New England Baptist Hospital

Reducing the Risk of Orthopedic Infections: The Role of Innovative Suture Technology

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Abstract

Background:
The National Healthcare safety Network (NHSN) has reported an overall infection rate of 1.3% and 0.9%, respectively for total hip and knee replacement. These infections are associated with significant patient morbidity. An interdisciplinary study was carried out to determine the benefit of adoption of an innovative suture technology to reduce the risk of infection in patients undergoing total joint replacement.

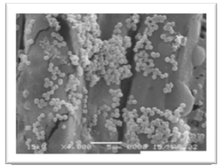
Method:
From September 2005 to August 2006, active surveillance was carried out in 3678 patients undergoing total joint replacement procedures. Cases of SSI were defined by NHSN criteria and patients were stratified by risk (ASA score, operative site and operative site). All patients during this study period were closed using a triclosan-coated polyglactin 910 suture material. Because of implantation of a biomedical device, active surveillance extended a full 12 months post-device implantation. The surgical infection rate observed during this period was compared to a historic interval, September 2004 to August 2005 and involved 3413 patients. All surgical variables with the exception of the suture technology during both study periods were identical. No other risk reduction strategies were implemented during the evaluation period.

Results:
During the suture evaluation period, 12 patients of 3678 total joint procedures (0.33%) developed SSI's compared to the 15 of 3413 in the historical control group (0.44%). No significant difference was observed in the SSI rate for the time intervals studied. However, subgroup analysis did document 6 fewer Staphylococcus aureus infections in the triclosan-suture group (N = 4) compared to the historical control (N = 10).

Conclusions:
Use of triclosan-coated sutures resulted in a slight reduction in overall surgical site infection rates and a 62% reduction in total joint infections involving Staphylococcus aureus. Further studies are warranted to evaluate the efficacy of impregnated suture technology to reduce the risk of surgical site infections.

Risk of Biofilm

- Biofilm is created when microorganisms like bacteria attach themselves to living or nonliving surfaces in internal or external environments
- For instance, postoperative bacteria may contaminate the tissue in a surgical wound as well as the suture material itself
- Furthermore, the bacteria develop extracellular polymers that promote greater adhesion and resistance to antimicrobial treatment



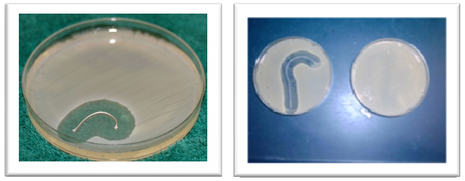
Non-coated suture with Staphylococcus aureus colonies

Purpose of Antibacterial Suture
To prevent colonization of the suture material by bacteria in surgical wounds, triclosan coated polyglactin 910 suture with antibacterial activity was developed. Several studies have showed a considerable decrease in bacteria adherence in vitro.

Properties Of Polyglactin 910 Coated Suture With Triclosan

- 2,4,4´-tri-chloro-2´-hydroxydiphenyl ether High-purity material that meets USP specifications for triclosan, with minimal residue content
- Biocompatible, nontoxic
- Contained in many consumer products (eg mouthwash, toothpaste, antibacteria soap)
- Affective against methicillin-sensitive and methicillin-resistant S aureus and S epidermidis (most common for device infections)
- Active against Escherichia coli and Klebsiella pneumoniae
- Compatible with suture processing and maintains excellent suture properties

In-vitro testing of triclosan suture on seeded agar plates with 0.5 MacFarland broth prepared clinical isolates of Staphylococcus aureus.
Agar plate on the left demonstrates a wide zone of inhibition around the triclosan-coated polyglactin braided suture 5 days after inoculation and incubation. The plate on the right shows a similar zone of inhibition around the suture at day 10 but does show breakthrough of bacteria at the cut ends of the suture. This breakthrough was not associated with emerging resistance but rather was associated with termination of antimicrobial activity. To the right of it is an agar plate with a non-coated suture as a control and shows bacterial growth surrounding the entire suture.



Examination Of The Potential For Air Current Contamination

To examine this potential risk, air settling plates were placed for the last hours of a total hip replacement and showed air current contamination from room activity. Often anesthesia, instrument reps, circulators and orderlies may move in and out of the room at the end of a case, resulting in air current transmission of common skin microorganisms. The blood agar plates show Staphylococcus colonies on the anesthesia cart, computer desk and bovie cart. This was the major reason for implementing coated sutures to the bundle of prevention measures, so tissues would be protected at a critical time when room contamination might occur from staff activity and movement.

Anesthesia Cart | Computer Desk | Bovie Cart

Results

During the suture evaluation period, 12 patients of 3678 total joint procedures (0.33%) developed SSI's compared to the 15 of 3413 in the historical control group (0.44%). No significant difference was observed in the SSI rate for the time intervals studied. However, subgroup analysis did document 6 fewer Staphylococcus aureus infections in the triclosan-suture group (N = 4) compared to the historical controls (N = 10).

Triclosan suture	Infections	Cases	Rate(%)		
			Lower	p	Upper
Pre-trial	15	3413	0.26	0.44	0.74
Trial	12	3678	0.20	0.33	0.63

Table 2: Orthopedic Infection During Historical Control Period (September 2004 – August 2005)

Surgical Procedure	NEBH Infections	Cases	NEBH Rate	NNIS Rate*	P Value
Hip Prosthesis: 0	1	653	0.2	0.86	0.041*
Hip Prosthesis: 1	2	822	0.2	1.65	0.001*
Hip Prosthesis: 2+3	1	191	0.5	2.52	0.064
Knee Prosthesis: 0	3	642	0.2	0.88	NS
Knee Prosthesis: 1	6	902	0.7	1.28	0.068
Knee Prosthesis: 2+3	2	203	1.0	2.26	NS
Total	**15**	**3413**	**0.44**		**p = <0.05***

**NNIS data: January 1992-October 2004*

Table 3: Orthopedic Infections During Suture Evaluation Period (September 2005–August 2006)

Surgical Procedure	NEBH Infections	Cases	NEBH Rate	NNIS Rate	P Value
Hip Prosthesis: 0	0	856	0.0	0.86	0.006*
Hip Prosthesis: 1	2	762	0.3	1.65	0.011*
Hip Prosthesis: 2+3	3	198	1.5	2.52	NS
Knee Prosthesis: 0	1	840	0.1	0.88	0.015*
Knee Prosthesis: 1	3	844	0.4	1.28	0.013*
Knee Prosthesis: 2+3	3	178	1.7	2.26	NS
Total	**12**	**3678**	**0.33**		***p = <0.05***

**NNIS data: January 1992-October 2004*

Table 4: Staphylococcus Surgical Site Infections in Historical Control Group (September 2004-August 2005)

Type of Joint	# SSI	# Procedures	Rate	#Staph aureus	SSI Rate
Hip	4	1666	0.25	3 (75%)	0.18
Knee	11	1747	0.63	7 (64%)	0.40
Total	**15**	**3413**	**0.44**	**10 (67%)**	**0.29***

Table 5: Staphylococcus Surgical Site Infections in Triclosan-Coated Suture Group (September 2005 - August 2006)

Type of Joint	#SSI	# Procedures	Rate	#Staph aureus	SSI Rate
Hip	5	1818	0.27	2 (40%)	0.11
Knee	7	1862	0.37	2 (28%)	0.11
Total	**12**	**3678**	**0.33**	**4 (33%)**	**0.11***

**62% reduction in Staphylococcus aureus in treated group*

Discussion

The Centers for Disease Control and Prevention (CDC) defines SSIs as those occurring within 30 days of an operation, and within 1 year if a non-human derived implant is placed surgically. Clearly exquisite surgical technique, antimicrobial prophylaxis, skin antisepsis and a competent infection control program are mainstays for preventing surgical site infections. In addition, other adjunctive strategies such as iodophor-impregnated incise drapes, appropriate hair removal techniques, ventilated surgical suits, laminar air flow, limited access to the operating room during procedures have been reported in the literature to reduce the risk of SSIs in orthopedic surgery. Other innovative technologies aimed at reducing postoperative SSI have included glycemic control, increased tissue oxygenation, normalizing core body temperature. antibacterial irrigations, antibiotic cement spacers, antibacterial wound dressings and antimicrobial impregnated implanted devices. These selected interventions are designed to augment the host wound defense posture or to diminish wound bed contamination, fostering an environment for wound healing.

It has been suggested that the implanted suture material can serve as a nidus for bacterial colonization and by virtue of being a foreign body, lower the inoculum burden required development of a surgical site infections for contribute to subsequent infection. Braided suture has been shown to have a higher affinity for microbial adherence and colonization than monofilament devices. The factors that influence adherence include the specific microbial species and the structure and composition of the suture material. Placement of a suture within the surgical wound which elutes an antimicrobial substance within the wound bed may be helpful in reducing the risk of wound contamination and subsequent SSI.

In our study, use of triclosan-coated polyglactin 910 suture demonstrated a small reduction in the hip and total joint surgical site infection rates. However, a marked reduction was noted in Staphylococcus aureus infections in both total knee and hip replacement surgery during the 12-month evaluation period. The use of triclosan-coated sutures for closing fascia and superficial skin layers would appear to offer protection at the end of the surgical case when possible exogenous contamination might occur within the wound bed. Antibacterial sutures should be viewed as a salient component of an overall risk reduction strategy, which includes timely and appropriate antimicrobial prophylaxis, effective skin antisepsis and other potential evidence-based interventions in an effort to improve clinical outcome in the surgical patient population.

Conclusions

Use of triclosan-coated sutures resulted in a slight reduction in overall surgical site infection rates and a 62% reduction in total joint infections involving Staphylococcus aureus. Further studies are warranted to evaluate the efficacy of impregnated suture technology to reduce the risk of surgical site infections.

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