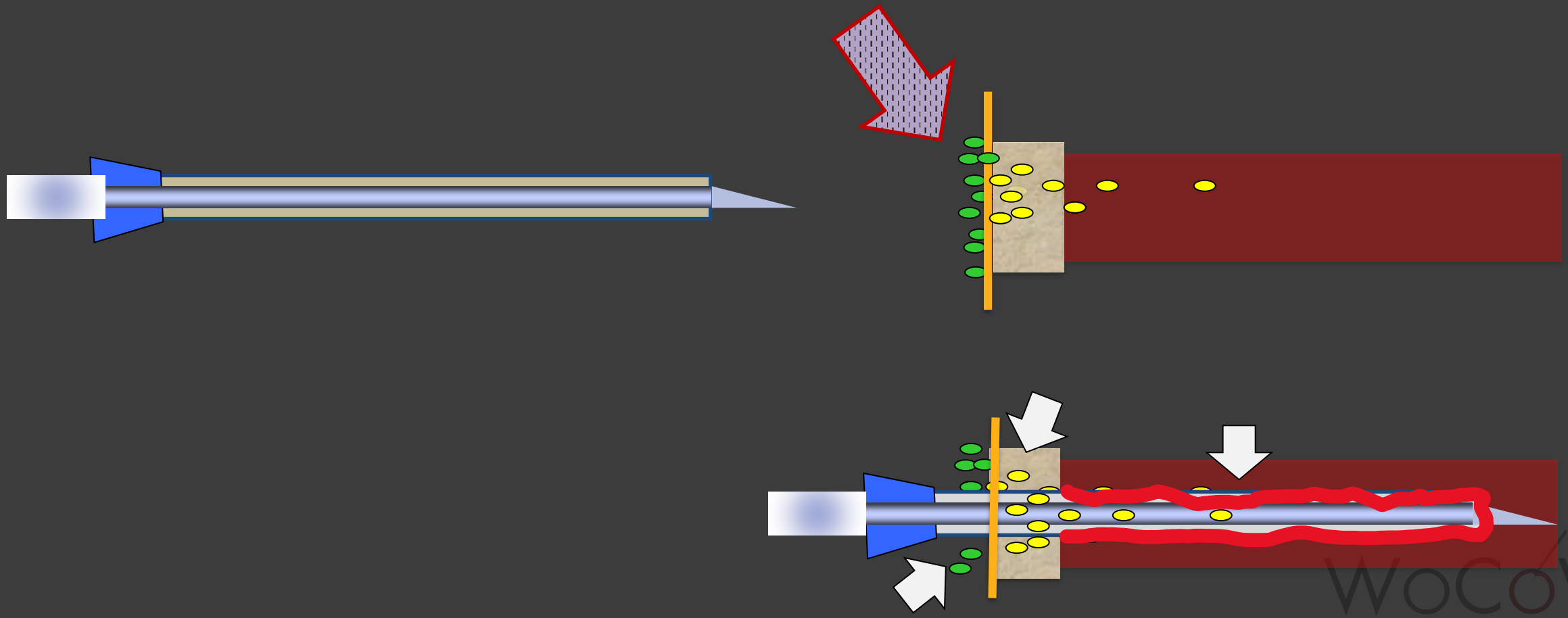
biofilm cells are profoundly different:

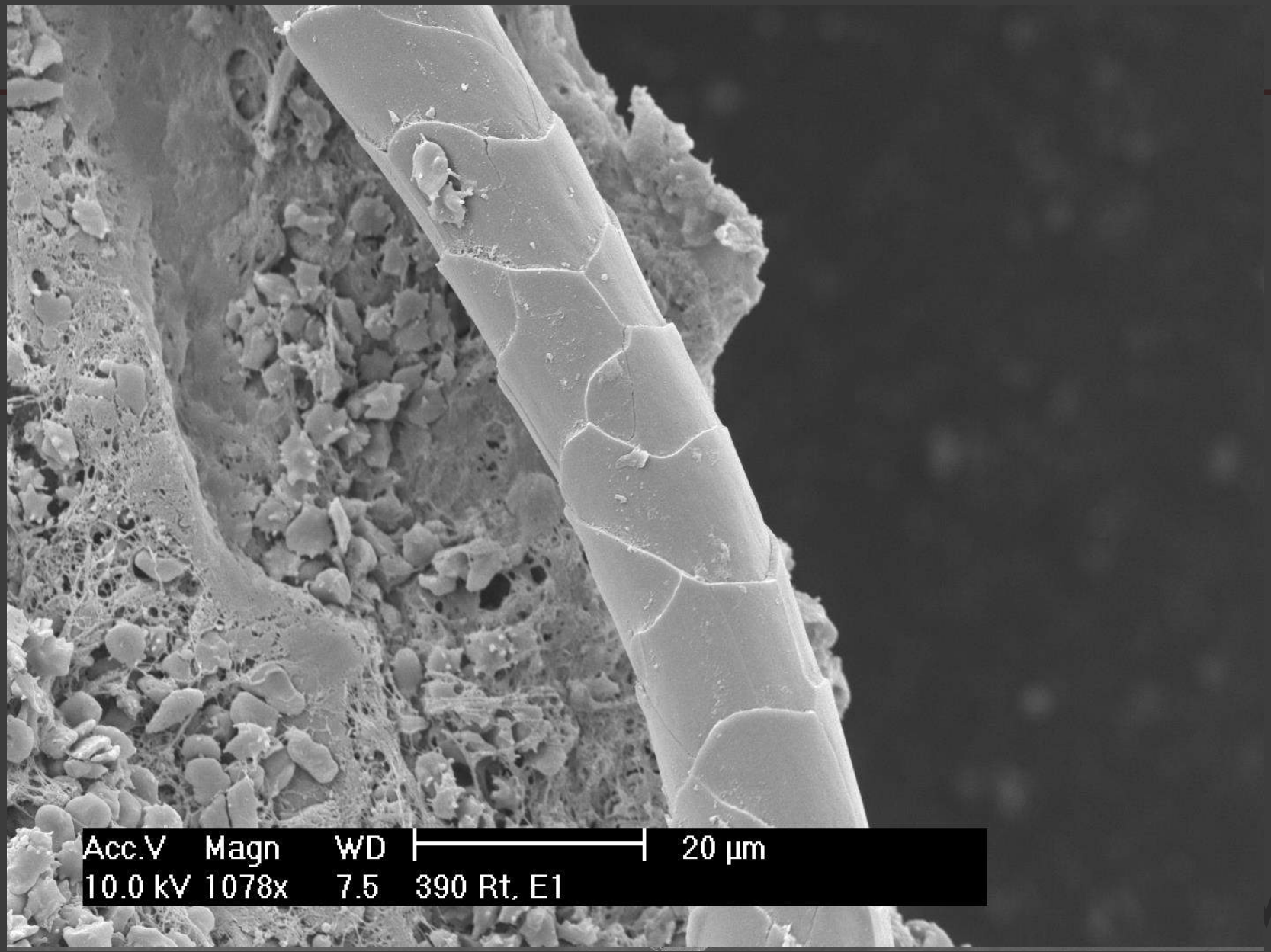
- resistant to host defenses
- resistance to antibiotics, antiseptics
- rapidly increase antimicrobial resistance within the biofilm
- dead cells release endotoxin within the matrix
- strongly adherent to the surface
- release large numbers of cells
- most not culturable by standard culture methods

…..it's all about biofilm

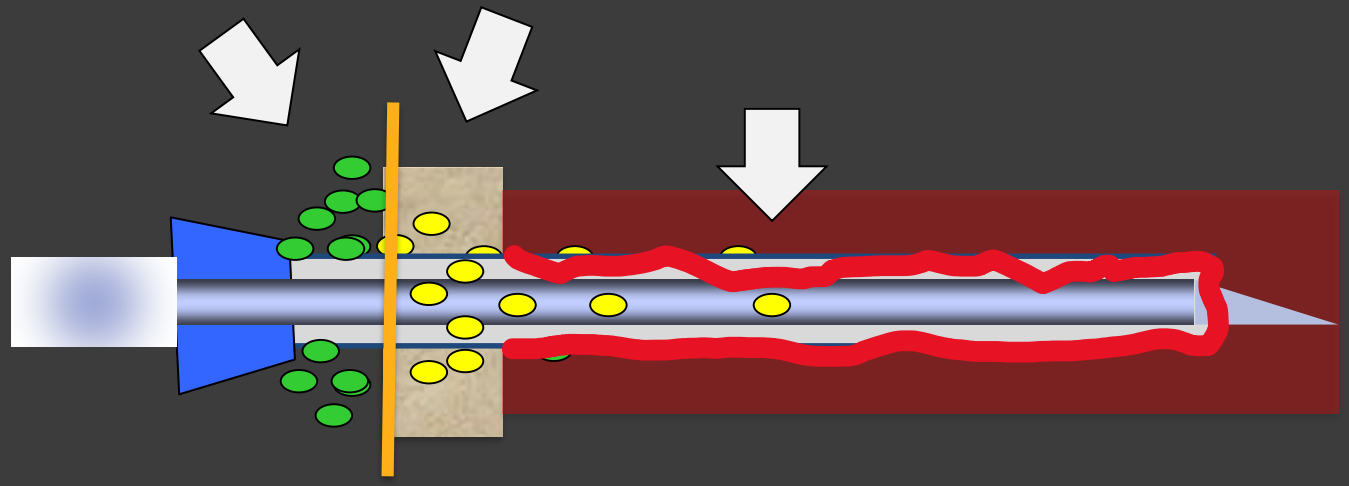
the science of bacterial transfer: extraluminal

how do the microorganisms get there?





the science of bacterial transfer: extraluminal



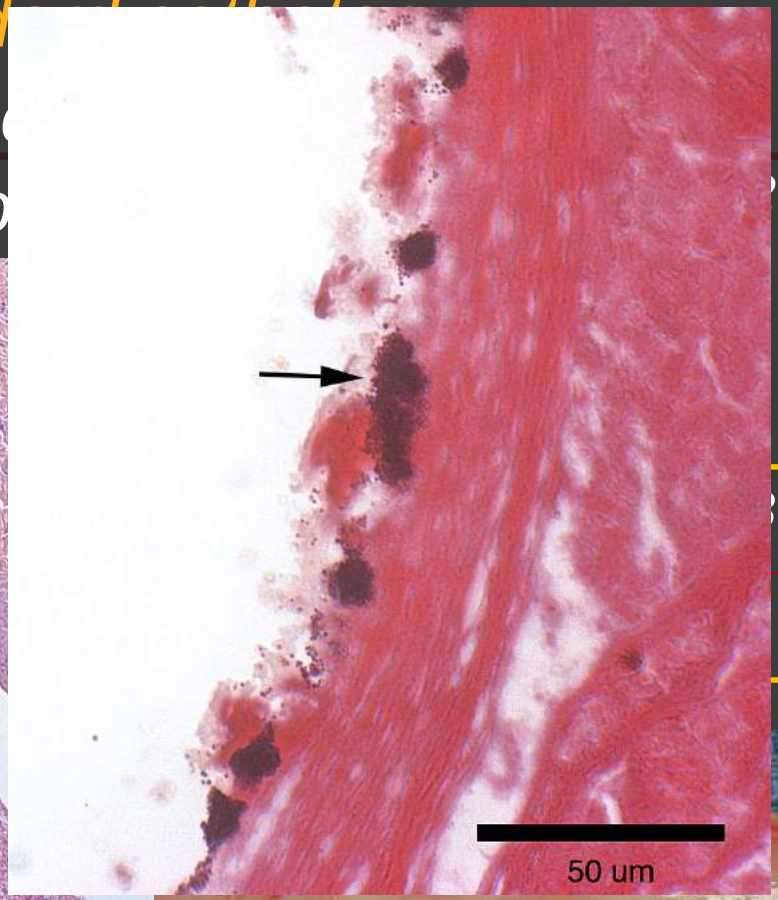
what do they do when they get there?

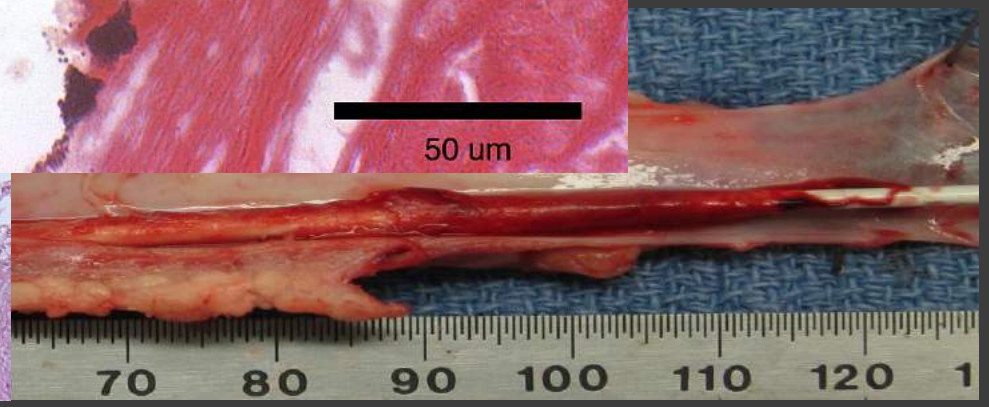
antimicrobial catheter vs stand

- *skin antisepsis: soap th*
- *skin inoculated Staphylo*

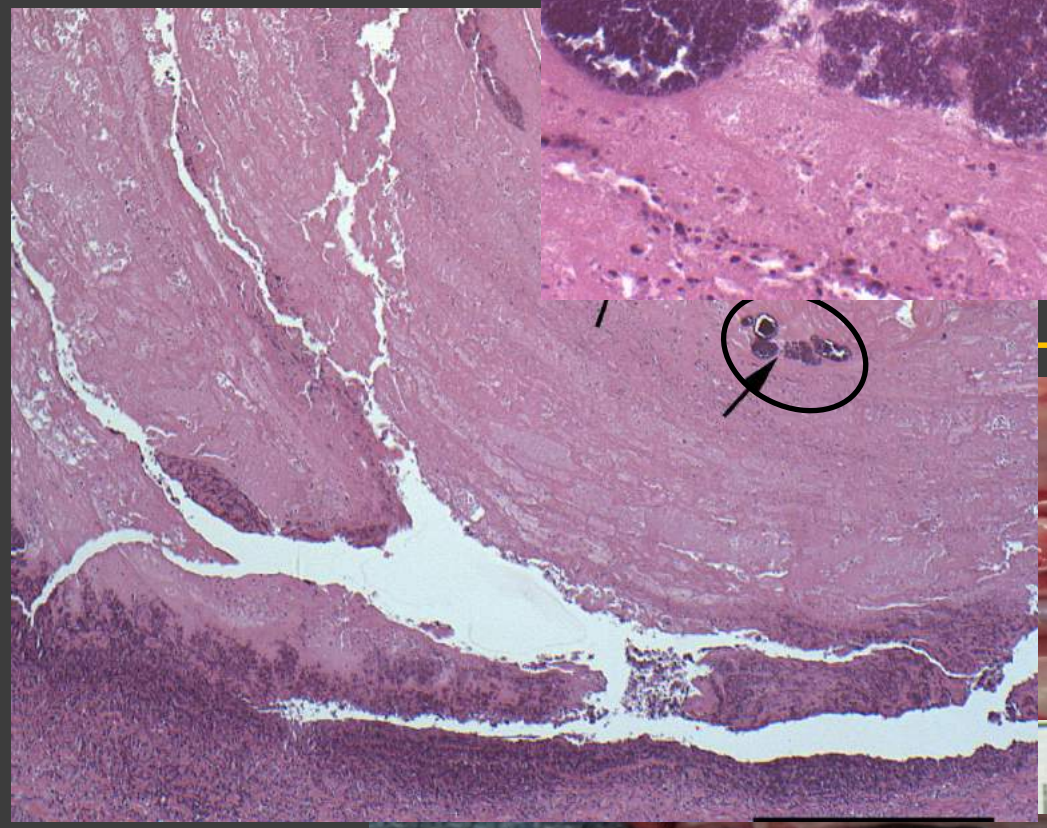
C	*terminal day*
	5

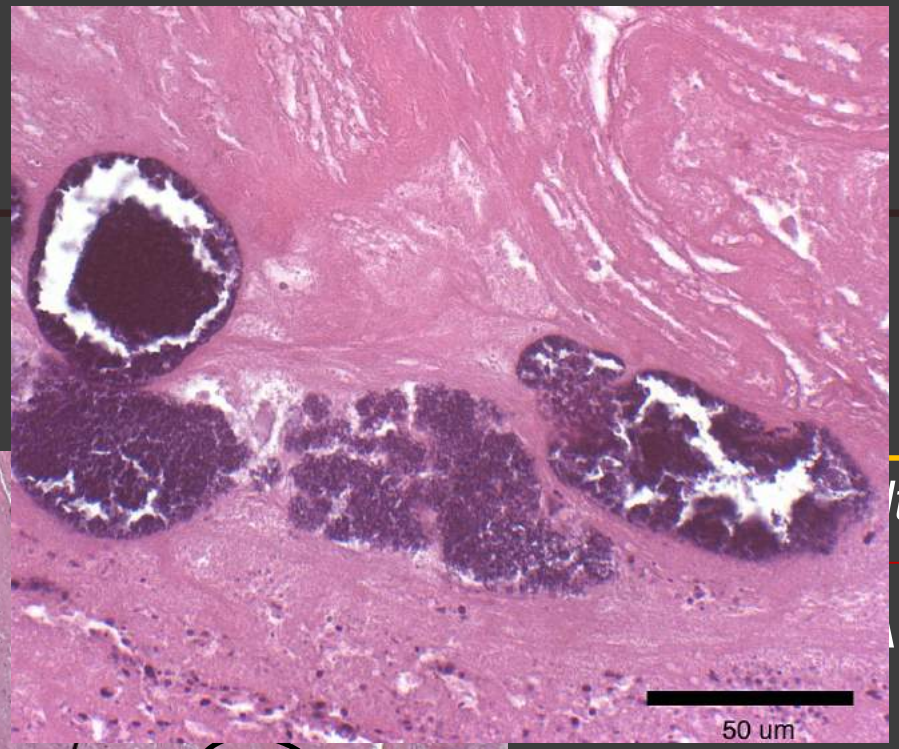
fibrinous lining of subcutaneous tract

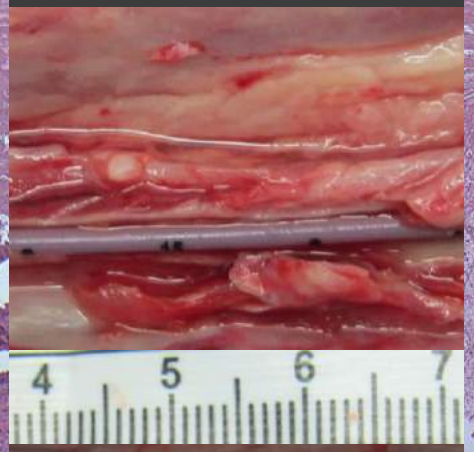




control catheter





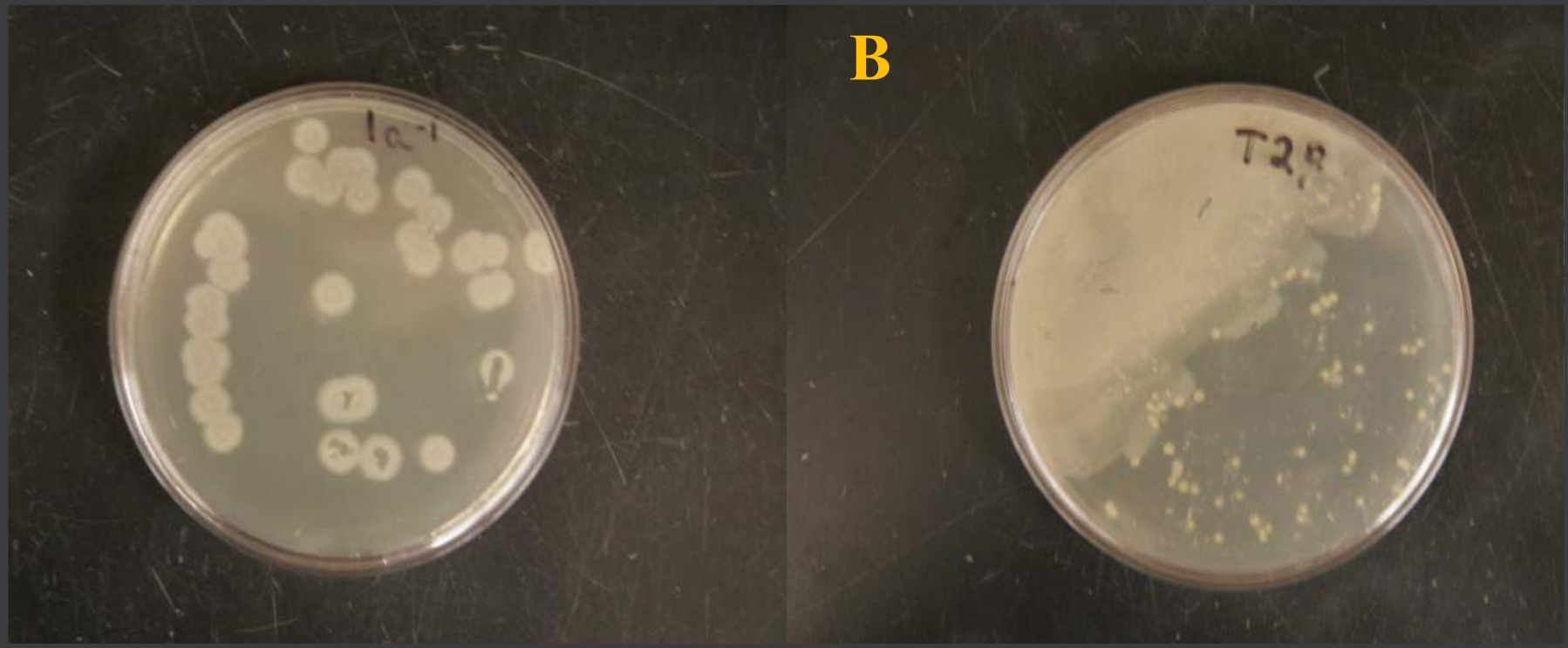


fibrin sheath at venous Insertion site

control catheter

vein wall at catheter tip

week 1	week 2	week 3	week 4	terminal culture	terminal BC	terminal day
SA 2+	SA 2+	SA +2 bacillus sp	SA +2	SA 3+	NG	33



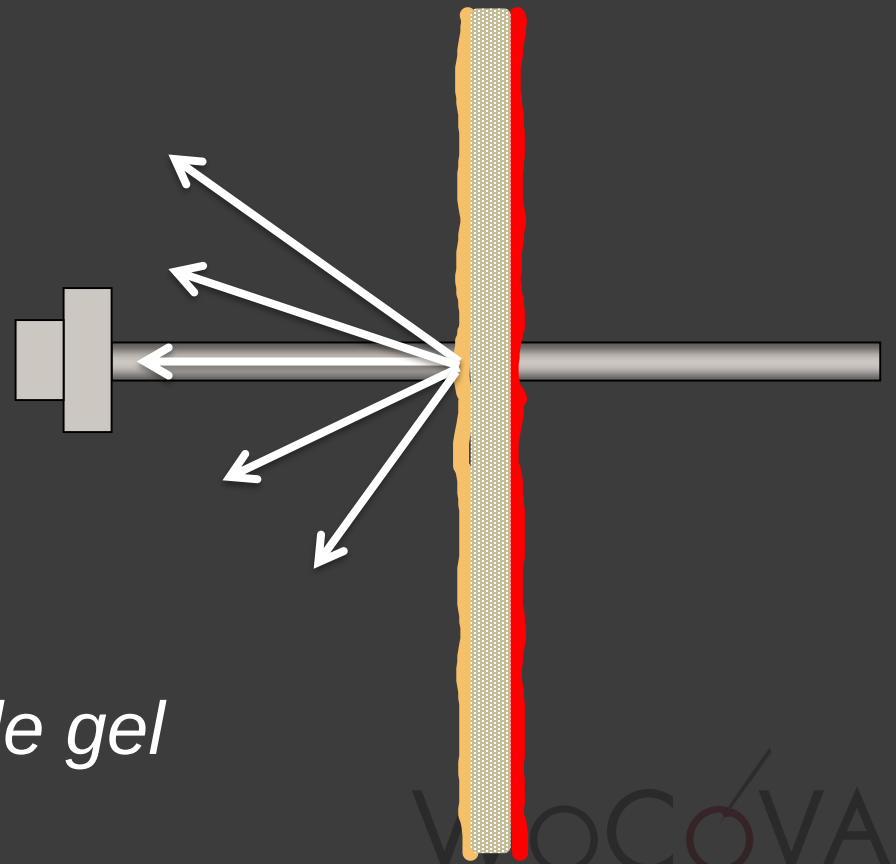
proximal catheter section
mixed species

fibrin sheath
SA and bacillus

ALL VADs!!!!

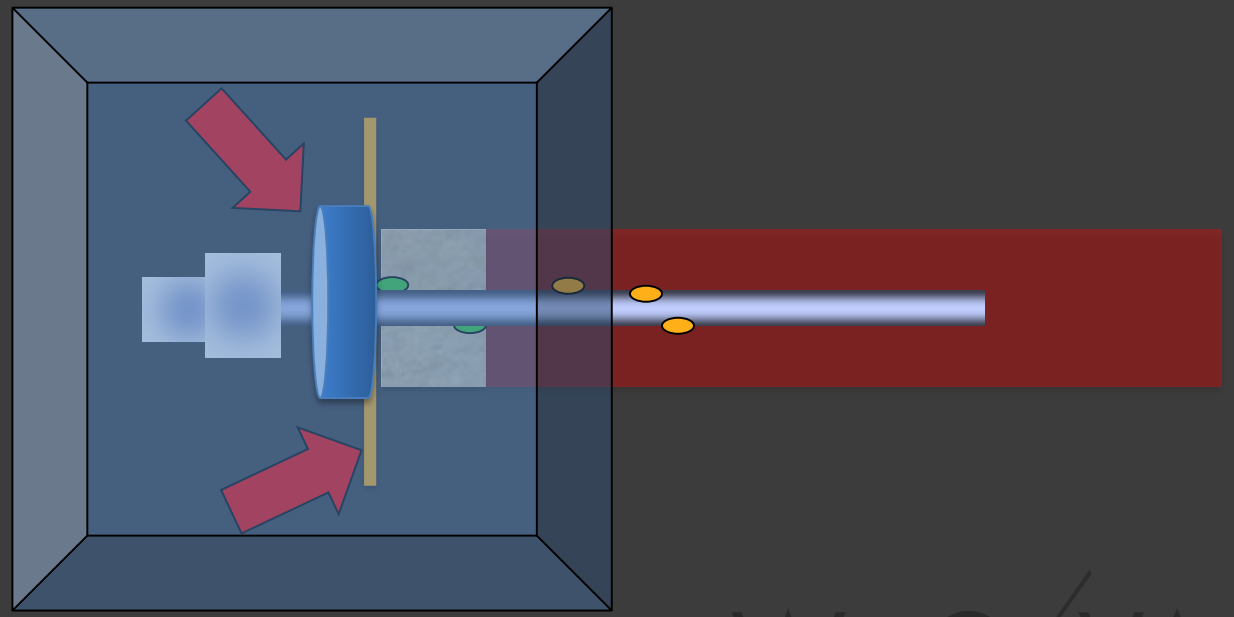
prevention of extraluminal bacterial transfer: insertion

- *pre-procedure skin cleansing*
- *pre-procedure skin antisepsis*
- *aseptic insertion procedure S-ANTT*
- *US disinfection, sterile probe cover, sterile gel*



prevention of extraluminal bacterial transfer: post-insertion

- *evaluate necessity / removal*
- *standard ANTT*
- *repeated insertion site antisepsis*
- *continuous antimicrobial protection*
- *catheter stabilization*
- *adhesive remover / liquid adhesive*
- *transparent dressing*
- *CHG bathing*
- *site monitoring/intact dressing*



….the science of bacterial transfer: intraluminal

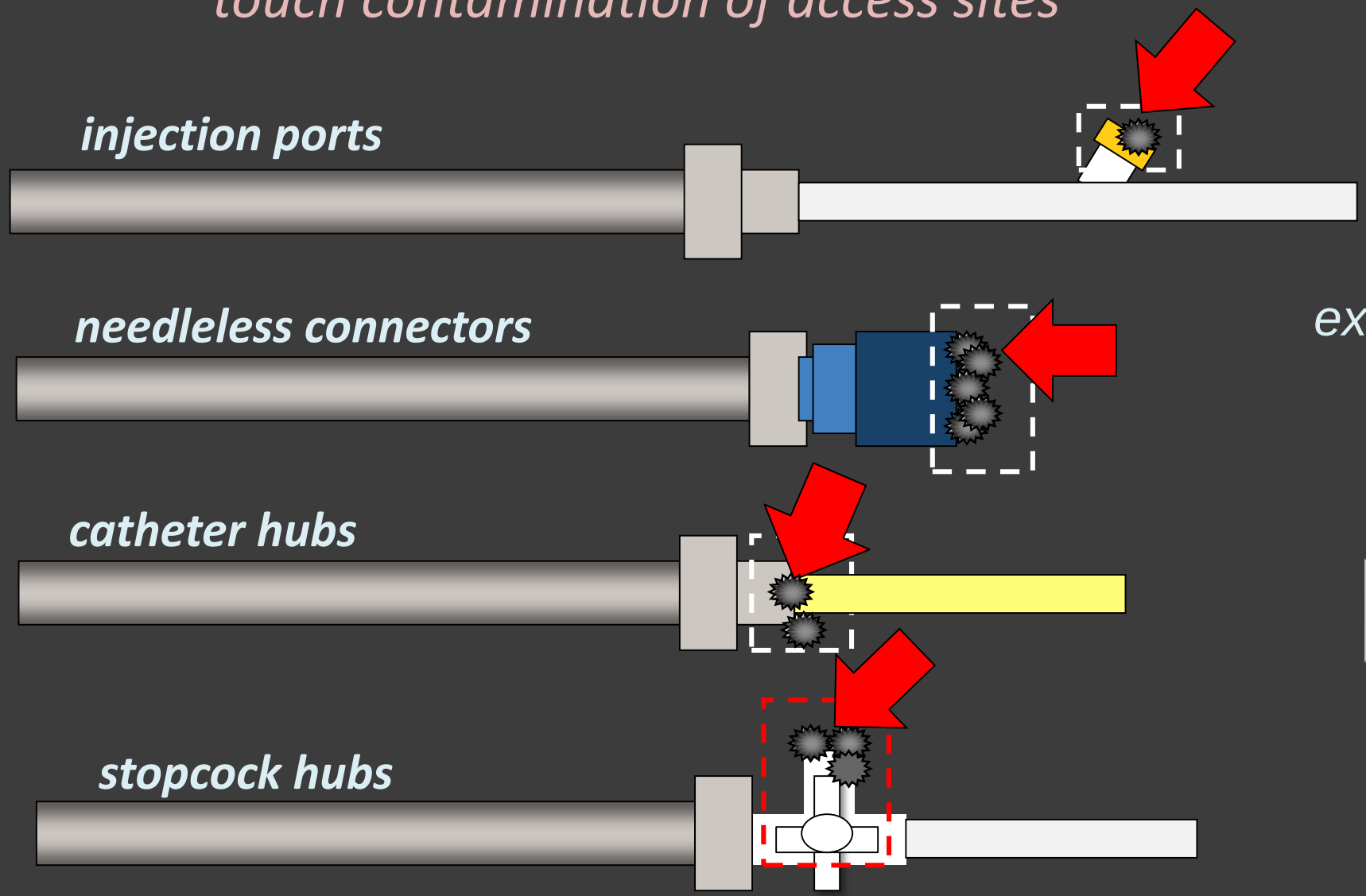
touch contamination of access sites

injection ports

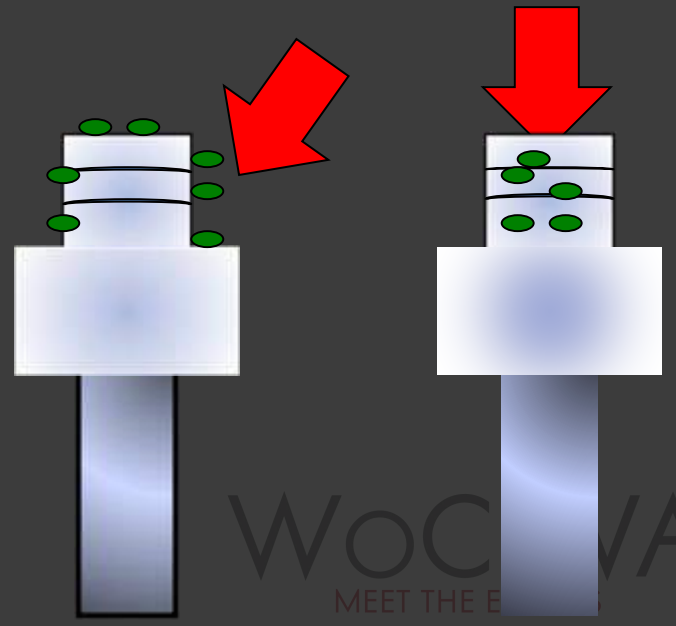
needleless connectors

catheter hubs

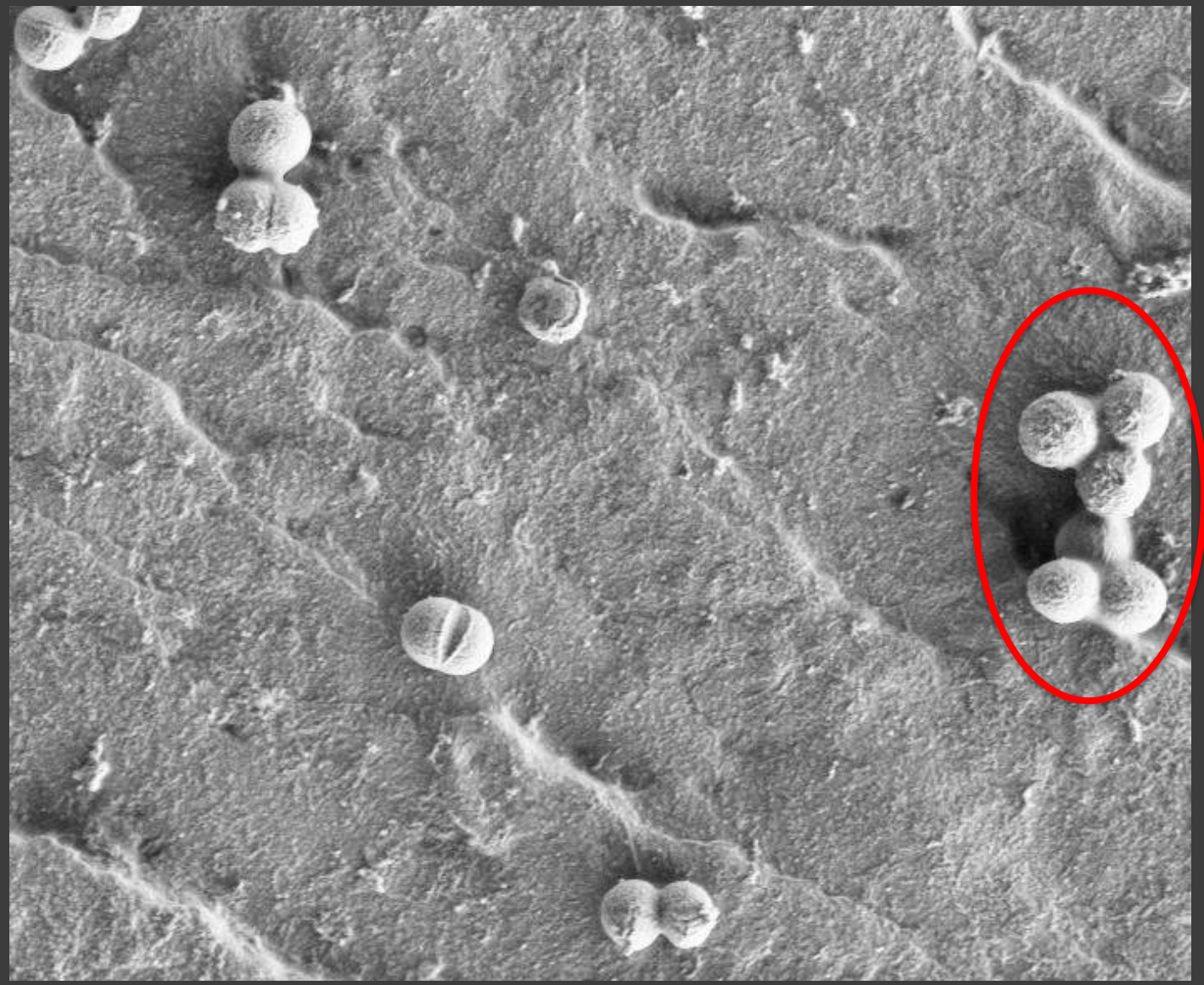
stopcock hubs

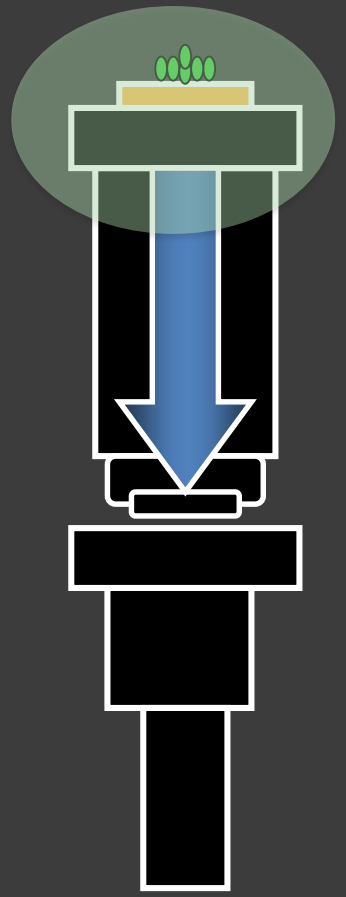


external / internal surfaces



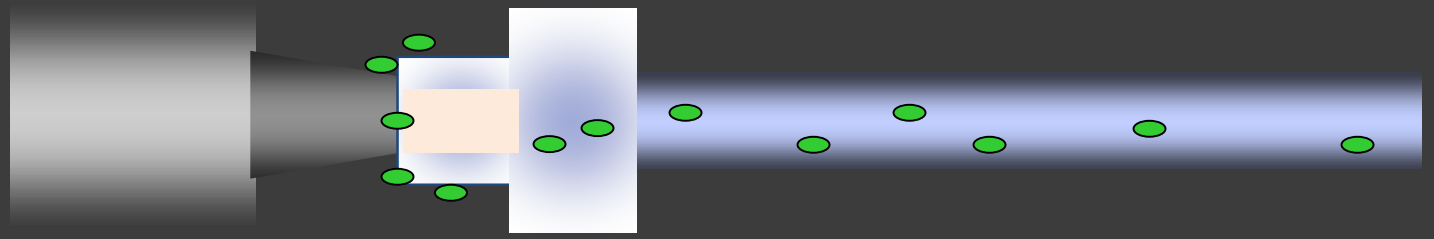
what do they do when they get there?



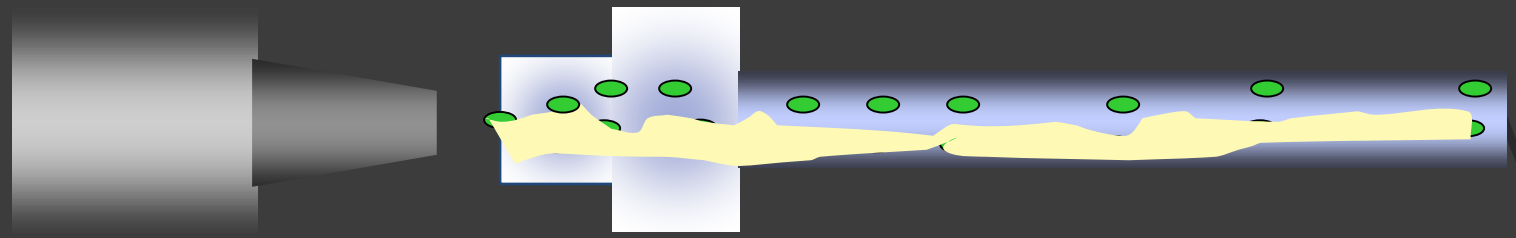


….the science of bacterial transfer: intraluminal

bacteria are flushed into the catheter from an access site or hub



biofilm bacteria are flushed into the bloodstream as planktonic cells or biofilm clumps



MICROSCOPIC EVALUATION OF MICROBIAL COLONIZATION ON NEEDLELESS CONNECTORS

MARCIA RYDER, PhD; CHRISTOPH SCHAUDINN, MSc; AMITA GORUR MSc; JOHN W. COSTERTON PhD
USC | CENTER FOR MEDICAL BIOFILM RESEARCH

Fig. 1a) The scanning electron microscopy images shows the rim (arrow 1) and a small part of the access port (arrow 2) of a connector that has been used on a intensive care patient.

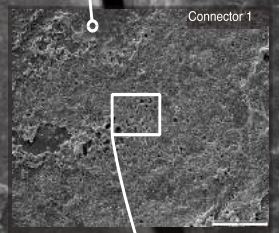


Fig. 1b) Higher magnifications reveal that large aereas of the rim are covered with a dense biofilm.

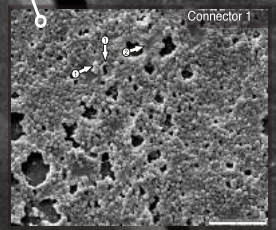


Fig. 1c) The biofilm consists of a monolayer of cocci of varying sizes (arrows 1), which are embedded in a dense exopolymeric matrix (arrow 2).

ISSUE: The use of needleless connectors has been documented as a risk factor for catheter-related bloodstream infection (CRBSI). In vitro study has demonstrated that there is a significant difference among the connectors in their capacity to transfer bacteria through the connector. Prevention strategies to minimize bacterial transfer include access site disinfection and routine connector exchange. Methods for disinfection and appropriate time intervals for replacement have not been well-studied, thus current guidelines for these procedures are non-specific. The purpose of this project was to evaluate the presence and distribution of microorganisms on the connector external access surface and the internal flow path after use in the clinical setting.

PROJECT: Four needleless connectors were collected from patients in a medical intensive care unit following routine exchange; one from a subclavian triple-lumen catheter, one from a femoral central venous catheter (CVC) and two from a radial arterial catheter. The connectors were immediately preserved in ethanol for microscopic evaluation. All sample connectors were engineered with a silicone split septum and an internal collapsible silicone mechanical valve. The external access surface and the internal flow path of each connector were examined with Scanning Electron Microscopy (SEM) by standard methods and Confocal Laser Scanning Microscopy (CLSM) after application of a DNA stain.

RESULTS: Microorganisms on the external surface observed by SEM were prevalent both on the plastic rim of the device as well as on the silicone septum. Multiple microbial species were observed, some as single cells attached to the surface but predominately in biofilms where the organisms are embedded in extracellular polymeric substance(s) (EPS).

On some, the split septum was observed to have areas of separation leaving large gaps open to the flow path. The internal silicone surface of the flow path revealed microorganisms of mixed species in copious amounts of EPS. The biofilms were observed covering all areas of the surface in various stages of development from attachment phase to well established biofilms. SEM findings suggestive of the presence of microorganisms within biofilm were confirmed by CLSM.

LESSONS LEARNED: Microbial colonization of predominantly dry and abiotic external surfaces of medical devices is perceived as transient non-attached single microbial cells readily removed by brief antiseptic exposure and wiping. Because needleless connectors are "closed systems" they are perceived as protective against microbial entry. Microscopic examinations of the sampled connectors confirm the presence of extensive multispecies biofilms on both the external access surface and the internal flow path. Deterioration and loss of the approximation of the split septum may allow for microbial entry during and after infusion. This work establishes that microorganisms exist on abiotic surfaces in the absence of sustained moisture as well as in the fluid environment of the flow path. Transfer of microorganisms as single cells or biofilm fragments through the connector allows for biofilm colonization on the internal lumen of the catheter and potential bacteremia. Disinfection of the access portal prior to use is crucial. Biofilms are tenaciously attached to surfaces, are not easily removed, and require high-level disinfection for complete kill. Adequate disinfection will require the use of disinfectants capable of biofilm eradication as well as sufficient mechanical friction to remove surface biofilm.

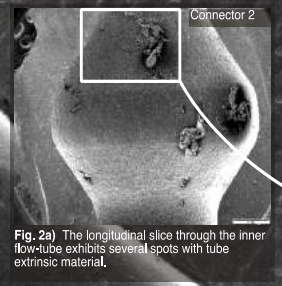


Fig. 2a) The longitudinal slice through the inner flow-tube exhibits several spots with tube extrinsic material.

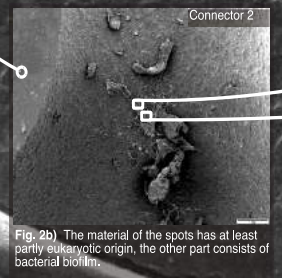


Fig. 2b) The material of the spots has at least partly eukaryotic origin, the other part consists of bacterial biofilm.

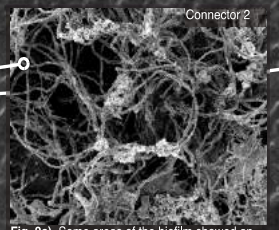


Fig. 2c) Some areas of the biofilm showed an almost mono-species biofilm long filamentous bacteria.

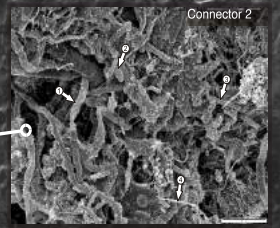


Fig. 2d) Other areas revealed a highly mixed species biofilm with many hyphae (arrow 1), short rods (arrow 2), big spiral rods (arrow 3) and fine,long, flexible rods (arrow 4).

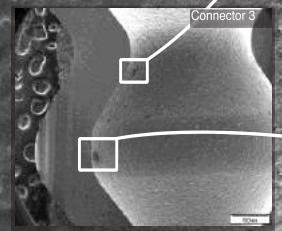


Fig. 3a) A similar picture was found on the sliced inner flow-tube from another connector; small spots which showed bacterial growth.

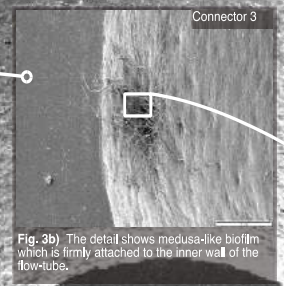


Fig. 3b) The detail shows medusa-like biofilm which is firmly attached to the inner wall of the flow-tube.

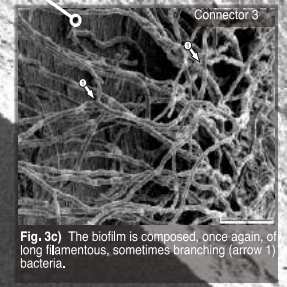


Fig. 3c) The biofilm is composed, once again, of long filamentous, sometimes branching (arrow 1) bacteria.

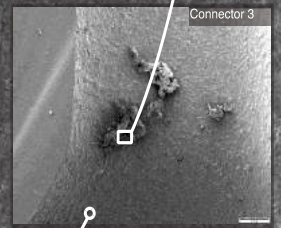


Fig. 3d) The eukaryotic material that adhered to the inner flow-tube wall was often partly or completely covered with biofilm.

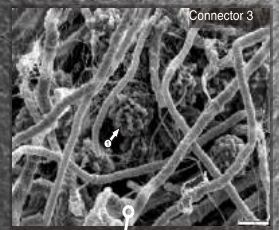
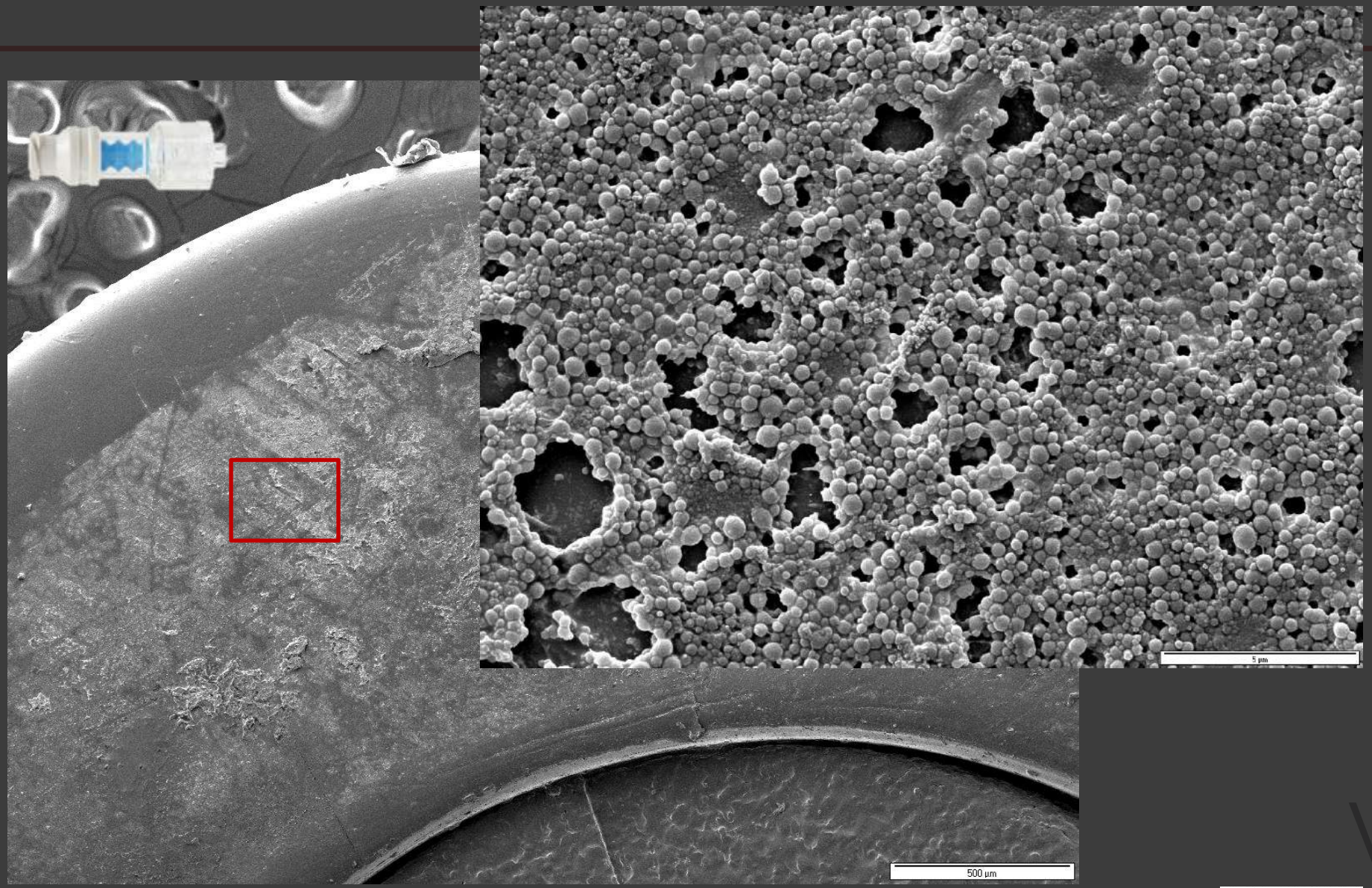
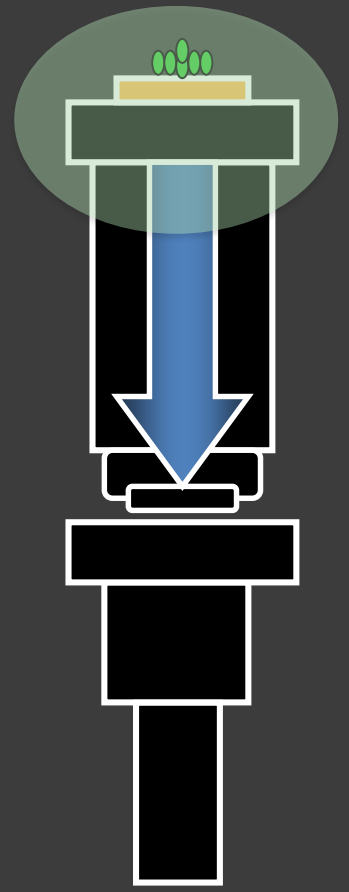
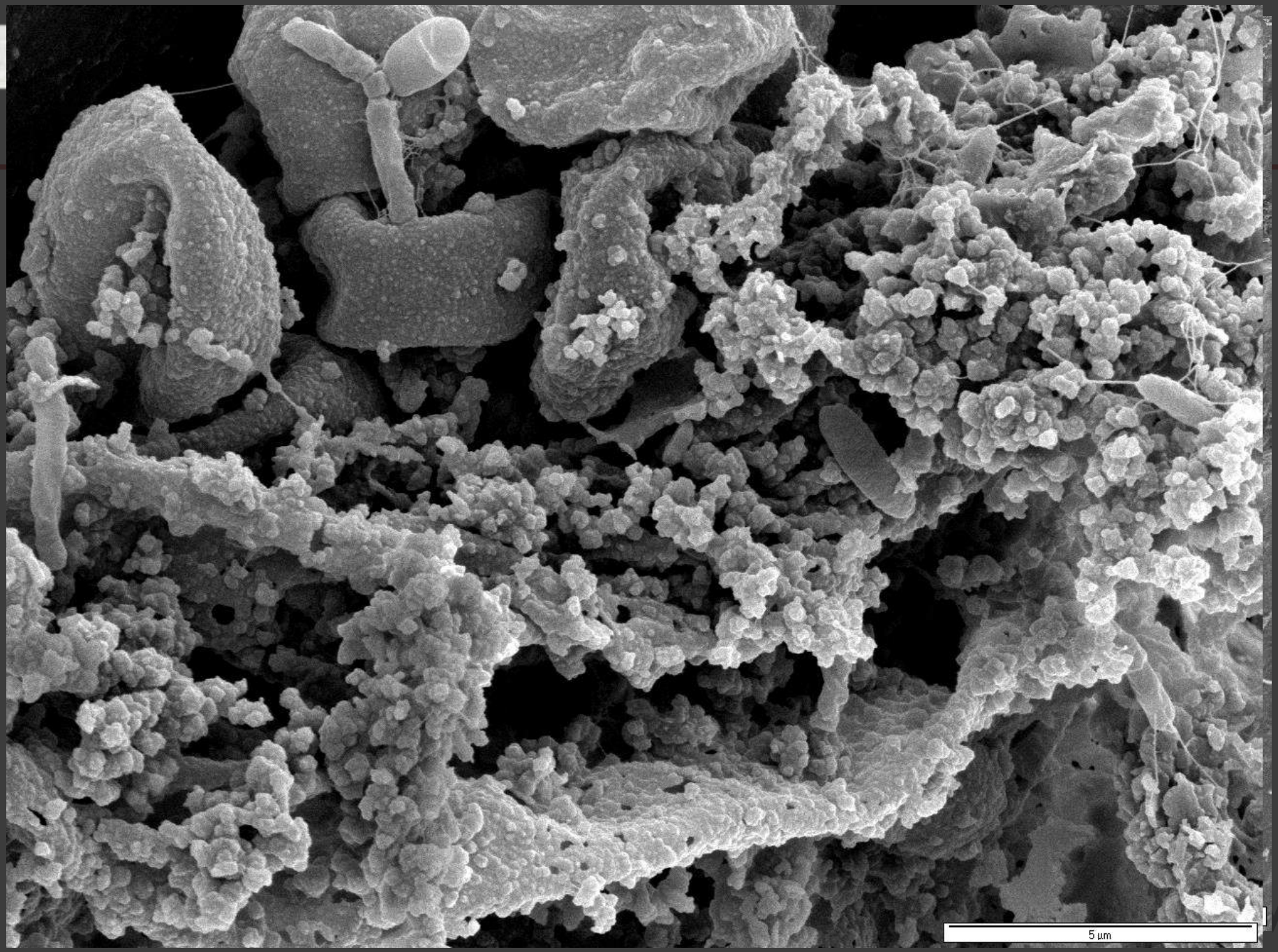


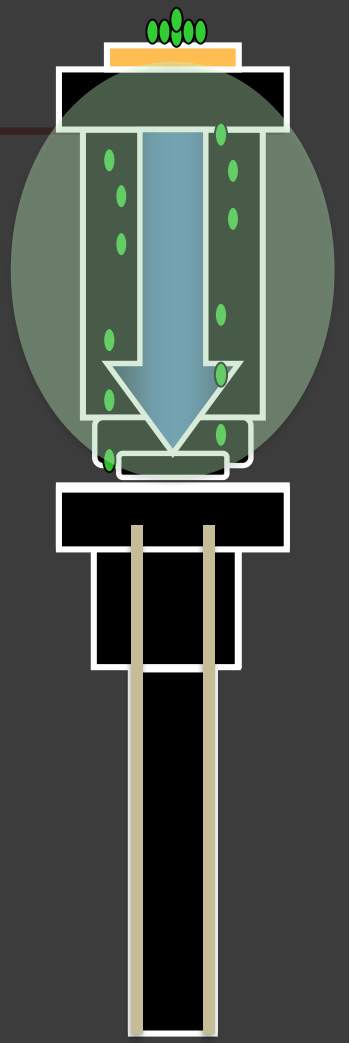
Fig. 3e) Long filamentous are are known from some hyphae- forming Actinomyces species, here together with eukaryotic cells (arrow 1).

needleless connector septum: central venous catheter









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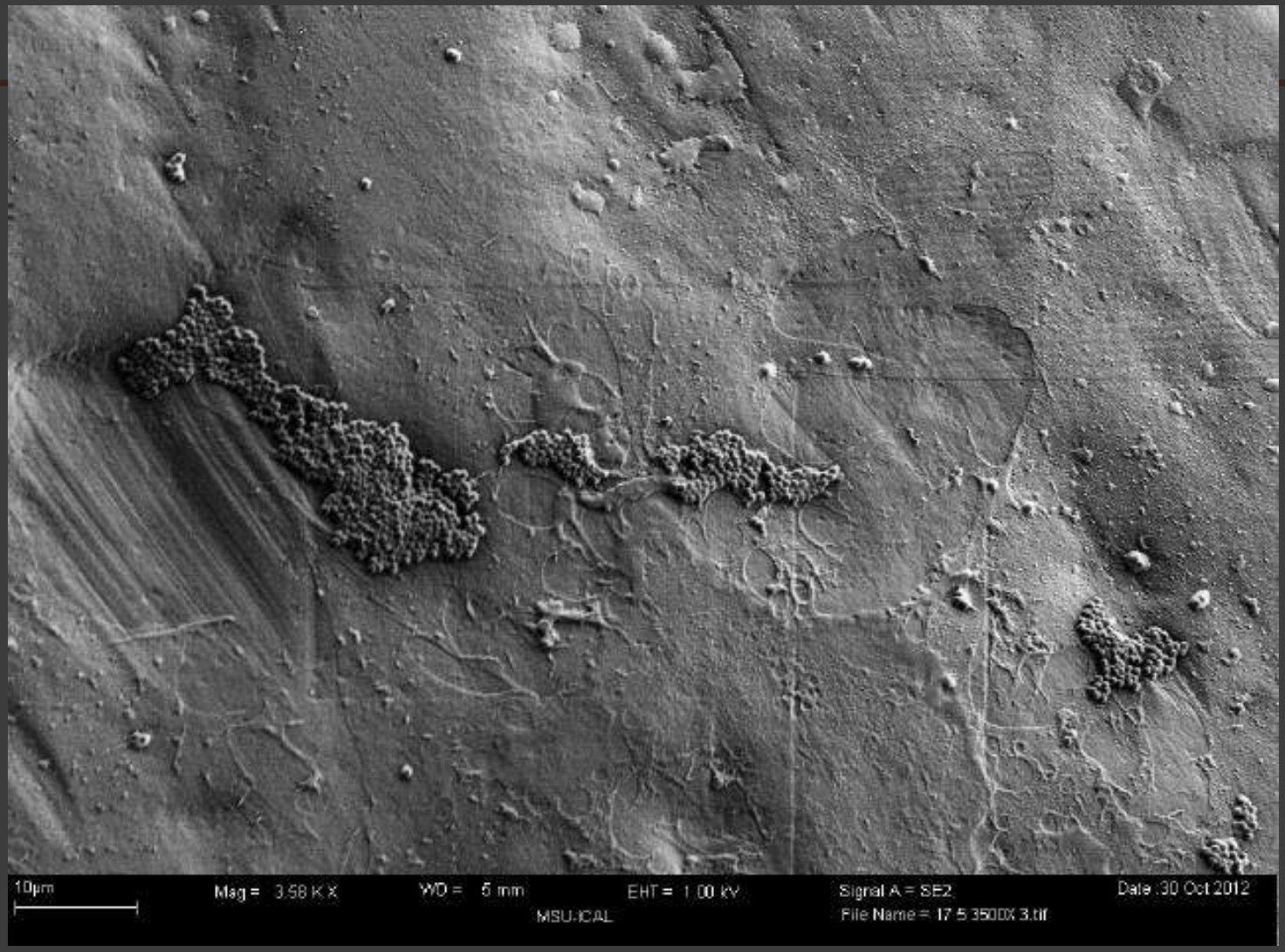
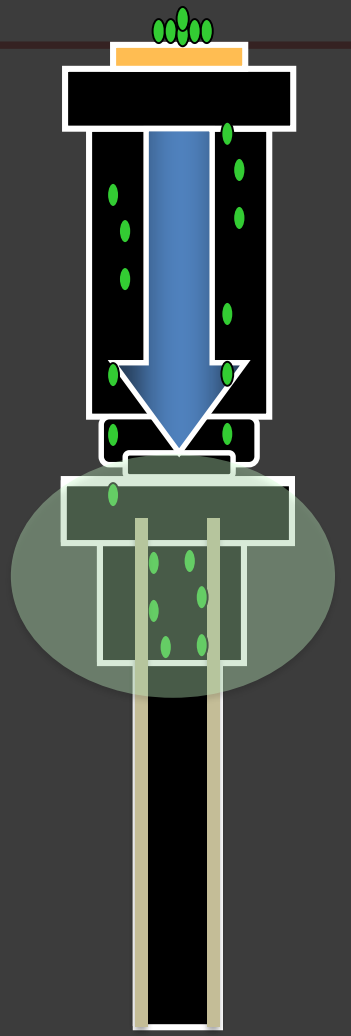
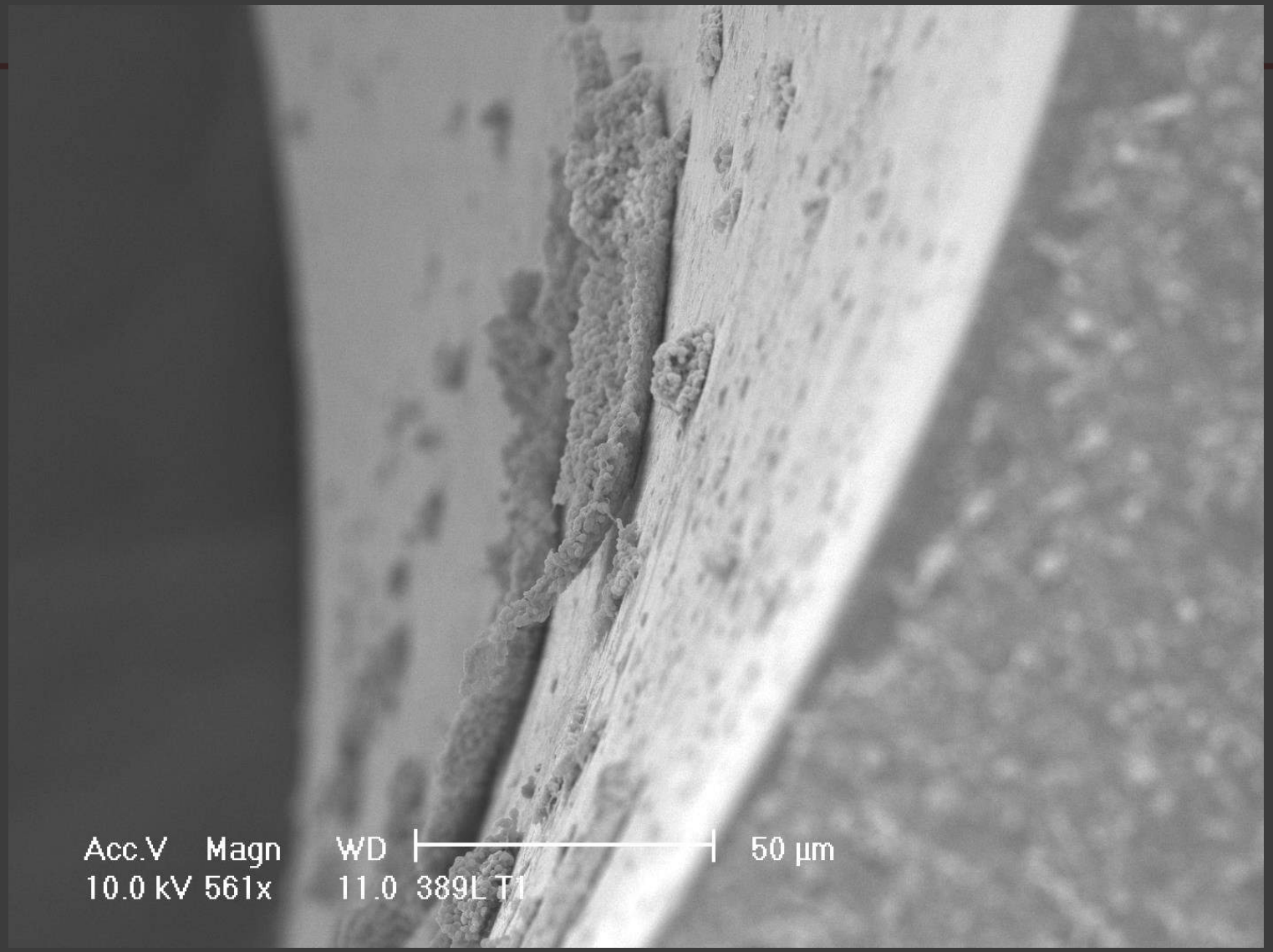
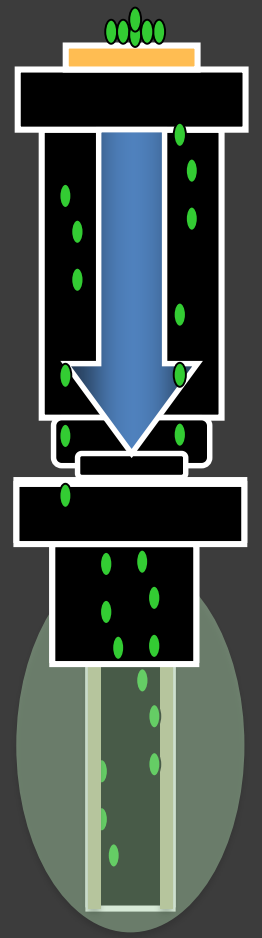




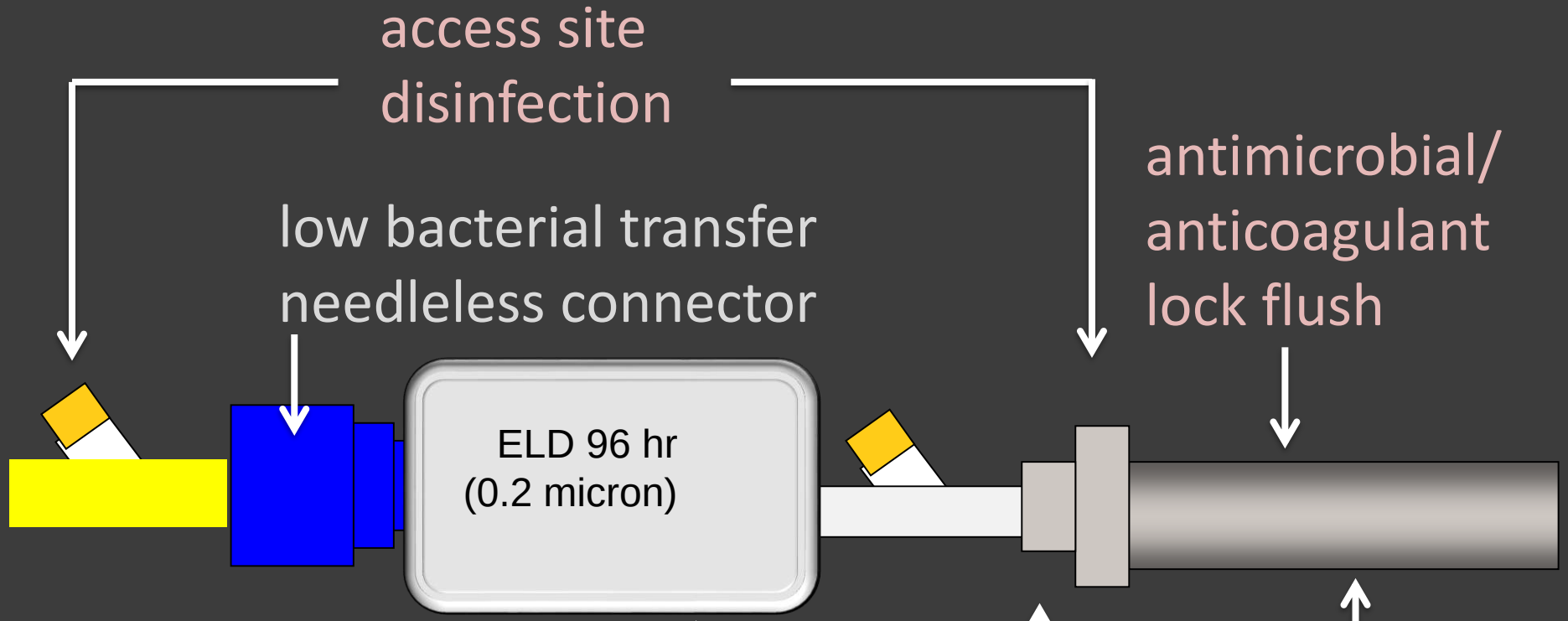
PIV catheter hub



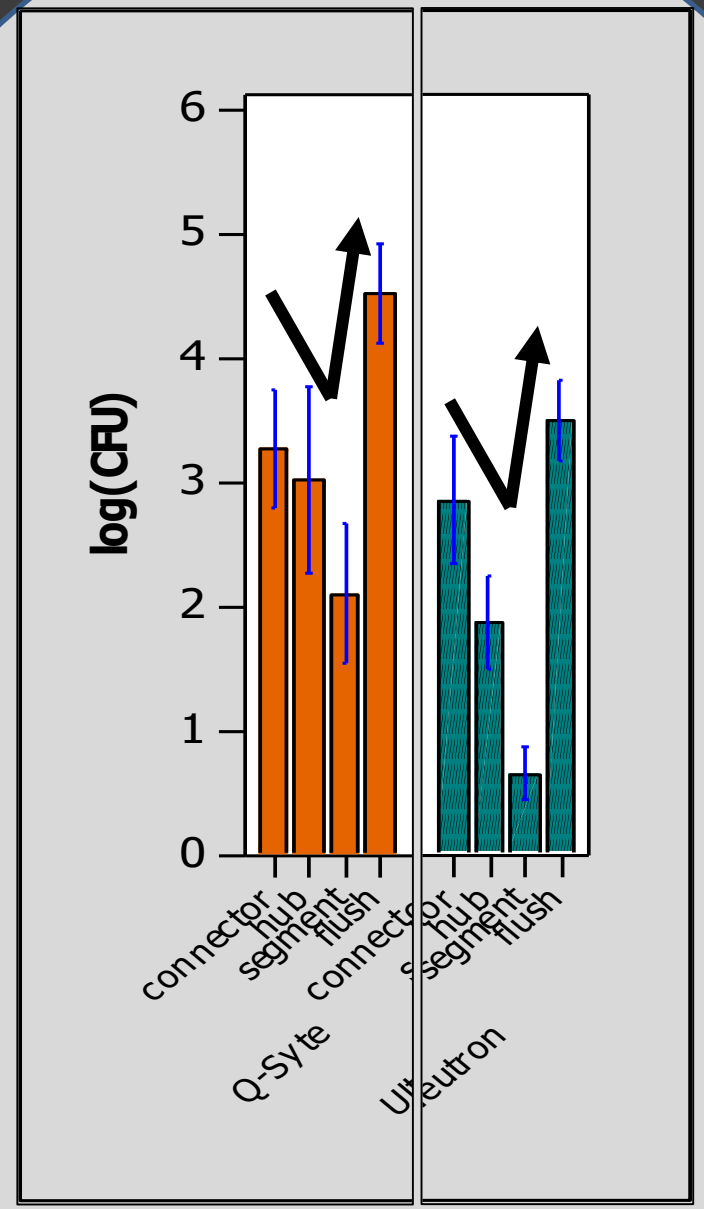


ALL VADs!!!!

protective technologies for prevention of intraluminal bacterial transfer: post insertion



FLUSH		
Connector	**Least Square Mean (log(CFU/Flush))**	**Significant Groups**
Q- Syte	5.37	A
Ultrasite	5.15	A
CLC2000	5.04	A B
MaxPlus	4.66	B C
Lily Neutral	4.46	C D
Invision-Plus	4.45	C D
Clearlink	4.26	C D E
SmartSite	4.26	C D E
Planecta	4.24	C D E
TKO-6P	4.22	D E
MaxZero	4.08	D E F
Caresite	4.00	E F G
One-Link	3.99	E F G
Q2	3.75	G H
Bionector	3.72	F G H I
Kendall	3.55	H I
SafeTouch	3.50	H I J
SafeAccess	3.32	I J
MicroClave	3.20	J
Neutron	3.14	J



protective technologies for prevention of intraluminal bacterial transfer: post insertion

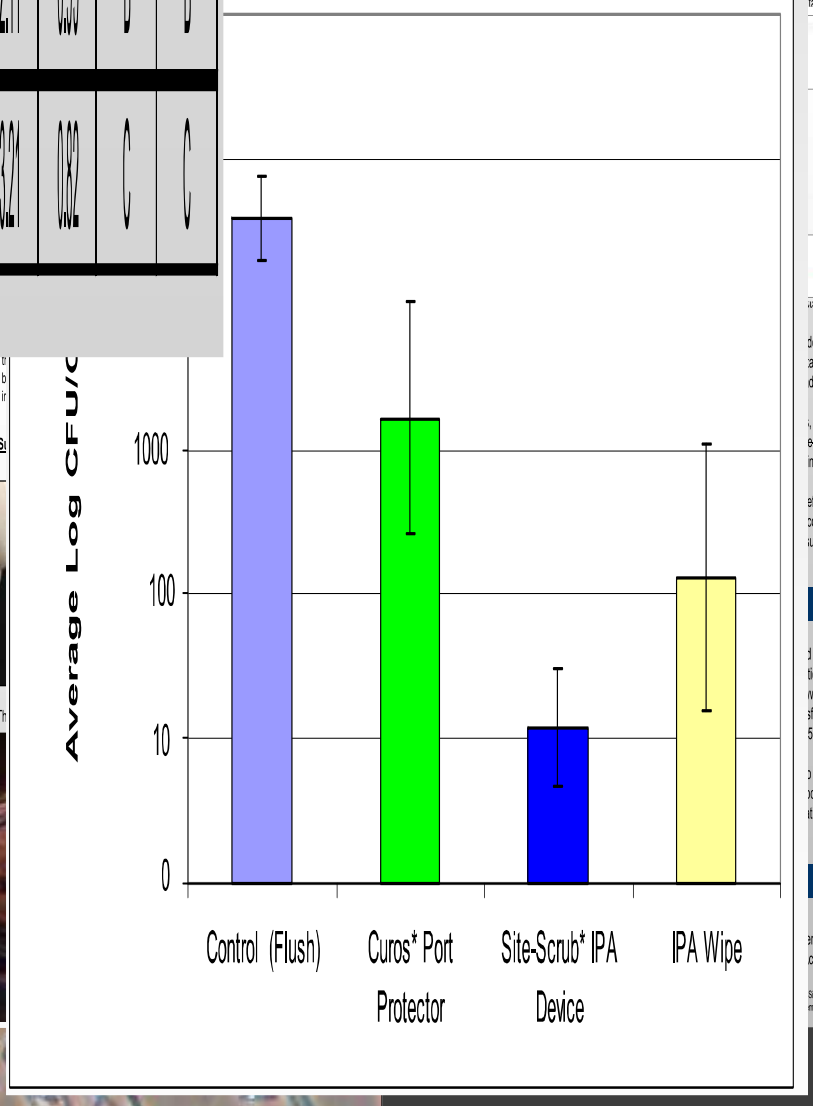
Bacterial Spore Contamination from Connectors using Disinfection Devices

Elinor deLancey Pulcini and Garth A. James
for Biofilm Engineering Montana State University-Bozeman

Poster #944
IDWeek
10/2012

Device	Mean Log Growth	St Dev* Log Growth	Grouping 95% CI	Grouping 99% CI
Site-Scrub® IPA Device	1.07	0.49	A	A
IPA Wipe	2.11	0.99	B	B
Curos® Port Protector	3.21	0.82	C	C

Viable Plate Count Results



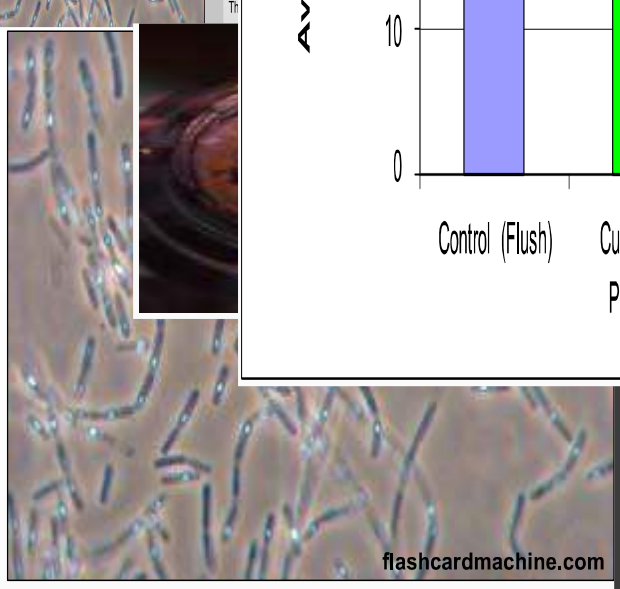


Figure 1. Phase contrast image of *Bacillus cereus* culture. Endospores are shown as small, bright blue ovals within the *B. cereus* cells.

Contents lists available at ScienceDirect

American Journal of Infection Control

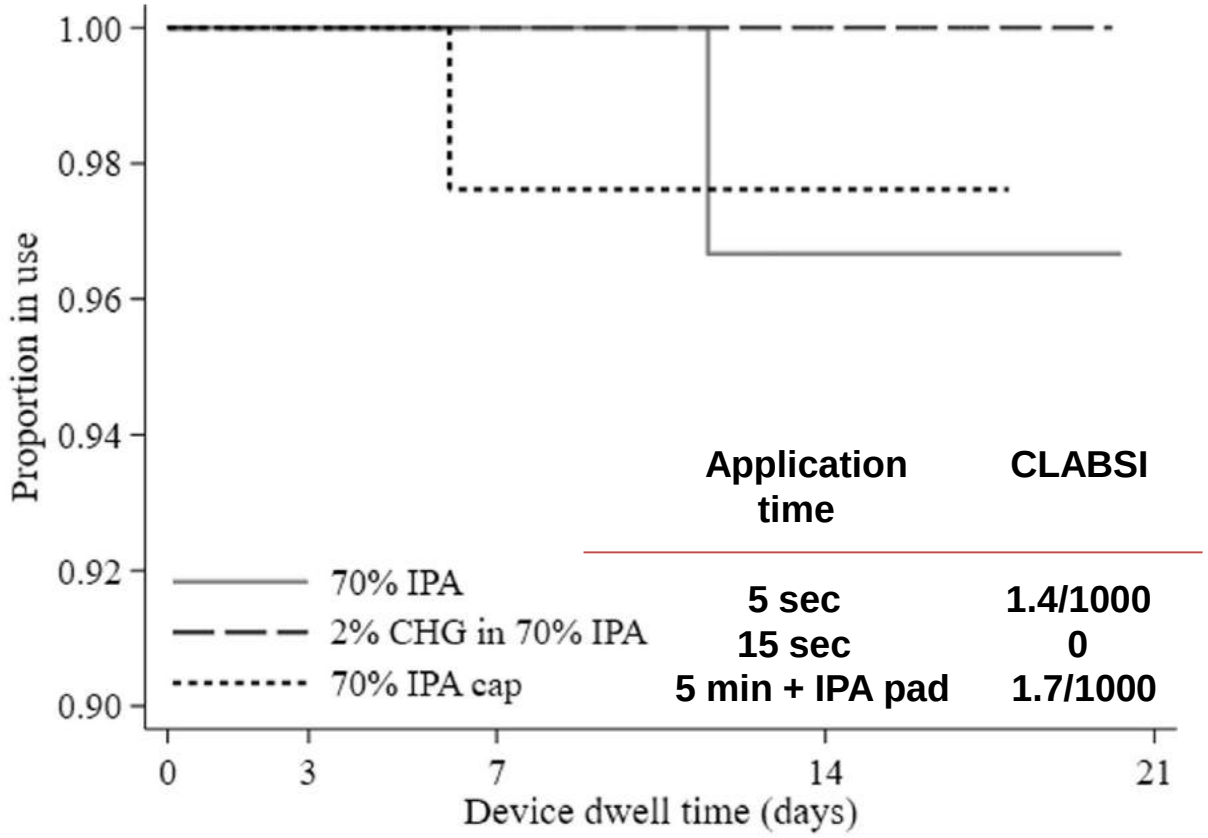
journal homepage: www.aji

Brief Report

Needleless connector decontamination for preve access device infection: A pilot randomized contr

Claire M Rickard PhD [a,b,c,*], Julie Flynn [a,b,c,d], Emily Larsen GDH
E Geoffrey Playford PhD [a,f], Joanie Shaw GCCancerNurs [g], Sama
Amanda Ullman PhD [a,b,c,h], Li Zhang PhD [a,i], Nicole Gavin PhD [a,
Vineet Chopra MD [a,j], Alexandra L. McCarthy PhD [a,k], Patricia K

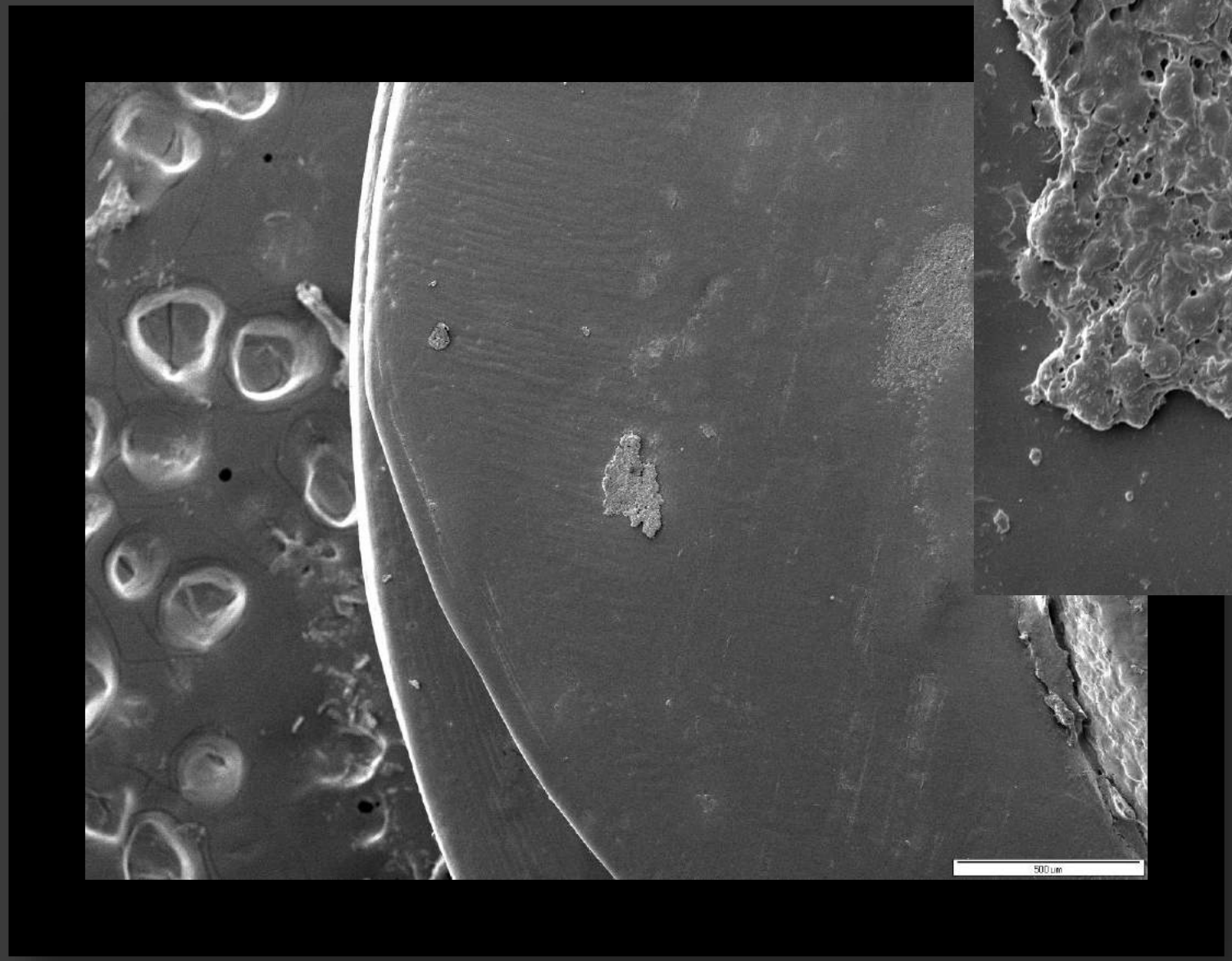
- 2 university hospitals
- adult patients
- PICC or Tunneled CVAD
- > 7 days
- 2 connectors
  - 1 positive displacement
  - 1 negative displacement

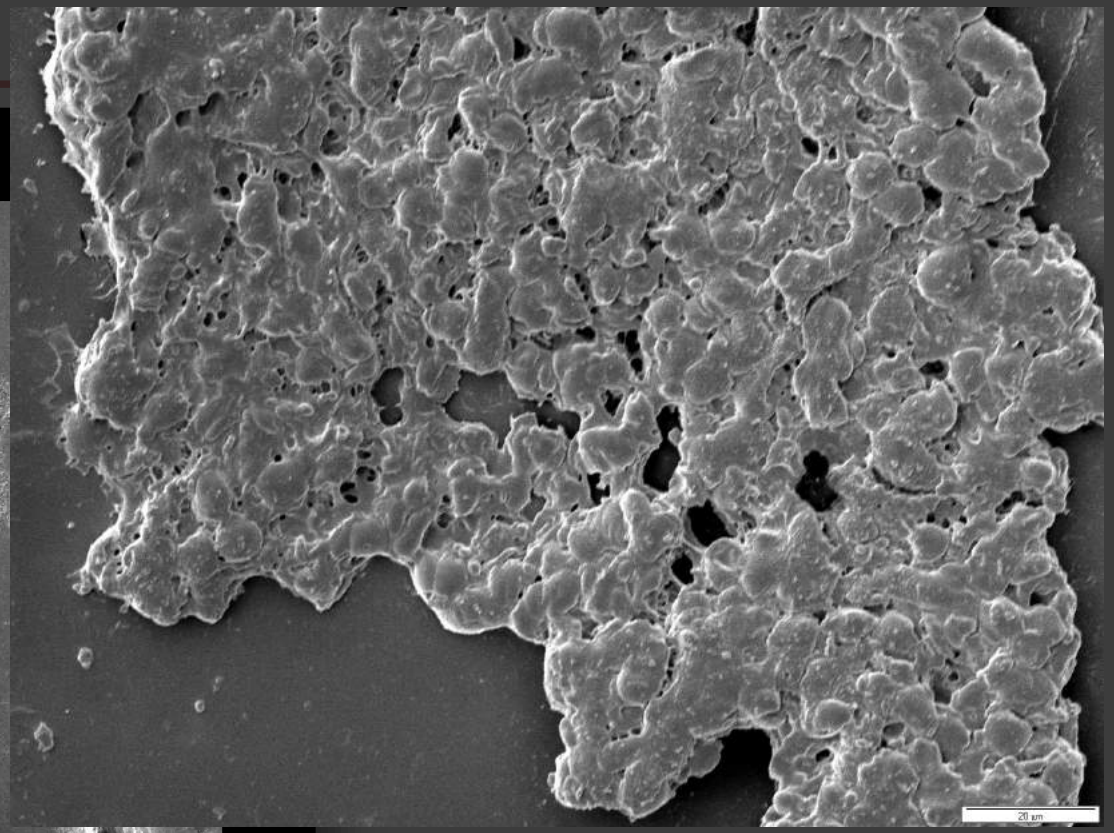


Application time	CLABSI
5 sec	1.4/1000
15 sec	0
5 min + IPA pad	1.7/1000

Fig 2. Kaplan-Meier survival estimates for central line-associated bloodstream infection by study group. *CHG*, chlorhexidine gluconate; *IPA*, isopropyl alcohol.

- *no studies to date have evaluated the eradication of biofilm on needleless connector surfaces*





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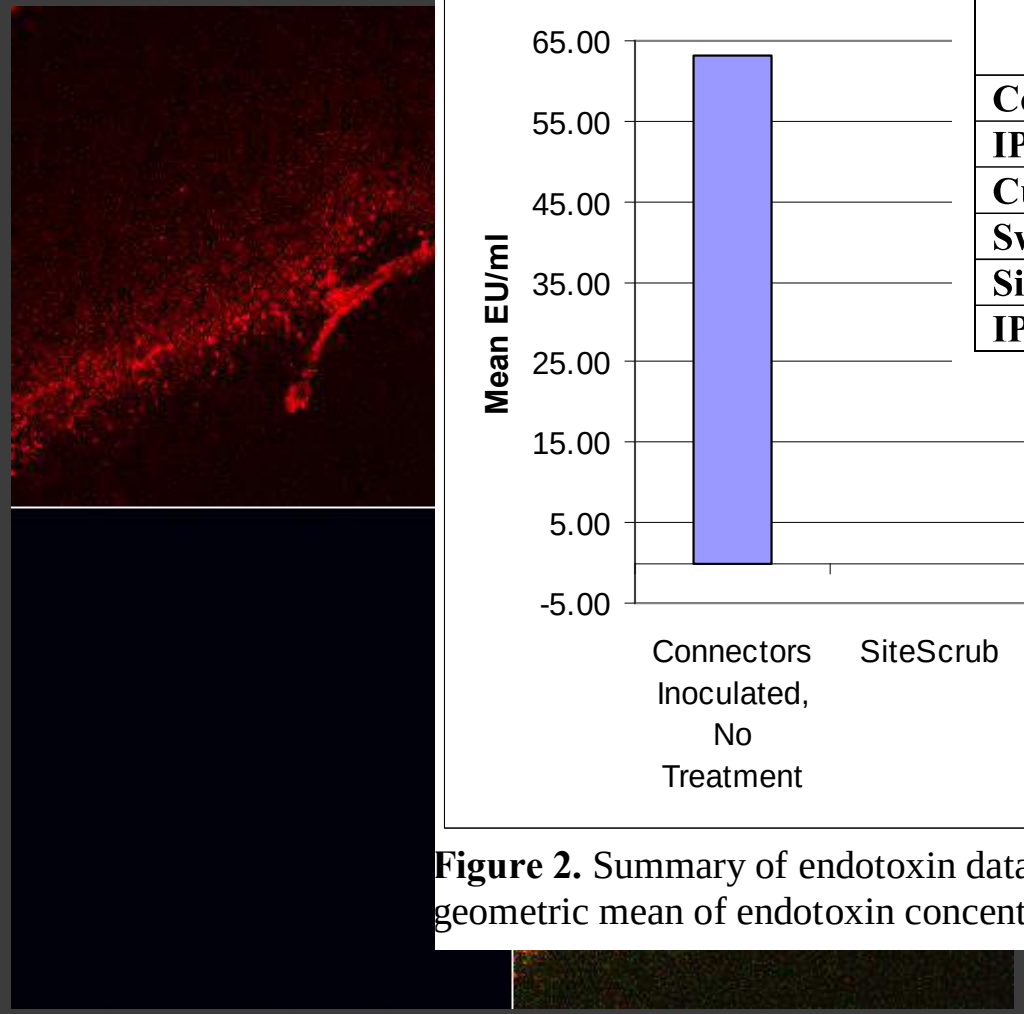
Endotoxin release during disinfection of contaminated needleless connectors: a pilot study

…..something to think about!



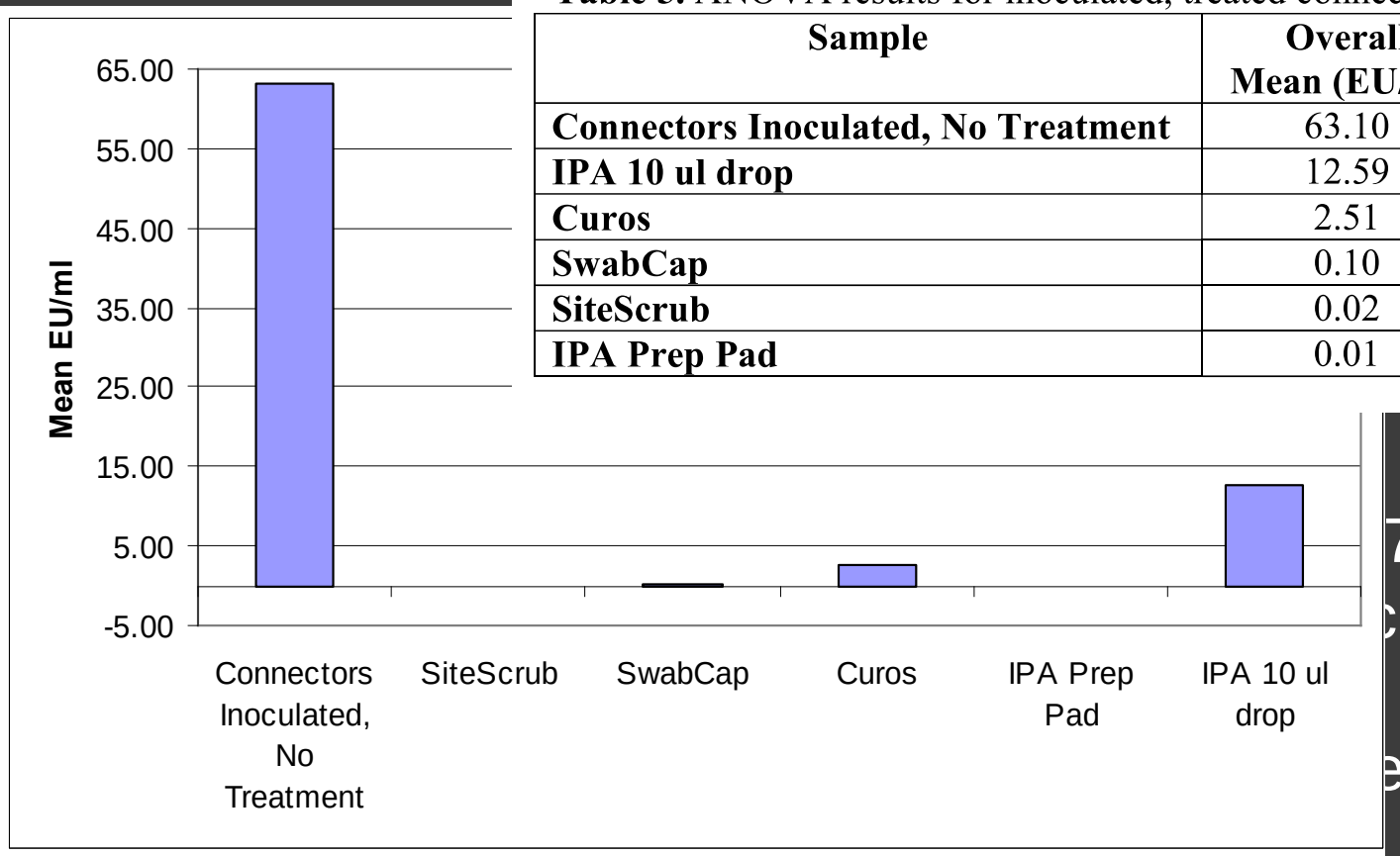


Table 5. ANOVA results for inoculated, treated connectors.

Sample	Overall Mean (EU/ml)	Significant Groups			
Connectors Inoculated, No Treatment	63.10	A			
IPA 10 ul drop	12.59	A	B		
Curos	2.51		B		
SwabCap	0.10			C	
SiteScrub	0.02			C	D
IPA Prep Pad	0.01				D

Figure 2. Summary of endotoxin data for three experimental runs. Values represent the geometric mean of endotoxin concentrations for three experimental runs.

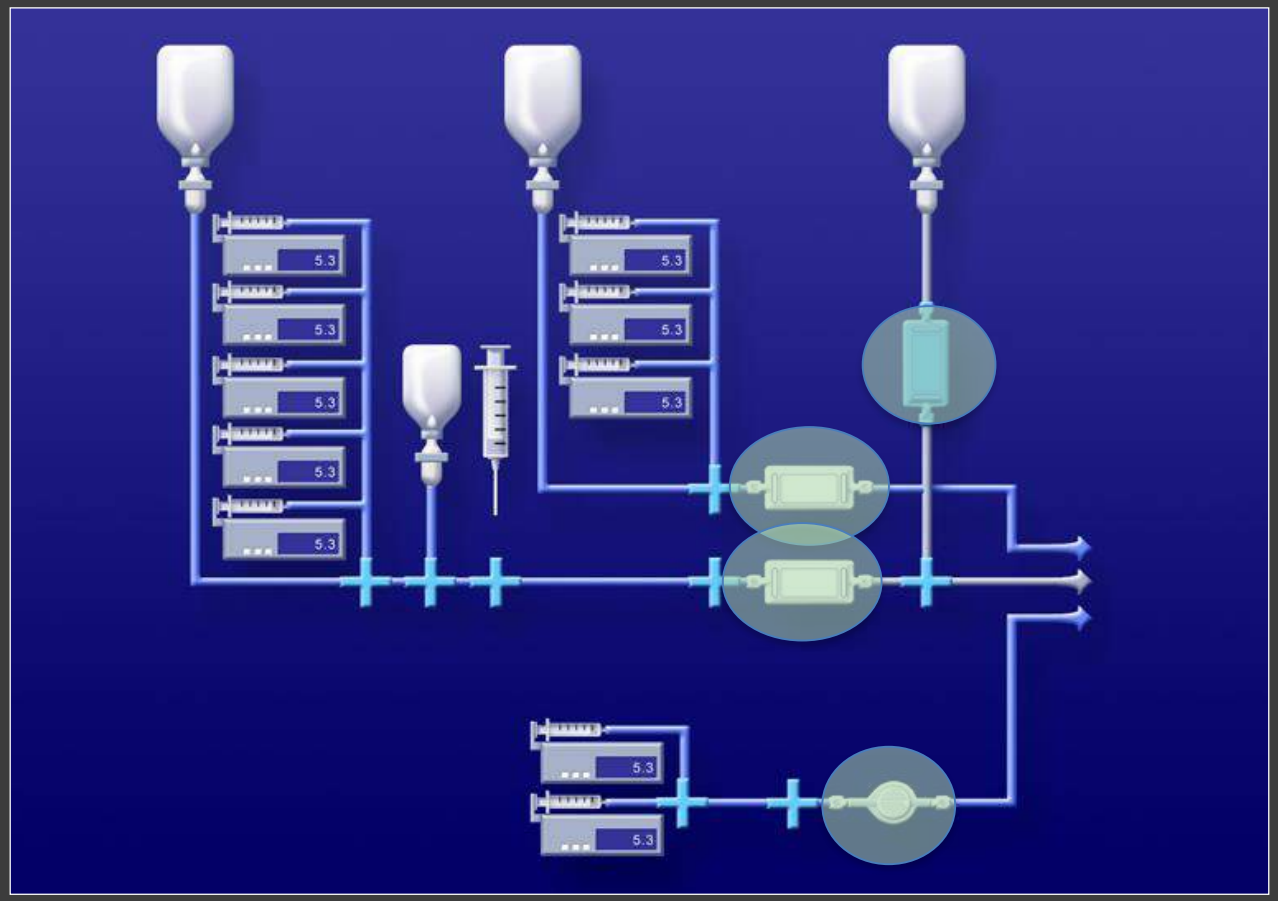
70% pad, scrubbing
caps, IPA drop

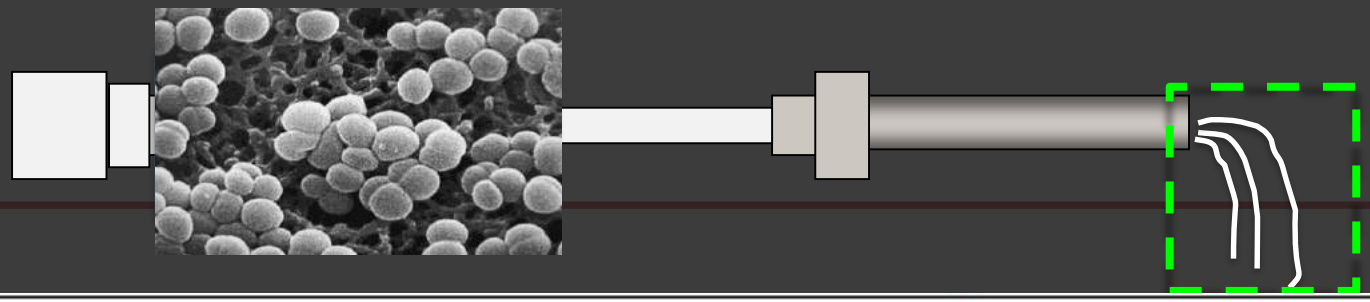
easured

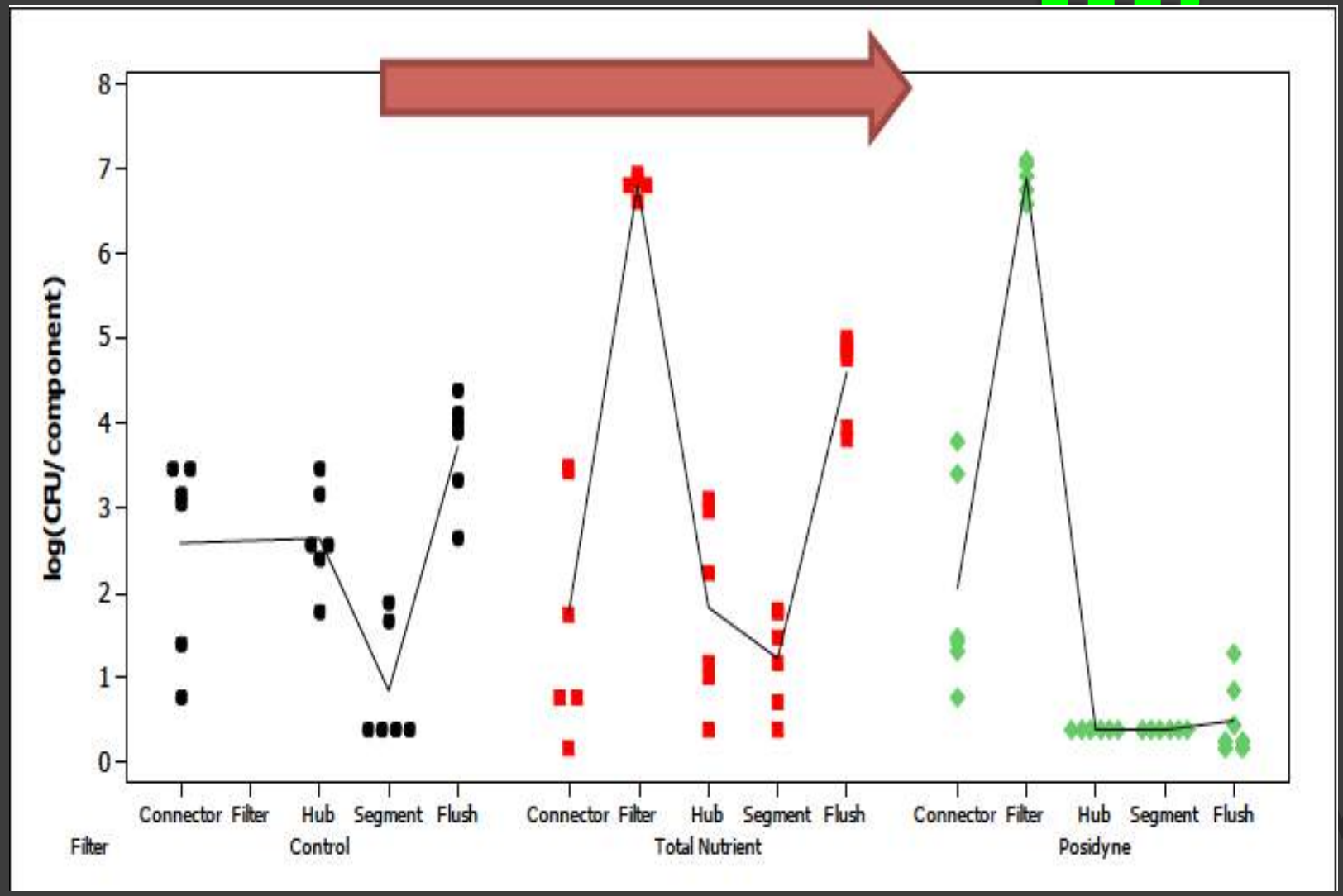
physical barrier to bacterial transfer

bacteria, particulate, and endotoxin retentive, air eliminating filtration

0.2 micron filters retain all bacteria, fungi and protozoa

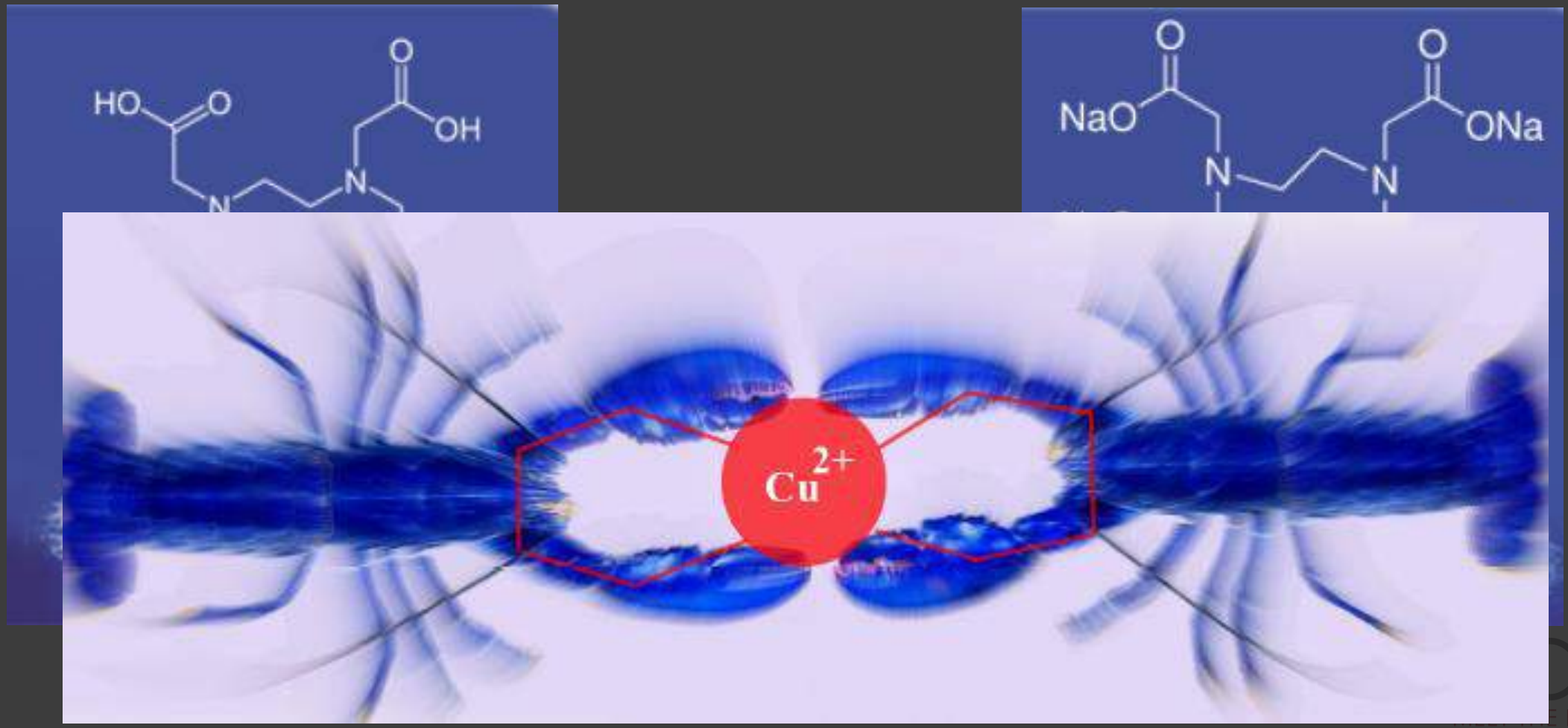




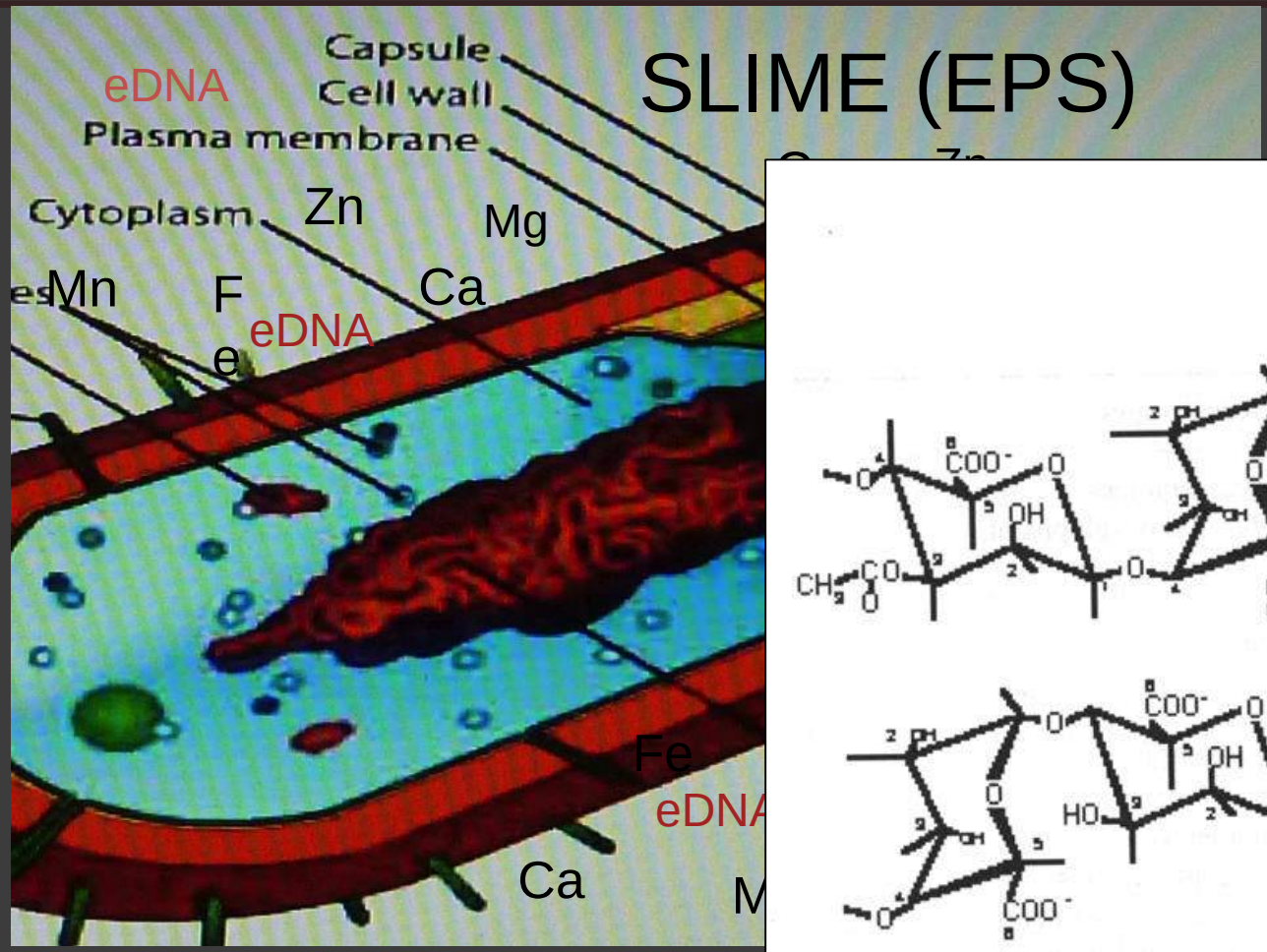


TETRASDIUM EDTA lock flush solution

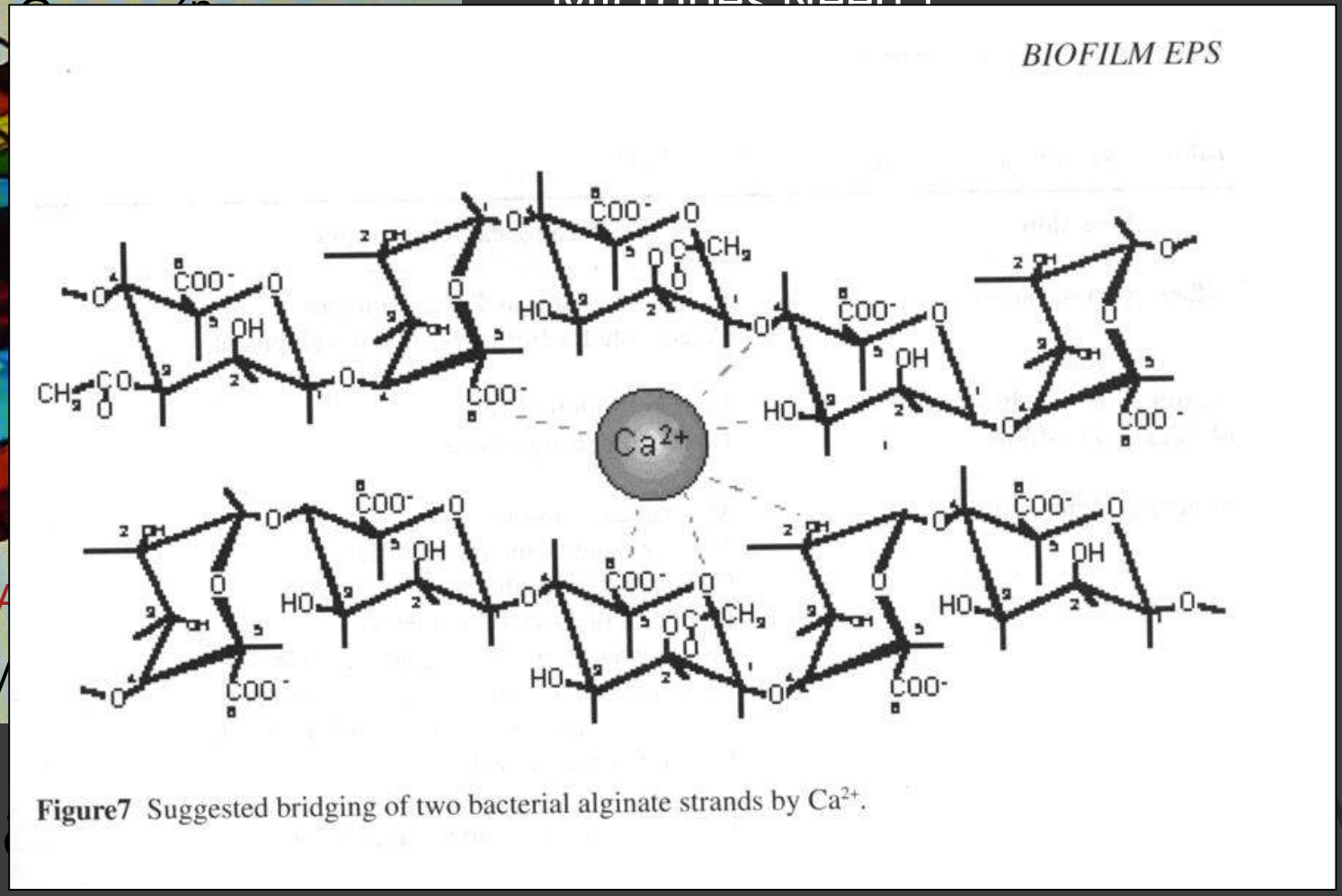
characteristics



…..minerals are to microorganisms as oxygen is to humans!



Microbes Need I



t/EDTA Steals Met

access site
disinfection

low bacterial transfer
needleless connector

antimicrobial/
anticoagulant
lock flush

bacteria retentive
endotoxin retentive
air eliminating
particulate retentive

catheter
hub
disinfection

questions?

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