



Prevention and therapy of infection in orthopedic surgery

Luca Vezzoni, DVM, Cremona, Italy

luca@vezzoni.it



Surgical theatre 1891

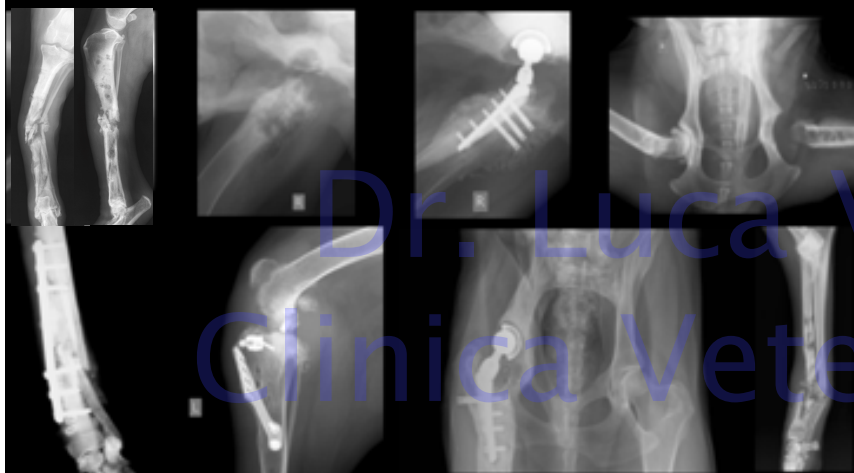


Surgical theatre 2018



Surgical infection is still an issue

Dramatic impact in orthopedics and traumatology



Surgical infections in orthopedics

- ▶ Clean surgery
- ▶ Limited incidence (1-5%)
- ▶ Greater incidence in joint surgeries (0,8 - 15,8%)
- ▶ Significant impact for the patient, the owner and the surgeon
- ▶ SSI can lead to implant loosening and fixation failure
- ▶ Periprosthetic infection can lead to complete failure of the prosthesis

Maremmano shepherd, M, 2yrs
FU 4 mos
Enterococcus spp.

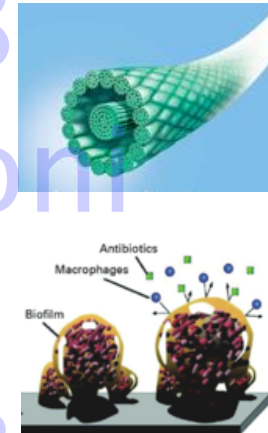


Surgical infections in orthopedics

- ▶ Risk of infection increases exponentially at every revision surgery
- ▶ First surgery 1.5 to 3%
- ▶ First revision 2.25% to 9%
- ▶ Second revision 5% to 81%
- ▶ Third revision 25% to >100%
- ▶ Vascular impairment
- ▶ Devitalized tissues
- ▶ Major attentions to prevent SSI

Surgical infections in orthopedics

- ✓ Braided non absorbable sutures can keep inside bacteria for long time
- ✓ Adhesion of bacteria to the implant
- ✓ Biofilm production
- ✓ Number of bacteria necessary to cause SSI it's inversely related to implant dimension

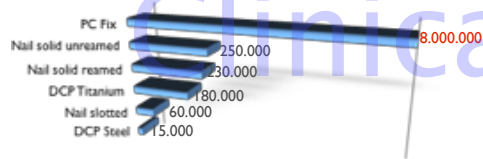


Surgical infections in orthopedics

- ✓ Influence of implants design
- ✓ Influence of implants material
- ✓ Titanium VS Stainless Steel
- ✓ Superficial coating
- ✓ Silver particles



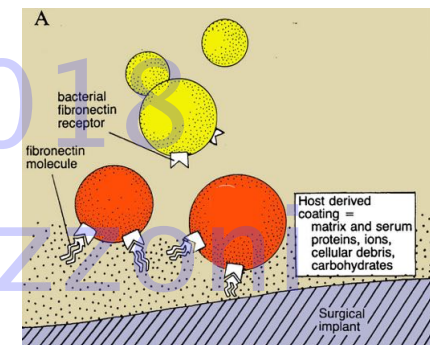
HyProtect™ Bone Plate Systems



"N° of bacteria required to develop SSI" Perren S.

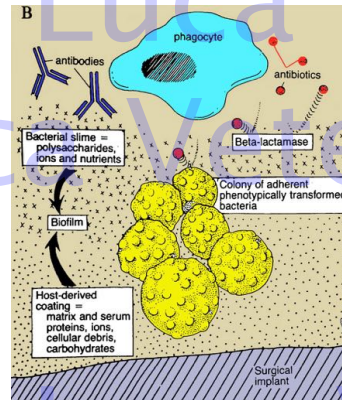
Surgical infections in orthopedics

- ✓ The implant surface is coated with a protein film
- ✓ Some bacteria, such as Staphylococcus, can bind directly to these proteins



Surgical infections in orthopedics

- ▶ Bacteria produce a slime
- ▶ The slime, in association with the substances produced by the organism = **biofilm or glycocalyx**
- ▶ Biofilm can contain beta-lactamase
- ▶ It can make some bacteria more resistant
- ▶ It is a powerful barrier against leukocytes, antibodies and antibiotics



Surgical infections in orthopedics

✓ Most common bacteria:

- ▶ Staphylococci 45%
- ▶ Streptococci/enterococci 18%
- ▶ Escherichia coli 13%
- ▶ Enterobacter cloacae 9%
- ▶ Pastorella & Proteus 5%

Patient related

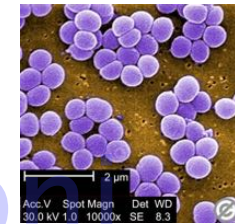
✓ Other bacteria

- ▶ Pseudomonas aeruginosa
- ▶ Serratia marcescens
- ▶ Aerobacter spp.
- ▶ Burkholderia cepacia
- ▶ Stenotrophomonas maltophilia

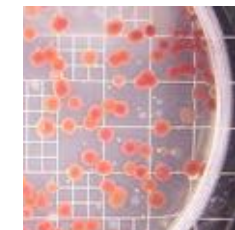
Environment related

✓ Anaerobes may be present in 50% of cases

✓ Increased incidence of methicillin-resistant strains of *Staph. pseudointermedius* (MRSP)



Staphylococcus aureus



Serratia marcescens

Surgical infections in orthopedics

✓ PREVENTION

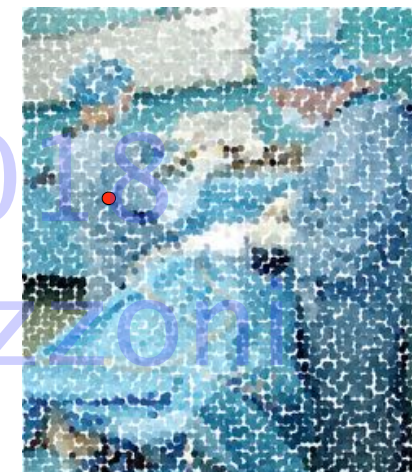
- ▶ Peri-operative and surgical asepsis
- ▶ Patient conditions
- ▶ Respect of tissues during surgery
- ▶ Implants stability
- ▶ Antimicrobial prophylaxis



Surgical infections in orthopedics

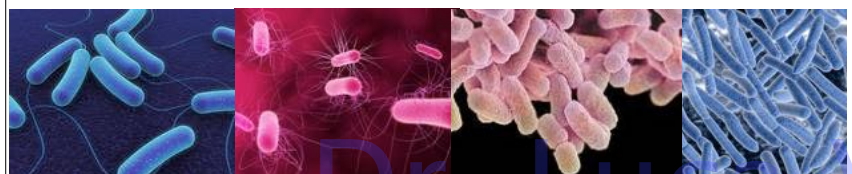
✓ PREVENTION

- ▶ Antimicrobial prophylaxis is only one of the pieces of the puzzle of SSI prevention
- ▶ Antimicrobial prophylaxis alone is totally insufficient

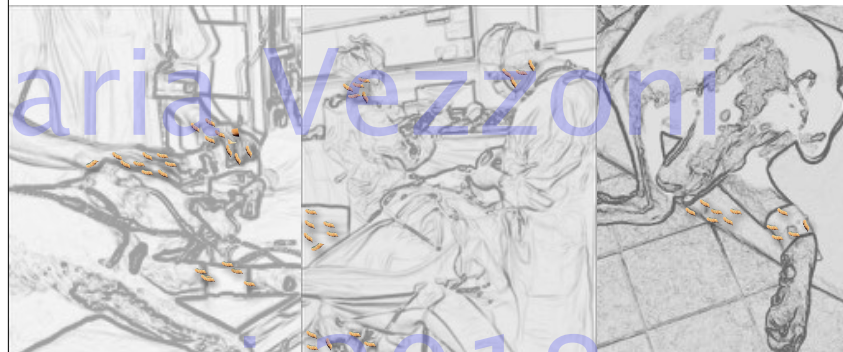




Where does infection come from?



Bacteria are everywhere!!



Bacteria are everywhere

It's imperative to create and maintain barriers

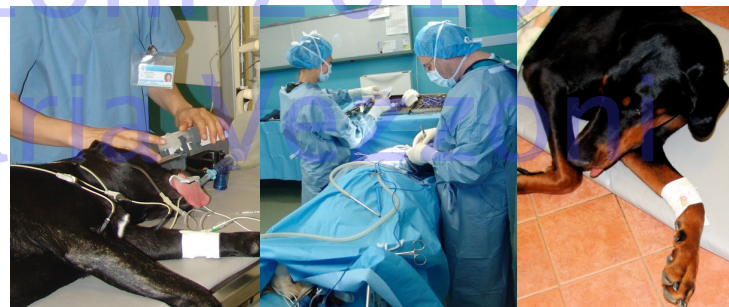
- ▶ OR staff major contaminator
- ▶ Every person releases in the environment 1 million bacteria per hour



Surgical infections in orthopedics

Contamination pathways and preventive measures:

- ▶ Patient
- ▶ Pre- and peri-operative
- ▶ Intra-operative
- ▶ Post-operative



Pre operative contamination

✓ Patient related factors

- ✓ Old animals
- ✓ Immunodepression
- ✓ Endocrinopathy
- ✓ Animals carries of MRSP
 - ▶ *Staphylococcus pseudintermedius* MRSP
 - ▶ Piodermitis
 - ▶ Topical treatment
 - ▶ Systemic treatment only with severe conditions



Amikacina	S
Amoxicilina + acido clavulanico	R
Cefalotina	R
Cefazolina	R
Cefotaxime	R
Ceftazidime	R
Ciprofloxacina	R
Clindamicina	R
Enrofloxacin	R
Eritromicina	R
Gentamicina	R
Oxacilina	R
Ritampicina	S
Sulfamoxazol/Trimethopim	R
Tetraciclina	R
Vancomicina	S

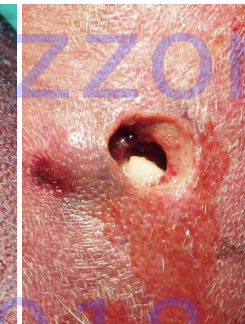
Pre operative contamination

- ✓ Open fractures
- ✓ Patients with chronic infections

1° degree



2° degree

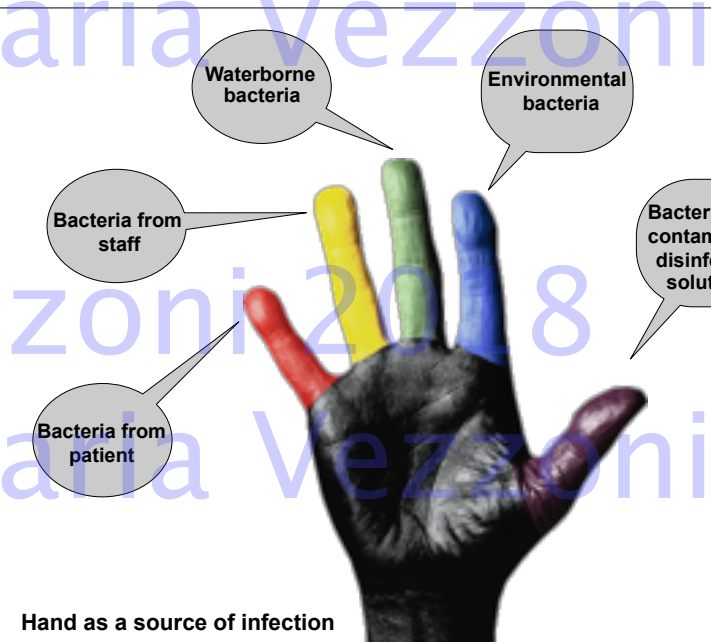


3° degree



Peri-operative contamination

- ✓ The most underestimated source of infections
- ✓ Unintentional contamination of the patient by the staff
- ✓ Contamination of the patient before, during and after surgery
- ✓ Contamination pathway:
HANDS



Peri-operative contaminations

✓ Hair clipping

- ▶ Risk of contamination of staff's hands with the skin bacteria
- ▶ *Staphylococcus intermedius*, *Streptococcus spp*, *Enterobacter spp*, *Escherichia coli*, etc.
- ▶ Contaminated hands, bacteria carriers
- ▶ Hair clipping after induction of anaesthesia

Evaluation of Bacterial Contamination of Clipper Blades in Small Animal Private Practice

JAAHA | 52:2 | Mar/Apr 2016

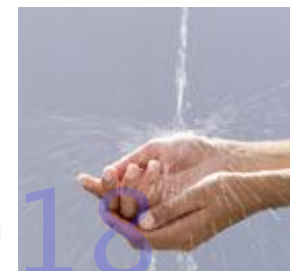
Rebecca Mount, DVM, DACVD, Anthea E. Schick, DVM, DACVD, Thomas P. Lewis II, DVM, DACVD, Heidi M. Newton, JD, DVM, DACVD



Peri-operative contaminations

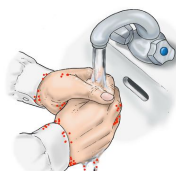
✓ Tap water and hands washing by the staff

- ▶ Tap water is NOT sterile
- ▶ Risk of contamination with water carried bacteria
- ▶ *Burkholderia cepacia*, *Stenotrophomonas maltophilia*, *Pseudomonas aeruginosa*, *Escherichia coli*, etc.
- ▶ Contaminated hands, bacteria carriers



Water pathogens and their diffusion in water pipes

Pathogen	Health significance	Persistence in water supplies	Relative infectivity
Bacteria			
<i>Campylobacter jejuni</i> , <i>C. coli</i>	High	Moderate	Moderate
Pathogenic <i>Escherichia coli</i>	High	Moderate	Low
Enterohaemorrhagic <i>E. coli</i>	High	Moderate	High
<i>Legionella</i> spp.	High	Multiply	Moderate
Non-tuberculosis mycobacteria	Low	Multiply	Low
<i>Pseudomonas aeruginosa</i>	Moderate	May multiply	Low
<i>Salmonella typhi</i>	High	Moderate	Low
Other salmonellae	High	Short	Low
<i>Shigella</i> spp.	High	Short	Moderate
<i>Vibrio cholerae</i>	High	Short	Low
<i>Burkholderia pseudomallei</i>	Low	May multiply	Low
<i>Yersinia enterocolitica</i>	High	Long	Low



WHO Guidelines
on Hand Hygiene in Health Care

Peri-operative contaminations

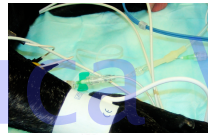
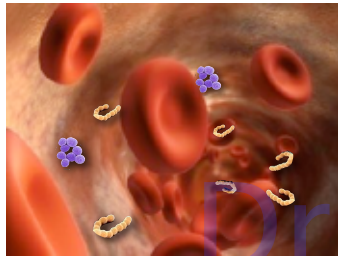
✓ Contaminated hands of staff

- ▶ Contamination of IV catheters, IV infusion lines and vials
- ▶ Contamination of IV solutions



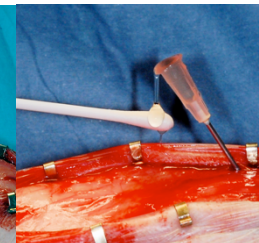
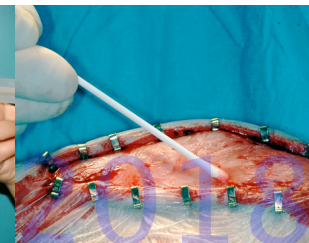
Peri-operative contaminations

- ✓ **Contaminated** IV solutions
- ✓ Time related bacteria replications
- ✓ Preserved solutions > higher contamination
 - ▶ **Contamination of the patient's blood stream**



Peri-operative contaminations

- ✓ **Contaminated** IV solutions
 - ▶ Hematogenous bacterial contamination and transient bacteremia
 - ▶ Contamination of the surgical field
 - ▶ Bacterial growth in blood clots and dead tissues
 - ▶ The animal's immune system will help most of the times



Peri-operative contaminations

✓ PREVENTION

- ▶ Peri-operative staff and anesthetist hands
- ▶ Dry skin **disinfectant gel**, alcohol based, to be renewed for every patient



Peri-operative contaminations

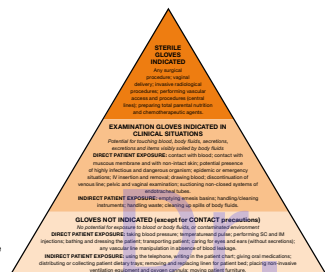
- ✓ PREVENTION
- ✓ Peri-operative staff and anesthetist
 - ▶ **Disposable gloves**, renewed for every patient



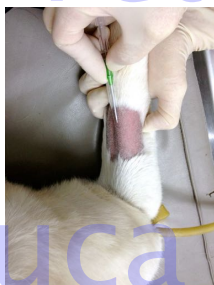
Peri-operative contaminations

✓ PREVENTION

- ▶ Aseptic technique for the insertion and care of IV catheters
- ▶ Prepare clean skin with alcohol based antiseptic solutions
- ▶ Wear clean gloves for peripheral IV catheters
- ▶ Wear sterile gloves for central IV and arterial catheters



WHO Guidelines on Hand Hygiene in Health Care



Peri-operative contaminations

✓ PREVENTION

- ▶ Discard all unused solutions
- ▶ DO **NOT** reuse them for the following patient
- ▶ DO **NOT** store them for further use
- ▶ Use a new set line for every patient



Peri-operative contaminations

- ▶ Soap and chlorhexidine, betadine soaked gauzes can be contaminated (*Serratia marcescens*)
- ▶ Surgical instruments and sutures left in disinfectant solutions can be contaminated by resistant bugs
- ▶ Consequent patient contamination

JOURNAL OF CLINICAL MICROBIOLOGY, Aug 1981, p. 157-160
0095-1137/81/080157-04\$01.00/0 Vol. 14, No. 2

Nosocomial Transmission of *Serratia marcescens* in a Veterinary Hospital Due to Contamination by Benzalkonium Chloride

JAMES G. FOX,¹* CELIA M. BEAUCAGE,¹ CAROLE A. POLTA,¹ and GUS W. THORNTON²
¹Division of Comparative Medicine, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, and ²Angell Memorial Hospital, Boston, Massachusetts 02126



Peri-operative contaminations

✓ PREVENTION

- ▶ Disposable sterile cans for skin scrub
- ▶ Individual prep solutions, to be discarded at the end of the day
- ▶ Use small bottles of disinfectant agents
- ▶ Several Gram neg bugs grow in scrub solutions let on air



Peri-operative contaminations

✓PREVENTION

- ▶ Pre scrub of distal extremities with soapy solutions



Peri-operative contaminations

✓PREVENTION

- ▶ Purse string suture for hip and femur surgeries
- ▶ Decontamination step with non medicated soap
- ▶ Careful and systematic scrub of the surgical area
- ▶ Clean with a soapy solution (Clorexidine 4% diluted)
- ▶ Rinse with hydroalcoholic solution
- ▶ Minimum 4 passages (Contact time around 5')



Peri-operative contaminations

✓PREVENTION

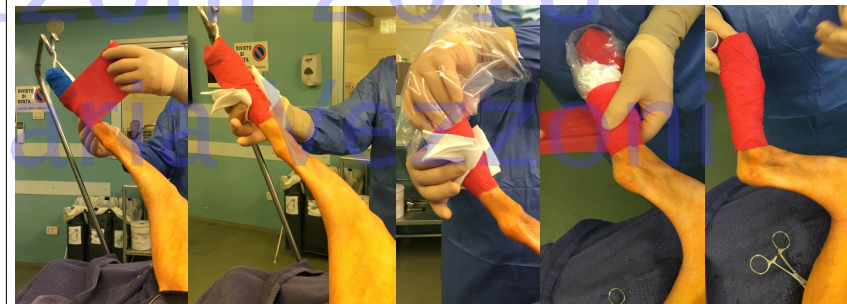
- ▶ Hydroalcoholic "colored" solution
- ▶ Propan-2-ol 72% + Belzanconium Chloride
- ▶ Action time 1' / 2'



Peri-operative contaminations

✓PREVENTION

- ▶ Sterile vetrap
- ▶ Gauze
- ▶ Autoclavable pouch
- ▶ Sterile vetrap



Peri-operative contaminations

✓PREVENTION



37

Peri-operative contaminations

✓PREVENTION

- ▶ Skin isolation
- ▶ Glue and adhesive drape



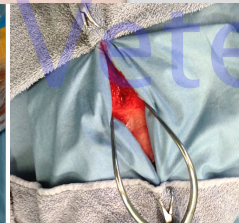
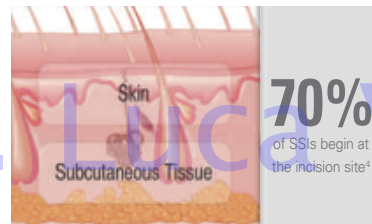
38

Intra-operative contamination and prevention

✓ Strict respect of asepsis guidelines

✓ Skin isolation

- ▶ **DO Not** touch the skin
- ▶ Adhesive drapes or stockinette
- ▶ Michel's clips

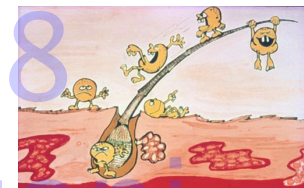


Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines

✓ Skin isolation

- ▶ Asepsis
- ▶ Bacteria deeply seated in hair follicles
- ▶ 20% of bacteria remain in the deepest layers



Before antiseptic application

Immediately following antiseptic application



Peri-operative contaminations

✓ PREVENTION

- ▶ Limit the number of blood stream accesses (ASA risk)
- ▶ Every blood stream access is a potential source of hematogenous infection
- ▶ Remove IV catheters asap after recovery from surgery



Intra-operative contamination and prevention

- ✓ Strict respect of aseptic guidelines in OR
- ▶ Clean zone separated from dirty zone
- ▶ Reduce the equipments to a minimum
- ▶ Sunlight in the room is better than only artificial light
- ▶ Large rooms are better



Intra-operative contamination and prevention

✓ Ambiental contamination

- ▶ Ventilation system - continuous change
- ▶ HEPA Filter (High Efficiency Particulate Air)
- ▶ Continuous positive airway pressure ventilation in the OR
- ▶ Airborne bacteria
- ▶ Laminar airflow



Intra-operative contamination and prevention

✓ Ambiental contamination

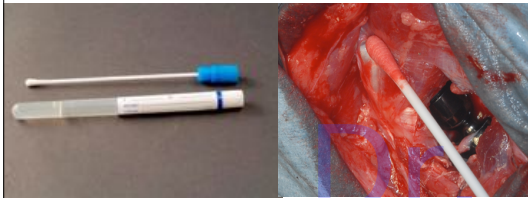
- ▶ Ozone
- ▶ UVA
- ▶ Ox-Aire (7,5% Hydrogen peroxide)



Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

- ▶ Regular daily cleaning and disinfection
- ▶ Periodical ozon disinfection if the OR can be sealed or UVA
- ▶ Renewal of MRSP cases
- ▶ Periodical samples
 - ▶ Environment
 - ▶ Surgical wound at the end of surgery



Tempi per la sterilizzazione con vapore

Nelle tabelle di seguito presentate, sono riportati i tempi minimi necessari per la distruzione di alcuni microrganismi mediante la sterilizzazione con vapore.

Batteri	
Diplo. Lactis	0' 14"
Staph. Hemolyticus (Alpha Type)	0' 28"
Staph. Aureus	0' 18"
Staph. Albus	0' 18"
Marcococcus Sphaerale 0' 25"	0' 25"
Serratia Lactis	0' 44"
Pseudomonas Fluorescens	0' 18"
Listeria Monocytogenes	0' 11"
Proteus vulgaris	0' 13"
Serratia Marcescens	0' 18"
Bacillus subtilis	0' 18"
Bacillus subtilis spores	0' 34"
Spillum rubrum	0' 10"
Escherichia Coli	1' 00"
Salmonella typhi	0' 40"
Shigella dysenteriae	1' 00"
Brucella Abortus	1' 00"
Staphylococcus	10' 00"
Pyogenic aerobus	10' 00"
Vibrio cholerae	30' 00"

Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

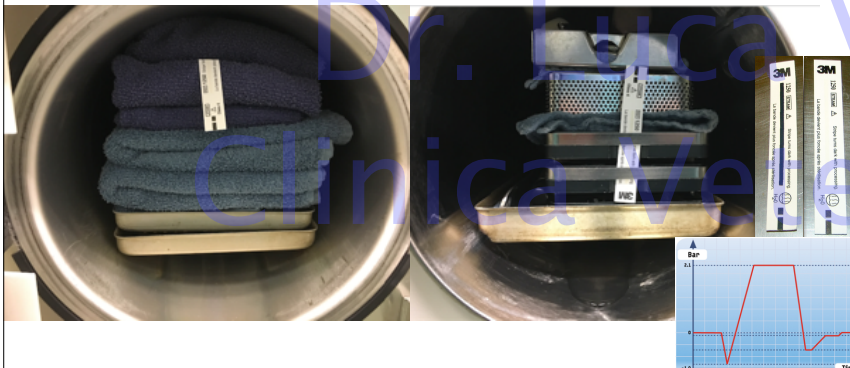
- ▶ Tacky mats placed outside the entrance of operating room / suite, not demonstrated to reduce the contamination
- ▶ Useful as a virtual barrier to the surgical suite
- ▶ Clean clogs for OR only



Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

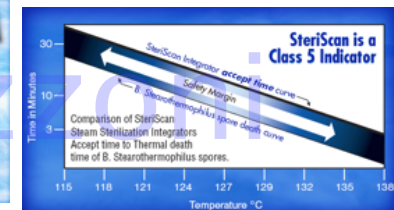
- ▶ Check for effective instruments and implants sterilization procedures
- ▶ Periodical microbial monitoring with biological indicators



Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

- ▶ Class 1 indicator outside the pack (indicator drape)
- ▶ Class 5 indicator in the deepest part of the pack



Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

- ▶ Envelopes and packs
- ▶ Integrity
- ▶ Sterilization indicator and date
- ▶ Double check:
 - ▶ immediate after the sterilization
 - ▶ before each use



Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

- ▶ Storage of packs and sterile envelopes in a isolated zone
- ▶ Periodical re-sterilization with new envelops

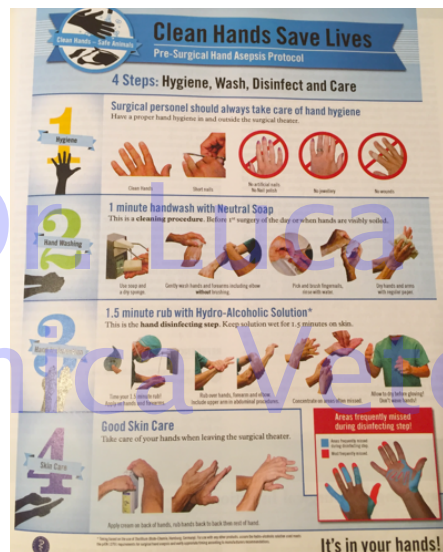


Peri-operative contaminations

✓ PREVENTION

✓ Hand disinfection

- ▶ Hygiene
- ▶ Cleaning
- ▶ Disinfection
- ▶ Skin care

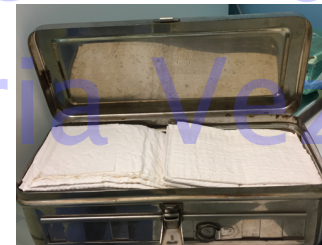


Peri-operative contaminations

✓ PREVENTION

✓ Hand disinfection

- ▶ Cleaning with neutral soap
- ▶ Accurate drying with sterile disposable paper and at the end mechanical hand dryer



Peri-operative contaminations

✓ PREVENTION

✓ Hand disinfection

- ▶ Hydroalcoholic solution
- ▶ Dry scrub most effective than traditional wet scrub
- ▶ Sterillum (Propan-2-ol 45% e Propan-1-ol 30%)
- ▶ Microfilm
- ▶ It lasts for several hours
- ▶ Sprayed on the skin and leave it dry
- ▶ 1.5'



53

Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

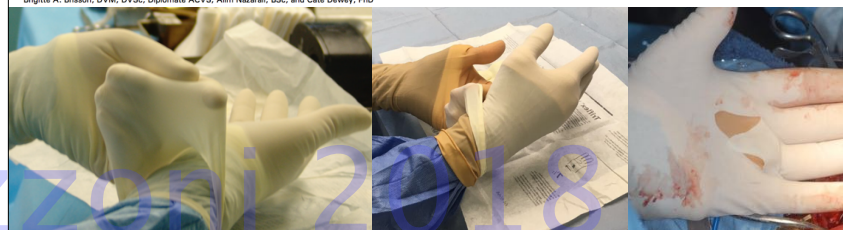
- ▶ Double gloving for orthopaedic sx, change of the outer pair when needed
- ▶ 26% - 43% perforation of at least one pair
- ▶ Inner glove intact in 63%
- ▶ Ability to detect the perforation 30% - 34%

Investigation of Incidence and Risk Factors for Surgical Glove Perforation in Small Animal Surgery

Galina M. Hayes, PhD, Deborah Reynolds, BVSc, Diplomate ACVS, Noel M.M. Moens, MS, Diplomate ACVS & ECVS, Ameet Singh, DVM, DVSc, Diplomate ACVS, Michelle Olsak, DVM, DVSc, Diplomate ACVS, Thomas W.G. Gibson, DVM, DVSc, Diplomate ACVS, Brigitte A. Brisson, DVM, DVSc, Diplomate ACVS, Alim Nazari, BSc, and Cate Dewey, PhD

Colored Indicator Undergloves Increase the Detection of Glove Perforations by Surgeons During Small Animal Orthopedic Surgery: A Randomized Controlled Trial

Lee B. Meskin, Oliver P. Gilman, Kevin J. Parsons, Neil J. Burton, and Sorrel J. Langley-Hobbs



Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

- ▶ Reduce the number of people in the room to a minimum
- ▶ For each additional person in the OR the risk of SSI can increase by as much as 30%
- ▶ Limit movements
- ▶ Security distance
- ▶ 30% greater risk of wound infection for each additional hour of anesthesia
- ▶ The risk of SSI approximately doubles for every hour of surgery time
- ▶ Major risk for surgical procedures >90'



Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

- ▶ Limit conversation
- ▶ Reduce spread of bacteria
- ▶ Change surgical mask for each surgery



Intra-operative contamination and prevention

✓ Strict respect of aseptic guidelines in OR

- ▶ Adequate surgical protection
- ▶ Ears, nose, mouth, and hairs



Source of bacterial shedding in laminar flow theatres

K.L. Owens, E. James, G.C. Bannister
Received: January 16, 2004; Accepted: June 14, 2004;



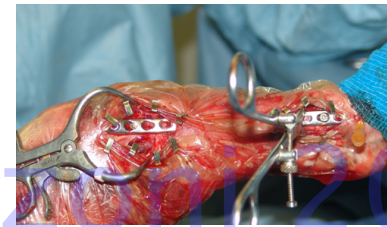
Intra-operative contamination and prevention

✓ Orthopaedic surgery

- ▶ Surgical approach
- ▶ Surgical technique (Halstead's principles)
- ▶ Respect of soft tissue and periosteum
- ▶ Preservation of blood supply
- ▶ Avoid dead spaces
- ▶ Duration of surgery



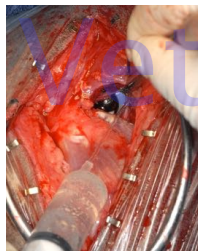
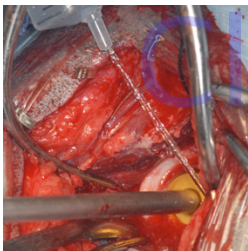
William Stewart Halsted nel 1874, NY



Intra-operative contamination and prevention

✓ Orthopaedic surgery

- ▶ Frequent lavages with sterile physiologic solution
- ▶ Keep tissues wet
- ▶ Copious lavage at end of surgery
- ▶ Eliminate blood clots and dead tissues
- ▶ Dilution of contamination

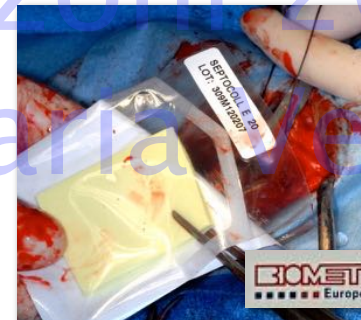


Intra-operative contamination and prevention

✓ Revisions of orthopedic sx

Local slow release antibiotic impregnated substances

- ✓ Prophylactic use
- ✓ Septocoll E: gentamicin sulphate and gentamicin crobafate
- ✓ Local activity from 8 to 10 days
- ✓ Antibacterial sutures



- ✓ Careful patient care

-
- The image consists of three vertical panels showing a surgical wound on a dog's back. The left panel shows a closed wound with sutures. The middle panel shows the wound open and red. The right panel shows the wound covered with a white bandage.

- ✓ Careful patient care

-
- A small dog, possibly a beagle, is wearing a clear plastic E-collar (cone) decorated with yellow paw prints. The dog is looking directly at the camera. A large blue watermark 'Zoni 20' is overlaid on the bottom half of the image.



✓ Careful patient care

-
- A close-up photograph of a light-colored dog's head, showing a surgical incision on the forehead. The incision is a horizontal line of sutures. A large, semi-transparent blue watermark with the text 'DVM Clin' is overlaid on the image.



- ▶ Repeat every 90 min in prolonged surgery (redosing every 2 half-lives)
- ▶ 1 or 2 additional (within the 24 hours)



PERIOPERATIVE ANTIMICROBIAL PROHYLAXIS (AMP)

- ▶ Elective procedures, closed fractures (Staphylococcus):
Cefazolin
- ▶ Open fractures (Staphylococcus, Streptococcus and anaerobes):
 - ▶ Cefazolin or clindamycin +/- aminoglycoside or fluoroquinolone (Enrofloxacin should be avoided with known or potential Streptococcus canis infection)



POSTOPERATIVE ANTIMICROBIAL PROHYLAXIS (AMP)

- ▶ Controversial topic
- ▶ Several studies with different results
- ▶ Recent evidence suggest that post op AMP may be indicated for certain procedures (TPLO)
- ▶ Clean surgery
- ▶ Duration
- ▶ Amoxicillin-Clavulanic A. 20 mg/kg every 8 hrs for 5 days

Efficacy of Postoperative Antimicrobial Use for Clean Orthopedic Implant Surgery in Dogs: A Prospective Randomized Study in 100 Consecutive Cases
Andrea Pavesi¹, DVM, PhD, CertSAS, DipECV, Andrew P. Moore², BVSc, DipSAS(Orth), Diplomate ECVS, Gary Osment³, BVSc, CertSAS, James Osler⁴, PhD, CertV, CertSAS, Diplomate ECVS, and Thomas W. Maddox⁵, BVSc, PhD, CertV, DipECV

Prospective, Randomized Comparison of the Effect of Two Antimicrobial Regimes on Surgical Site Infection Rate in Dogs Undergoing Orthopedic Implant Surgery
Miranda J. Allen¹, VetMB, MA, CertSAS, Thomas K. Hughes², VetMB, MA, CertSAS(Orth), Diplomate ECVS, Ralph H. Abercromby³, BVMS, CertSAS, Mark A. Holmes⁴, VetMB, MA, PhD, and Angela A. Anderson⁵, BVetMed, PhD, DSA(Orth)

Survey of Intraoperative Bacterial Contamination in Dogs Undergoing Elective Orthopedic Surgery
Nastila Andrade¹, Chad W. Schmidt², Karen Cornell³, MaryAnn G. Radlinsky⁴, Lauren Heddingfelder⁵, Kevin Clarke⁶, David J. Hurley⁷, and Whitney D. Henson⁸



Surgical treatment of orthopedic infections

First step

- ✓ Culture
- ✓ Isolation of bacteria and antibiogram
- ✓ Targeted antibiotic therapy



Surgical treatment of orthopedic infections

First step

- ✓ Culture
- ✓ Isolation of bacteria and antibiogram
- ✓ Targeted antibiotic therapy



Second step

- ✓ Removal of implants without further fixation in the case of infected but sufficiently consolidated fractures
- ✓ Removal of implants with new fixation in case of septic pseudoarthrosis (stable angle implants are preferred) Trapianto di spongiosa
- ✓ Insertion of substances impregnated with slow release local antibiotics
- ✓ Prolonged and targeted systemic antibiotic therapy
- ✓ Possible removal of the new consolidation system

Antibiotic therapy of osteomyelitis



- ▶ Most bone infections in animals are still sensitive to common antibiotics (amoxi-clav, cefazolin, doxycycline, sulfamethoxazole / trimethoprim, quinolones, amikacin)
- ▶ Culture Sensitivity Test
- ▶ **Frequent administration to maintain constant levels (every 4-6 h.)**
- ▶ Antibiotics that penetrate the glycocalyx and with a good distribution in the bone tissue (rifampicin, minocycline, tigecycline)
- ▶ Removal of implants often required

Antibiotic therapy of resistant osteomyelitis



- ▶ MRSP
 - ✓ Vancomycin, rifampicin, teicoplanin, linezolid (very expensive)
 - ✓ Associations with doxycycline, ciprofloxacin, clindamycin to reduce resistance
 - ✓ Fosfomycine
- ▶ Gram-negative (Pseudomonas, Klebsiella)
 - ✓ Amikacin, 3rd gen cephalosporines, ciprofloxacin
 - ✓ Colistine + rifampicin o co-trimoxazole

Strategies to prevent infections

- ✓ The surgeon is the first person in charge
- ✓ Prevention always and as much as possible
- ✓ Asepsis, stable fixation of implants
- ✓ Prevention of nosocomial infections, focus on **HANDS**
- ✓ Periodical environment samples and samples of the surgical wound at the end of surgery
- ✓ Antibiotic prophylaxis as unique strategy is useless

