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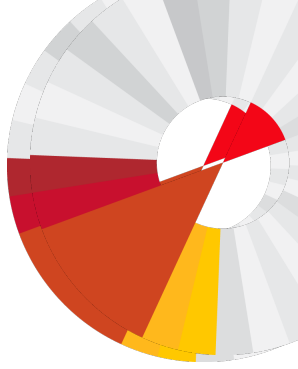
*Veritas, Probitas, Justitia*  
EST. 1849

FAKULTAS  
KEDOKTERAN

# Fundamental of Hemostasis **Hemostasis Management** Science of Bleeding Management



## The Science of Tissue Management

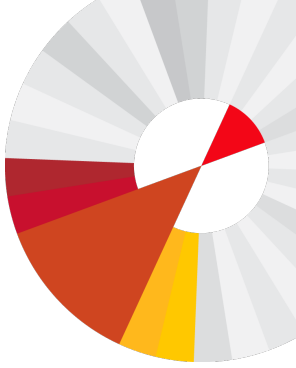


## Learning objectives:

→ Be familiar with:

- Role of Hemostasis in Surgery
- Methods of Managing Hemostasis
- Overview of Adjunctive Hemostasis Products
- Mode of Action
- Product Selection

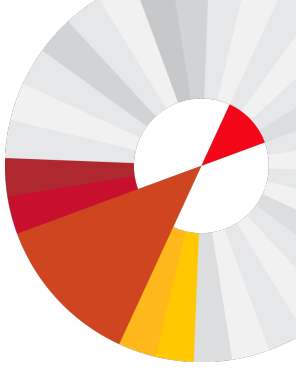




# Background

- Man attempt to stop bleeding of wound by applying a variety of topical agents
- The Egyptian used a mixture of wax, grease, and barley in an effort to stop bleeding
- In ancient Greece, hemostatic herbs were applied to wounds suffered in combat
- Native Americans used scrapings of an inside of animal hides mixed with hot sand as topical hemostatic agents

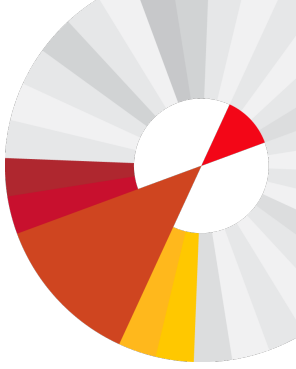




# Background

- Advances in Biotechnology have resulted in an explosive growth of topical hemostatic agents which are available to the modern surgeon
- A thorough understanding of various agents and their mechanism of action provides the basis for selecting the right agent at the right time.

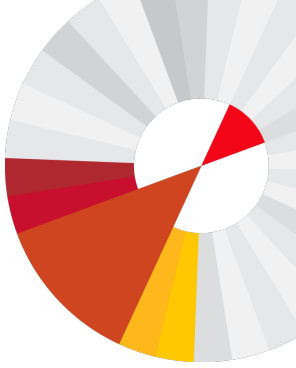




# The Importance of Blood Loss Reduction

- Minimize post-operative drainage
- Reduce or avoid transfusion
- Decrease post-operative hematoma
- Save operative time
- Reduce risk of return to OR
- Decreased length of stay
- Minimize the administration of prolonged antibiotics
- Decreased risk of infection
- Reduced pain and swelling

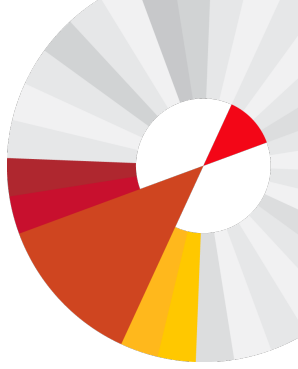




# Why use Hemostat?

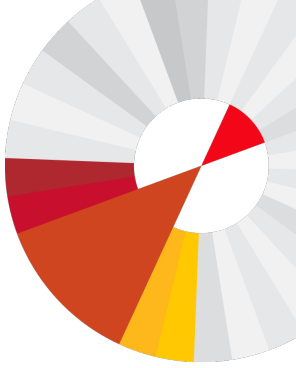
- Minimize blood loss
- Improve visualization
- Save operative time
- Reduce or avoid transfusion
  - More transfusion more morbidity
- Manage anti coagulated patients
  - Tend to bleed more
- Enable or avoid conversion of lap procedures
- Decrease post operative drainage





# Indications

- Peritoneal Surface
- Cut surface of solid organs
- Cut edges of bone
- Bleeding near nerves
- Bleeding near vital structures at risk for cautery-induced injury
- Bleeding from vascular structures or grafts due to suture holes
- Nasal structures as nasal packing
- Dental extraction sites
- Post Hemorrhoidopexy packing



# Methods of Managing Hemostasis

- Good surgical technique
- Primary methods
  - Suture
  - Staples
  - Bovie / Electrocautery
- Medications
- Adjunctive methods
  - Hemostasis products







# Electrocautery & Ultrasound Hemostats

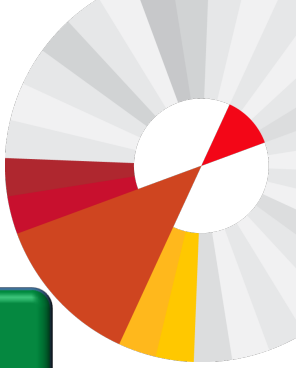
- Electrocautery
  - Monopolar
  - Bipolar / Advance Bipolar (Enseal)
- Ultrasound
  - Harmonic



Advancing Smooth Surgery

**Harmonic**<sup>TM</sup>





# Adjunctive Hemostats

**Topical Absorbable Hemostats (TAH)** • Provide matrix upon which blood can clot

Types of TAH include:

- Gelatin
- Oxidized Regenerated Cellulose (ORC)
- Collagen
- Microporous polysaccharide hemospheres (MPH)

**Biologic Hemostats**

- Interact with body's chemistry resulting in an activation or acceleration of the natural hemostasis cascade

Types of Biologics  
include:

- Thrombin
- Flowable Gelatin (used with thrombin)
- Fibrin Sealants

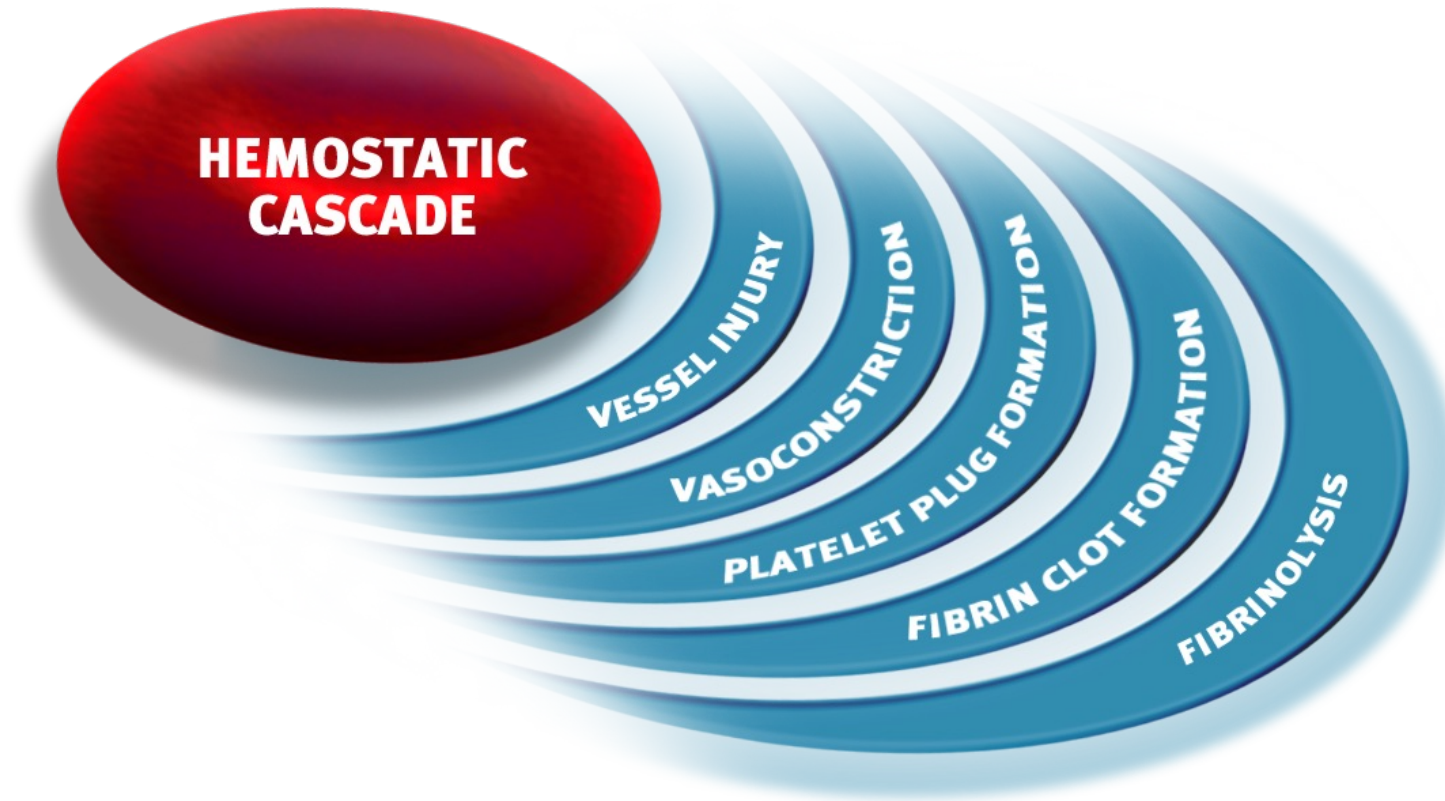
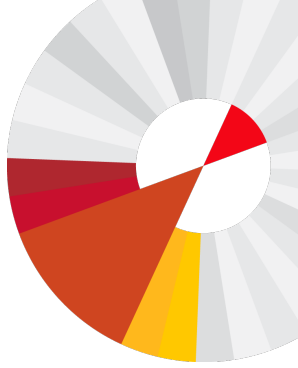
**Synthetic Sealants**

- Chemically synthesized agents that aid in the prevention of "leakage" from a repaired or damaged tissue

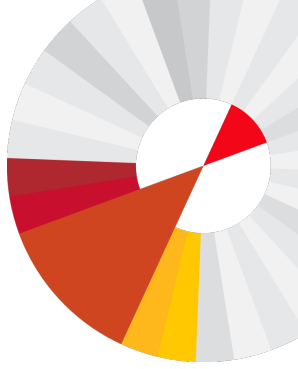
Types of Synthetics  
include:

- Cyanoacrylate
- Polyethylene Glycol
- Glutaraldehyde (used with albumin)

# The Hemostatic Cascade



# Hemostasis Phases



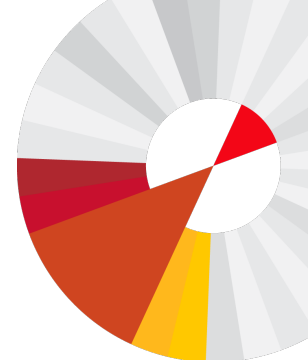
■ 1. Vascular constriction: This limits the flow of blood to the wound area, slowing the flow of blood through the vessels and minimizing blood loss.

■ 2. Platelet function: Platelets adhere, then aggregate at the site of injury, and bind to collagen that becomes exposed following rupture of the endothelial lining of vessels. This initial binding forms a temporary, loose platelet plug.

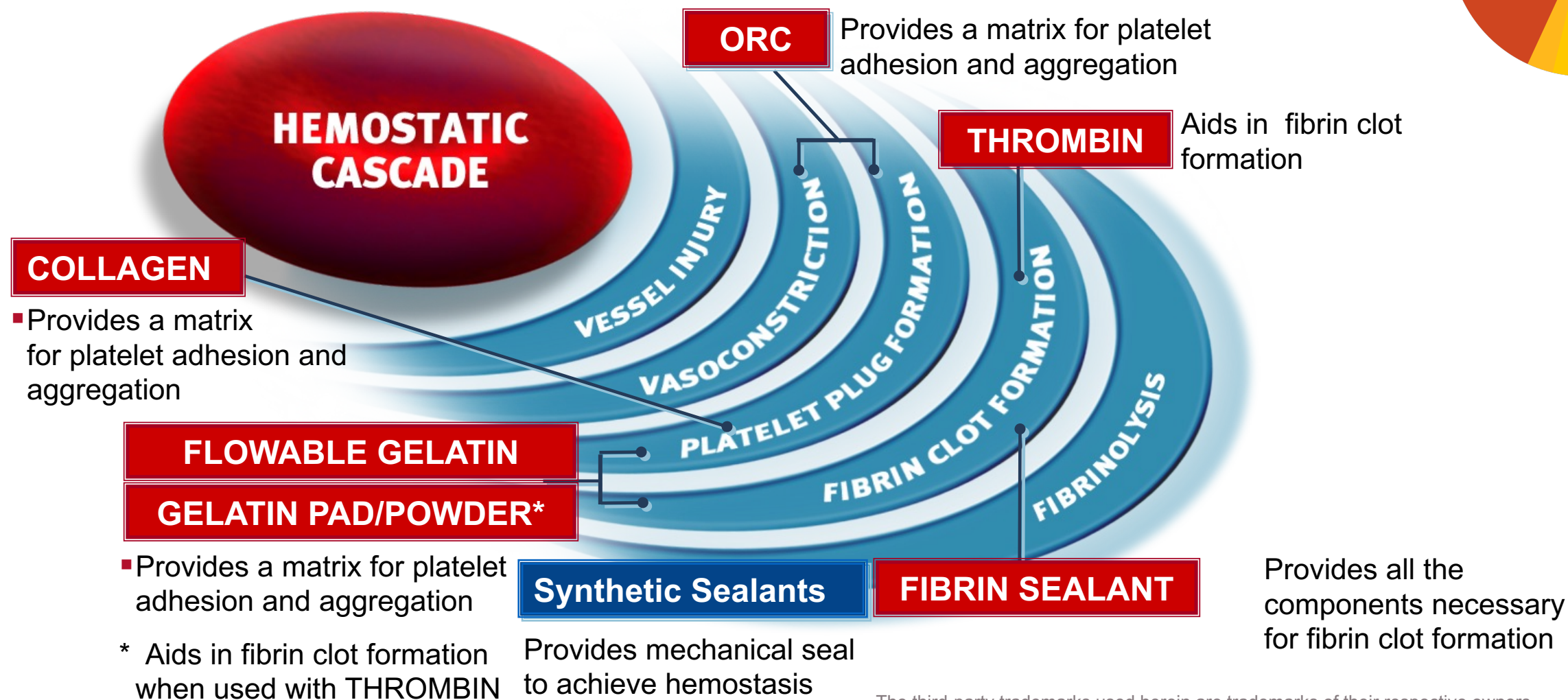
■ 3. Coagulation: Prothrombin is converted to thrombin. Thrombin acts upon soluble fibrinogen in the blood to form fibrin monomers which polymerize to form an insoluble fibrin clot (the clot is also referred to as a fibrin mesh). Once the clot is in place, the site of the injury heals.

■ 4. Fibrinolysis: The dissolution of the clot occurs from within, when an enzyme called plasmin works to dissolve the fibrin mesh, as well as the platelets held within. Once plasmin has completely dissolved the clot, normal blood flow through the vessel will resume.



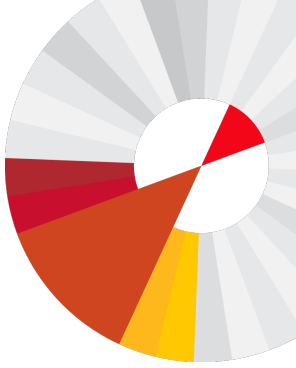
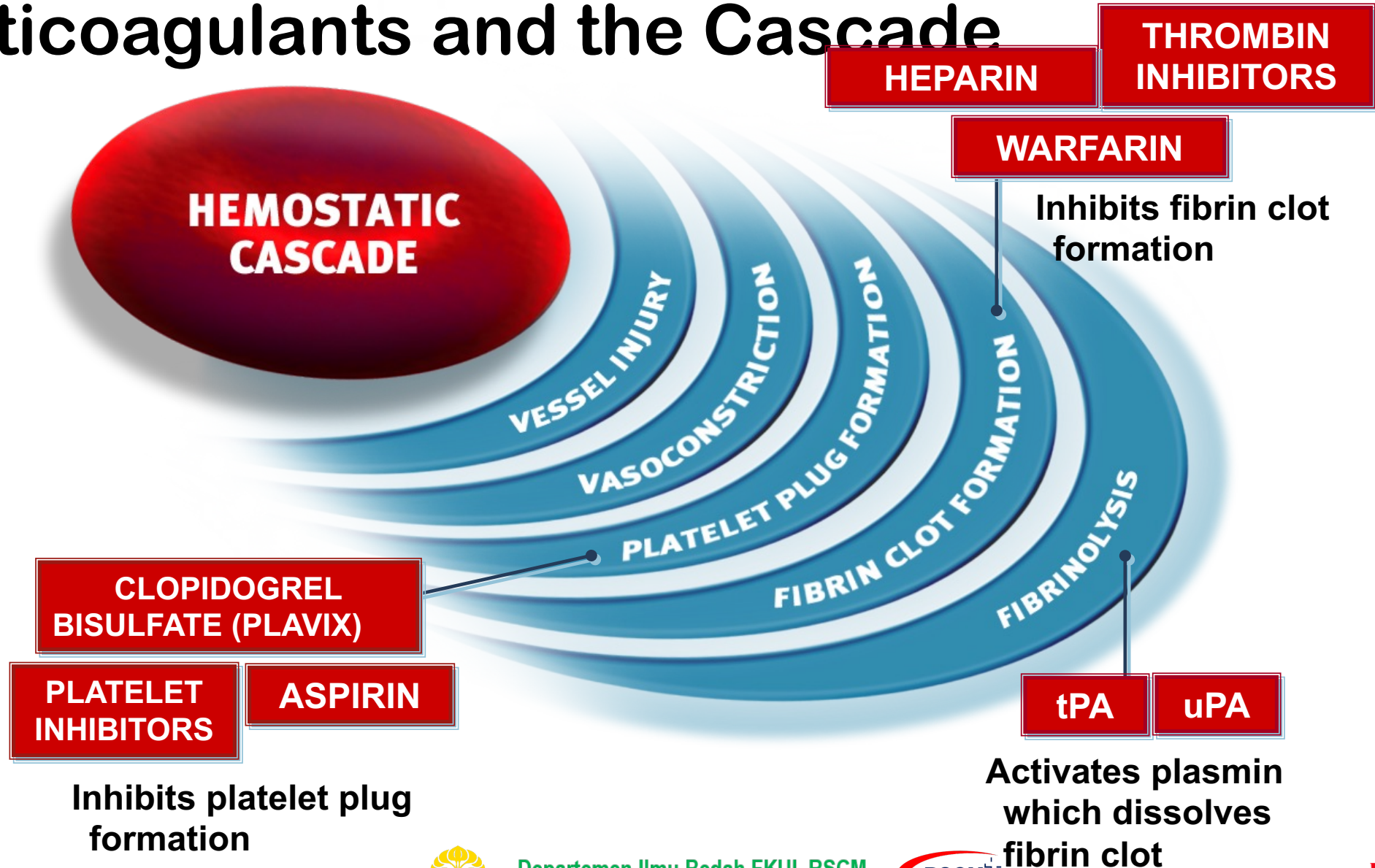


# When and What to Used?



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# Anticoagulants and the Cascade



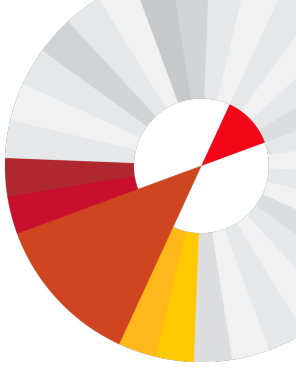
# Choosing a Hemostat

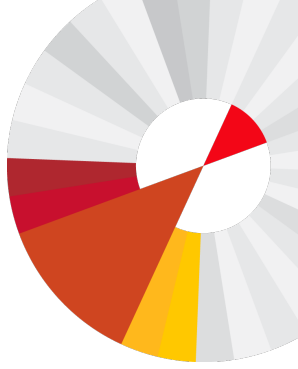
## CLINICAL FACTORS:

- Degree of bleeding (mild vs. heavy)
- Patient factors (i.e., coagulopathy, comorbidities)
- Tissue type (i.e., solid organ, soft tissue, vessel, bone, etc.)
- Access to bleeding site (i.e., open vs. laparoscopic)
- Site characteristics (i.e., raw surface, laceration, penetration, suture or staple line, etc.)

## PRODUCT FACTORS:

- Efficacy / time to achieve hemostasis
- Source (Bovine, Cellulose, Porcine)
- Impact on infection
- Ease of use (preparation & application, device flexibility)
- Cost per application





# S3 Framework

- Site
  - Where is the bleeding? (Confined Space, Raw Surface)
- Situation
  - What type of Bleeding? (Oozing, Mild, Arterial)
- Solutions
  - Electrocautery, ORC, Gelatin

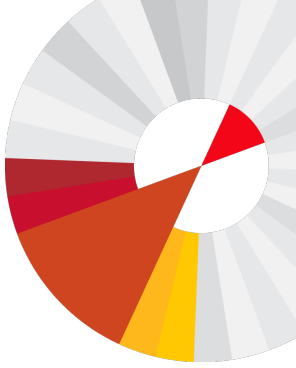






# Bone Wax

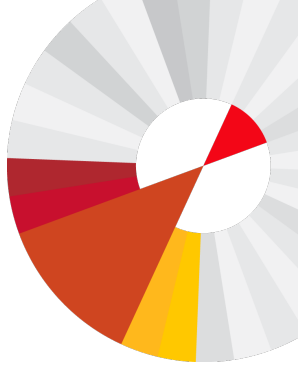




# Advantages/Disadvantages Bone Wax

- Advantages
  - Easy to handle
  - Stop bleeding almost instantaneously (tamponade effect)
  - Low Cost
- Disadvantages
  - Hinders Osteogenesis thus impairs bone healing
  - Impede bacterial clearance nidus for infection

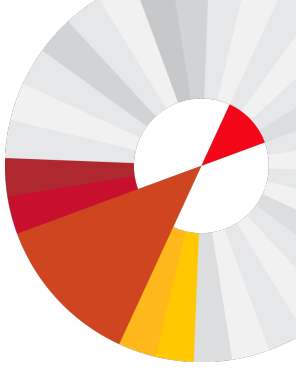




# Gelatin Sponge

## Topical Absorbable Hemostats





# Gelatin Sponges/Foam

- It provides physical matrix for clotting to be initiated
- Less infection and inhibitions compare to Bone Wax
- It swells a lot and double the volume (Good? Bad?)



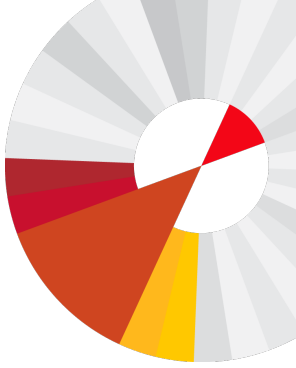


# Oxidized Regenerated Cellulose

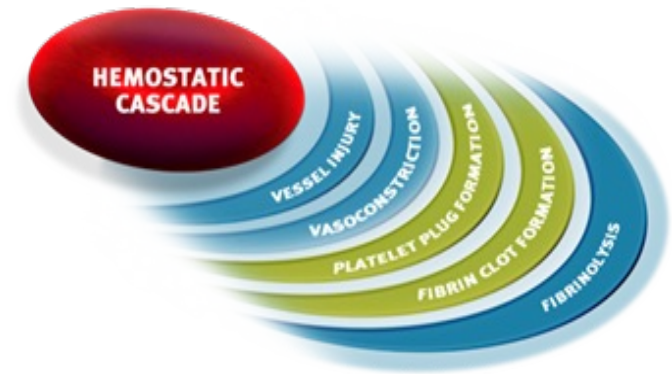
## Topical Absorbable Hemostats



# Topical Absorbable Hemostats Oxidized Regenerated Cellulose



- Product Category Overview
- Plant-based, fabric-like product
- Available in a variety of weaves
- Low pH creates bactericidal environment
- Absorbable in 7-14 days
- Broadly used across many procedures



## MECHANISM OF ACTION

Absorbs  
blood



Low pH causes  
localized  
vasoconstriction



Provides a matrix for platelet  
adherence, accelerating the  
formation of the platelet plug

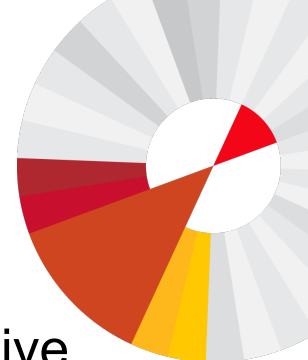
# How is Absorbable Hemostat Bactericidal?

- Absorbable Hemostat has no pH in the dry form
- Contact with moisture triggers the breakdown of cellulose and release of glucuronic acid
- Glucuronic acid is low in pH (2.5)
- Blood pH is around 7.4 – an ideal environment for bacteria to survive and proliferate (optimal growth range is pH 4.4–9)
- Under acidic conditions, bacteria becomes less active and many are unable to survive at pH levels lower than 4.4

Representative pH values	
Substance	pH
Hydrochloric Acid, 10M	-1.0
Battery acid	0.5
Gastric acid	1.5 – 2.0
Lemon juice	2.4
Cola	2.5
Vinegar	2.9
Orange or apple juice	3.5
Beer	4.5
Acid Rain	<5.0
Coffee	5.0
Tea or healthy skin	5.5
Milk	6.5
Pure Water	7.0
Healthy human saliva	6.5 – 7.4
Blood	7.34 – 7.45
Seawater	7.7 – 8.3
Hand soap	9.0 – 10.0
Household ammonia	11.5
Bleach	12.5
Household lye	13.5
Caustic Soda	13.9

pH of blood in contact with SURGICEL® Hemostat

Blood pH, bacteria proliferates

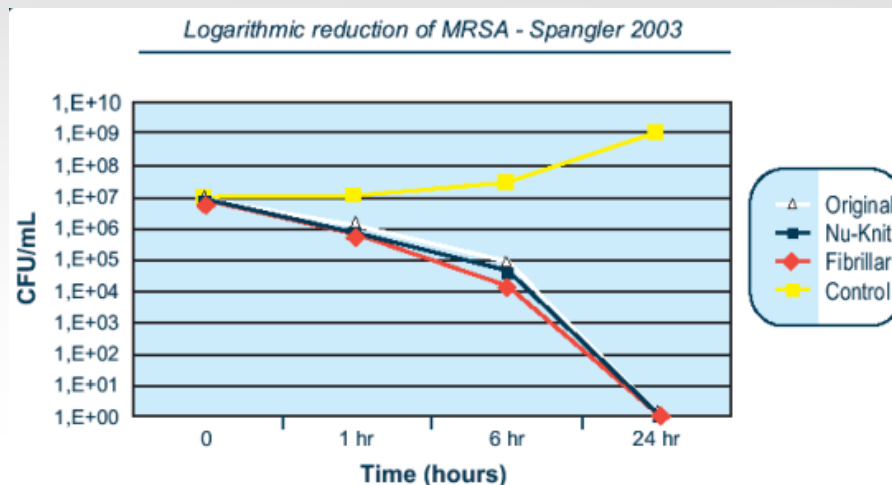


# Proven Bactericidal Advantage

Absorbable Hemostat that is proven to be bactericidal against a broad range of gram-positive and gram-negative organisms, including various antibiotic-resistant bacteria (MRSA, VRE, PRSP and MRSE)\* 1-3

\* **MRSA**, (methicillin-resistant Staphylococcus aureus); **MRSE** (methicillin-resistant Staphylococcus epidermis); **VRE** (vancomycin-resistant Enterococcus); **PRSP** (penicillin-resistant Streptococcus pneumoniae)

Family of Hemostats was effective at killing antibiotic resistant bacteria in vitro.

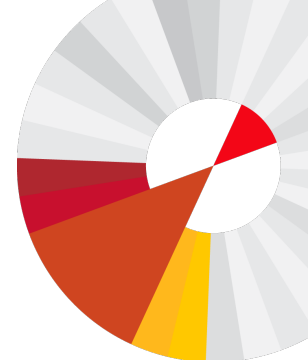


Clinical significance of these animal or in vitro data has yet to be determined. Closing Absorbable Hemostat in contaminated wound without drainage may lead to complications and should be avoided.

1. SURGICEL® Absorbable Hemostat Full Prescribing Information 2. Data on file, in vivo study, Ethicon, Inc. 3. Spangler D, et al. In Vitro Antimicrobial Activity of Oxidized Regenerated Cellulose against antibiotic-resistant microorganisms. Surgical Infection.2003: 4(3):255-262.



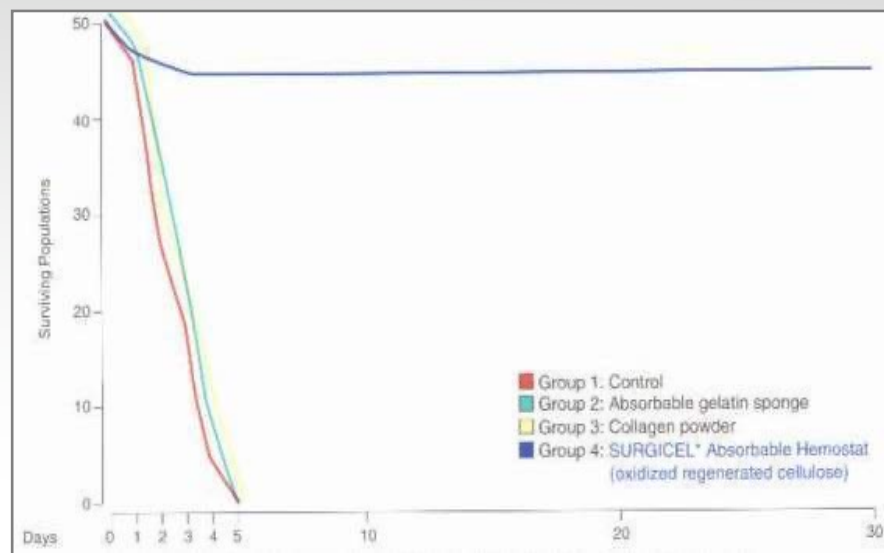




# Proven Bactericidal Advantage

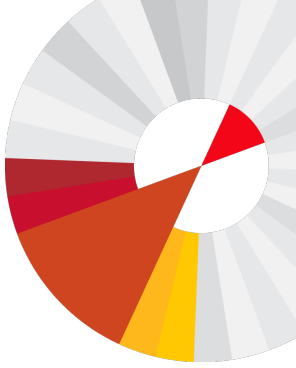
In vivo animal studies have proven Absorbable Hemostat, in contrast to other hemostatic agents studied, does not enhance infection<sup>1</sup>

In an in vivo, Absorbable Hemostat was 90% effective in preventing mortality from intra-abdominal bacterial contamination



Clinical significance of these animal or in vitro data has yet to be determined. Closing Absorbable Hemostat in contaminated wound without drainage may lead to complications and should be avoided.

The experimental model: 140 guinea pigs were utilized to simulate the development of intra-abdominal abscess and/or peritonitis which can occur in humans when a large blood clot becomes contaminated.



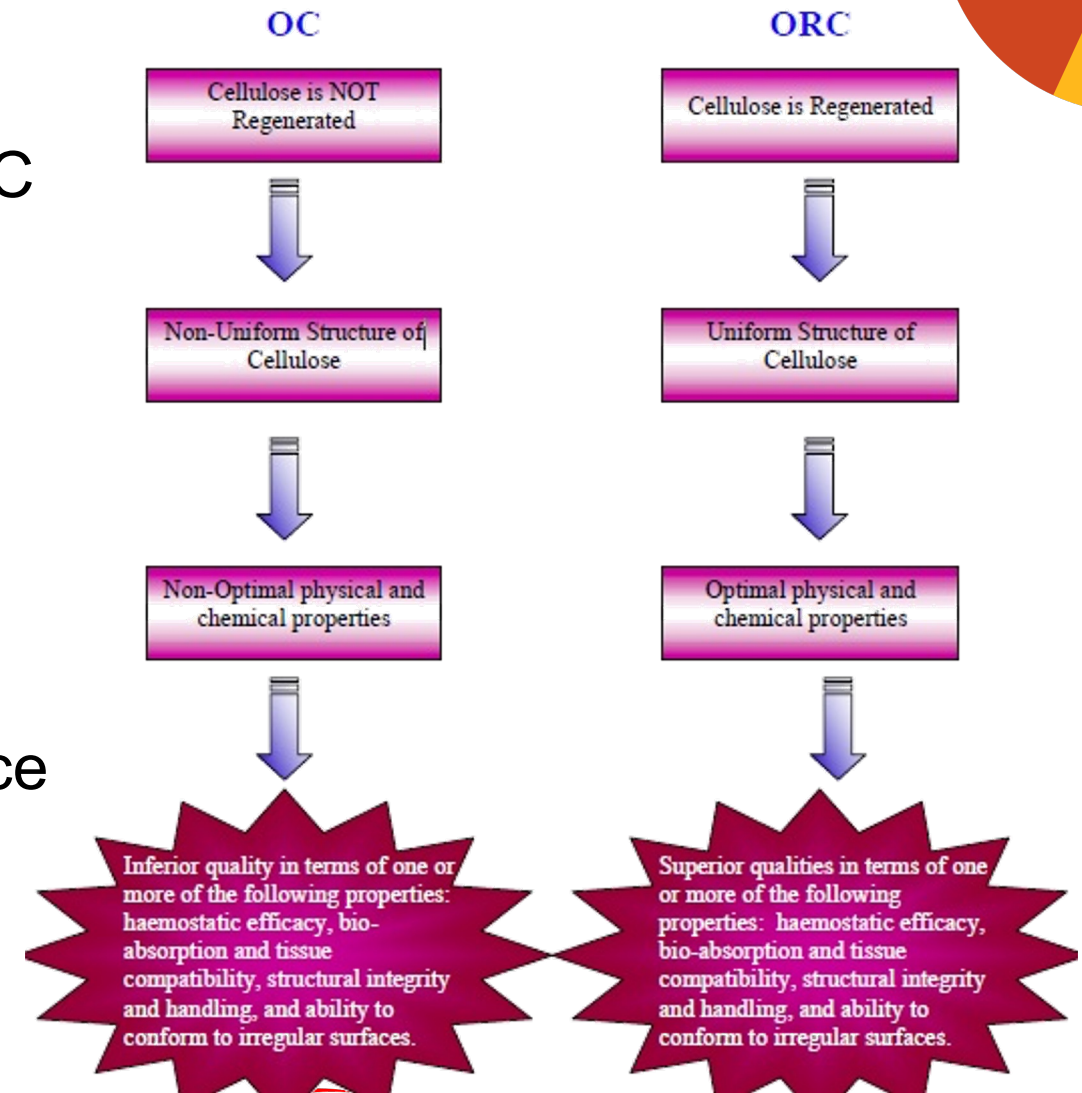
# Family Of Hemostats Bactericidal Against

- Methicillin-resistant *Staphylococcus aureus* (MRSA)
- Penicillin-resistant *Streptococcus pneumoniae* (PRSP)
- Vancomycin-resistant *Enterococcus* (VRE)
- Methicillin-resistant *Staphylococcus epidermidis* (MRSE)
- *Staphylococcus aureus*
- *Staphylococcus epidermidis*
- *Micrococcus luteus*
- *Streptococcus pyogenes* Group A
- *Streptococcus pyogenes* Group B
- *Streptococcus salivarius*
- *Branhamella catarrhalis*
- *Escherichia coli*
- *Klebsiella aerogenes*
- *Lactobacillus sp.*
- *Salmonella enteritidis*
- *Shigella dysenteriae*
- *Serratia marcescens*
- *Bacillus subtilis*
- *Proteus vulgaris*
- *Corynebacterium xerosis*
- *Mycobacterium phlei*
- *Clostridium tetani*
- *Clostridium perfringens*
- *Bacteriodes fragilis*
- *Enterococcus*
- *Enterobacter cloacae*
- *Pseudomonas aeruginosa*
- *Pseudomonas stutzeri*
- *Proteus mirabilis*

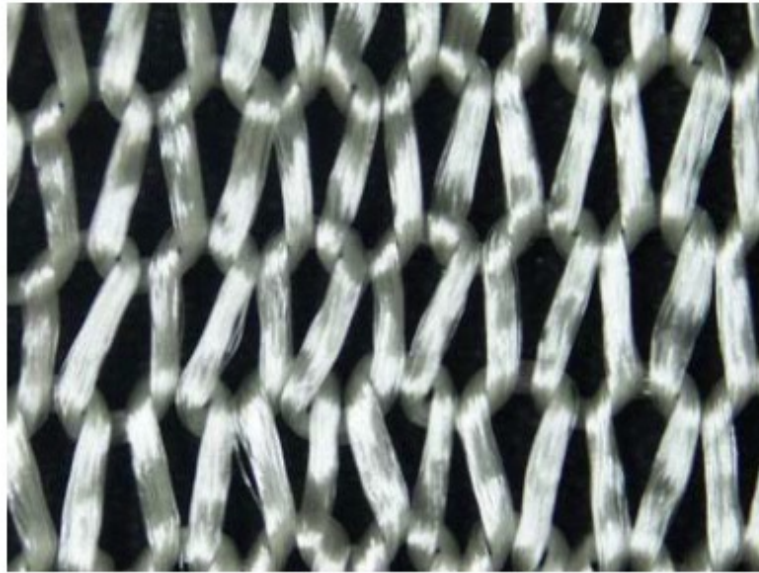


# Oxidized Cellulose vs. Oxidized Regenerated Cellulose

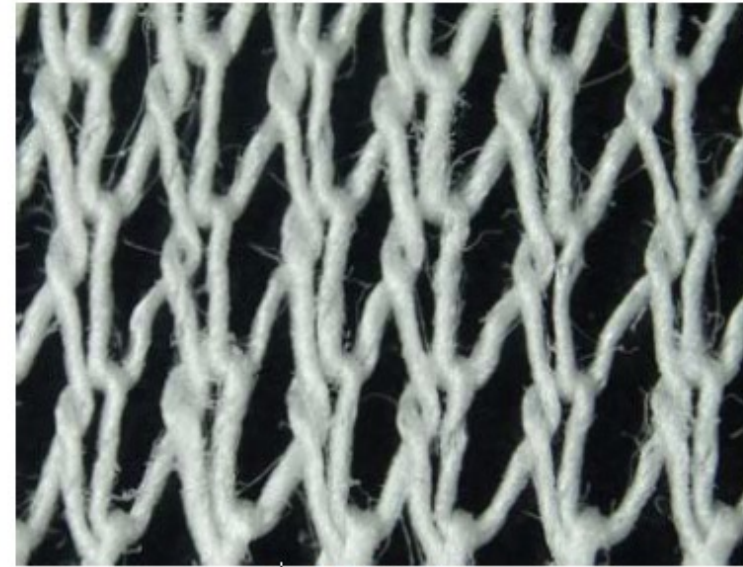
- Oxidized Cellulose is not same as ORC
- Regeneration process make uniform structure
- Inferior quality
  - Hemostatic efficacy
  - Bio Absorption
  - Structural Integrity and Handling
  - Ability to conform in irregular surface



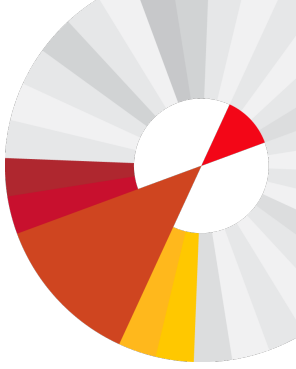
# Oxidized Cellulose vs. Oxidized Regenerated Cellulose



*SURGICEL*



*GELITACEL*

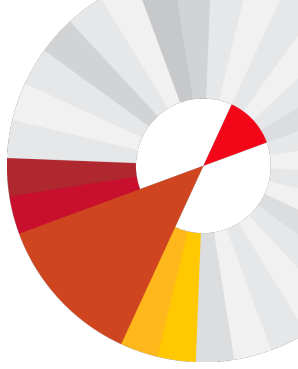


# Do's and Don't

- Do's
  - To be used in Oozing surfaces
  - Use of appropriate size
  - Use only as much is necessary for hemostatic on dry surface
  - Hold it firmly in place +/- 2 minutes (Pressure)
  - Remove any excess in order to facilitate absorption and minimize the possibility of foreign body reactions
- Don't
  - In Arterial bleeding



# Clinical Evidence



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## The role of oxidized regenerated cellulose in preventing surgical site infections: a randomized prospective study on 49 patients with “dirty” surgical wounds

Sergio Alfieri, Dario Di Miceli, Marco Pericoli Ridolfini, Fabio Rotondi, Andrea Di Giorgio, Futura Limongelli, Giuseppe Quero, Giovanni Battista Doglietto

### Background

The problem of surgical site infections (SSI) has significant repercussions clinically and economically since it is still the most common cause of nosocomial infections in surgery patients.

It is important to note the growing number of SSI due to antibiotic-resistant microorganisms. Research of medical aids aimed at minimizing the risk of SSI is a priority, especially for infections due to Gram+ bacteria, most commonly *Staphylococcus Aureus*, coagulase-negative staphylococci, and enterococci.

### Purpose

We report the results of a prospective randomized clinical study that evaluated whether oxidized regenerated cellulose (ORC), when applied to “dirty” surgical wounds, reduced the microbial burden and consequently the infection rate.

### Methods

The study included 49 patients who underwent intestinal re- canalization procedures between December 2003 and December 2006, with the stoma as the surgical site. The following were considered risk factors for SSI: diabetes, smoking, age > 65 years, transfusions, length of preoperative stay, operative time, and placement of a drainage tube. The patients were divided into two groups matched for gender, age, and risk factors; there were 26 patients in the treated group (A) and 23 in the control group (B). In group A, the surgical wound, previous site of the stoma, was packed with Surgicel®, containing ORC, whereas in group B gauze soaked in iodine was used. Microbial wound contamination was evaluated with cultures from 3 separate wound swabs (of the subcutis and dermis); in the operating room before packing the wound, on the

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the skin). The first swab culture evaluated initial contamination of the superficial layers of the wound, identifying the species of bacteria present. The other two evaluated whether the different types of packing (ORC vs. gauze soaked in iodine) had an effect on bacterial contamination.

### Results

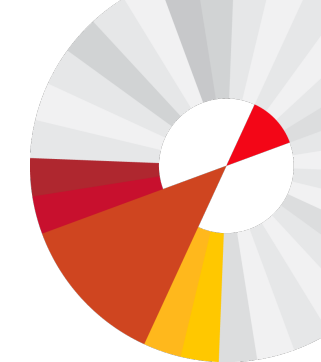
There were no cases of wound dehiscence and no clinically evident superficial or deep SSI in either group. The most frequently isolated microbial species when all swabs were considered was *Enterococcus Faecalis D*, *Escheria Coli*, *Staphylococcus Epidermidis* and *Pseudomonas Aeruginosa*. Analysis of all data revealed that the second and third swabs were negative and bacterial contamination of the wound decreased in 17 patients (65%) in group A, and in only 6 patients (26%) in group B.

### Conclusions

Although it is necessary to consider all factors which can have an influence on SSI and use all means shown to be effective to reduce the risk of SSI, there is a justifiable rationale for using ORC to prevent this infection, especially in patients who undergo “dirty” surgery.

**Key words:** surgical infections, postoperative infections, oxidized regenerated cellulose.

# Clinical Evidence



SURGICAL INFECTIONS  
Volume 4, Number 3, 2003  
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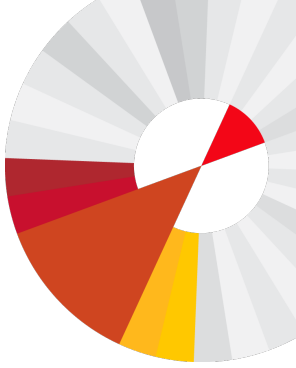
## *In Vitro* Antimicrobial Activity of Oxidized Regenerated Cellulose Against Antibiotic-Resistant Microorganisms

DANIEL SPANGLER,<sup>1</sup> STEPHEN ROTHENBURGER,<sup>1</sup> KIEN NGUYEN,<sup>2</sup>  
HANUMAN JAMPANI,<sup>3</sup> SCOTT WEISS,<sup>4</sup> and SHUBHANGI BHENDE<sup>1</sup>

### ABSTRACT

**Background:** The emergence of multi-drug resistant microorganisms presents a critical problem for patients undergoing surgery. Acidic pH, which is produced by oxidized regenerated cellulose (ORC), is a broad-spectrum physiological detriment to survival of microorganisms known to cause surgical infections. The purpose of this study was to examine the antimicrobial effect of ORC against antibiotic-resistant organisms.

**Methods:** ORC products were challenged with ATCC reference strains and clinical isolates of methicillin-resistant *Staphylococcus aureus* (MRSA), methicillin-resistant *Staphylococcus epidermidis* (MRSE), vancomycin-resistant *Enterococcus* (VRE), penicillin-resistant *Streptococcus pneumoniae* (PRSP), and non-resistant ATCC strains of *S. aureus* and *Pseudomonas aeruginosa*. Samples of three ORC products (SURGICEL\* absorbable hemostat, SURGICEL\* Fibrillar absorbable hemostat, and SURGICEL NU-KNIT\* absorbable hemostat (registered \*Trademark of Ethicon) and identified, respectively, as ORC-R, ORC-F, and ORC-N for this study) were inoculated with challenge organisms in nutrient broth to produce a weight to volume ratio of 15 mg ORC/L. Plate counts were performed at 0, 1, 6, and 24 h.



# Summary

- Multiple ways to manage bleeding (primary & adjunctive)
- Adjunctive hemostats play an important role
- Several considerations when choosing a hemostat
- Broad range of adjunctive hemostats available to meet different needs (i.e., Collagen, Oxidized Regenerated Cellulose, Gelatin, Flowables, Thrombin, Fibrin Sealants)







# End of modules: Thank You

