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Can a layer of antimicrobial agents be placed around breast implants to prevent staph infections from occurring?

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References: • Ajdic D., Zoghbi Y., Gerth D., Panthaki Z.J., & Thaller S. (2015). The Relationship of Bacterial Biofilms and Capsular Contracture in Breast Implants. Aesthetic Surgery Journal, 36(3), 297-309, doi: 10.1093/asi/sjv177 • Arad E., Navon-Venezia S., Gur E., Kuzmenko B., Glick R., Frenkiel-Krispin D., Kramer E., Carmeli Y., & Barnea Y. (2013). Novel Rat Model of Methicillin-Resistant Staphylococcus aureus-Infected Silicone Breast Implants: A Study of Biofilm Pathogenesis Plastic Reconstructive Surgery, 131(2), 205-214, DOI: 10.1097/PRS.0b013e3182778590. • Esposito, M., Grusovin, M.G., Loli, V., Coulthard, P., & Worthington, H.V. (2010). Does Antibiotic Prophylaxis at implant placement decrease early implant failures? A Cochrane systematic review European Journal of Oral Implantology, Vol. 3(2), pp.101-110. • Flemming K., Klingenberg C., Cavanagh J.P., Sletteng M., Stensen W., Svendsen J.S., & Flaegstad T. (2008). High in vitro antimicrobial activity of synthetic antimicrobial peptidomimetics against staphylococcal biofilms. Journal of Antimicrobial Chemotherapy, 63(1), 136-145, doi: 10.1093/jac/dkn464 • Gosau M., Burgers R., Vollkommer T., Holzmann T., & Prant L. (2012). Effectiveness of antibacterial copper additives in silicone implants Journal of Biomaterials Applications, 28(2), 300-313, doi: 10.1177/0885328212441957 • Heerde J.V., Turner M., Hoffmann D., & Moolman J. (2007). Antimicrobial coating agents: can biofilm formation on a breast implant be prevented? Plastic, Reconstructive, and Aesthetic Surgery, 65(5), 610-617, doi: 10.1016/j.bjps.2007.09.044 • Phillips B.T., Bishawi M., Dagnum A.B., Khan S.U., Bui D.T. (2013). A Systematic

Can a layer of antimicrobial agents be placed around breast implants to prevent staph infections from occurring?

By: Valerie Tran

Introduction:

The most common form of implant infection is a staph infection. Staph infections are caused by the bacteria staphylococcus, which is a biofilm that grows on top of one another while encasing the implant. Most of the time a staph infection tends to infect breasts implants. This is the most common implant that staphylococcus tends to grow on because of the general layout of the surgical procedure for breast augmentation.

As of now treatment options to treat this are oral, intravenous antibiotics, or surgery. Even though these methods have a low mortality rate, the efficiency of these methods are low and are costly. Therefore, there needs to be a more affordable and efficient way to treat staph infections. One way is to have a thin layer of antibiotics around the implant before it is surgically placed in a patient.

Presently, there are multiple ways to treat staph infections around a breast implant. However, these options have a low success rate and target the infection after it has developed. Therefore, there needs to be an option to treat staph infections before they occur. That is why a layer of antimicrobial agents is needed to surround the breast implant because this will reduce the presence of staph infections, and the use for inefficient treatment.

Figure1: types of breast implants currently on the market.
Unknown. (2015) http://www.collective-evolution.com/2015/10/21/breast-implants-the-ticking-time-bomb-in-millions-of-womens-bodies/

Methods and Materials:

In order to create a proper review of research, multiple perspectives were used. This created a well balanced paper to fully address the pros and cons to this question. The first perspective is to draw in sources that complete studies that use antimicrobial agents to treat staph infections around the breast implant. The second perspective is using other agents to surround the implant to prevent staph infections besides antimicrobial infections. The third and final perspective is to obtain articles that make the claim that pre-operative methods can be put in place or improving pre-operative methods can result in staph infection decrease. Therefore there is no need for a layer of antimicrobial agents to be placed around the implant.

All these perspectives provided data that allowed for a level of comparison to see which method to reduce staph infections is most affective.

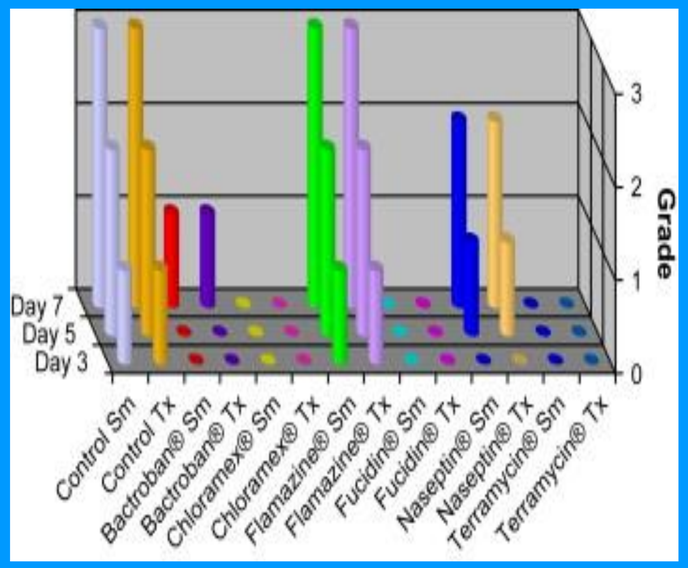

Figure 2: Results of various antimicrobial agents used to combat staph infections around breast implants.
Heerde J.V., Turner M., Hoffmann D., & Moolman J. (2007). Antimicrobial coating agents: can biofilm formation on a breast implant be prevented? Plastic, Reconstructive, and Aesthetic Surgery, 65(5), 610-617, doi: 10.1016/j.bjps.2007.09.044

Table 2. Summary of Results for Model (Untreated) Rats

Group	Temperature Change (°C)* Day 11	Weight Change (g)* Day 11	Wound Score† (mean ± SD) Day 11	Mean ± SD MRSA Counts from Implants or Surgical Pocket (CFU/ml)		Mean ± SD MRSA Counts from Spleens (CFU/g spleen)	
				Day 4	Day 11	Day 4	Day 11
A	0	9.7	0	$0.74 \pm 1.87 \times 10^5$‡	$2.43 \pm 1.38 \times 10^5$‡	0	0
B	0.3	−4.5	1.5 ± 0.93	$0.98 \pm 1.92 \times 10^6$‡	$2.15 \pm 4.38 \times 10^5$‡	$1.22 \pm 1.79 \times 10^6$	$3.71 \pm 5.03 \times 10^3$
C	0.3	5.5	1.13 ± 1.25	$7.12 \pm 8.73 \times 10^6$§	$0.99 \pm 1.22 \times 10^7$§	$7.07 \pm 8.24 \times 10^6$	$0.87 \pm 2.10 \times 10^2$

MRSA, methicillin-resistant *S. aureus*; CFU, colony-forming units.
* Values were normalized to day 4.
† Wound healing score was calculated according to the scale specified in the Materials and Methods section.
‡ Samples were from retrieved implants.
§ Samples were from surgical pockets.

Table 3. Summary of Results for Vancomycin-Treated Rats (Day 11)

Group	No.	Temperature Change (normalized day 4)		Weight Change (normalized day 4)		Wound Score*		MRSA Counts from Implants or Surgical Pocket		MRSA Counts from Spleens	
		°C	*p*†	g	*p*†	Mean ± SD	*p*†	CFU/ml	*p*†	CFU/g Spleen	*p*†
A	3	−0.1	0.88	14.5	0.49	0	1	$4.47 \pm 6.81 \times 10^6$‡	0.56	0	1
B	10	−0.4	0.04	−5.5	0.77	0.25 ± 0.46	0.01	$1.08 \pm 1.24 \times 10^4$‡	0.01	$4.98 \pm 7.94 \times 10^3$	0.67
C	7	−0.5	0.04	4.9	0.47	0.88 ± 1.13	0.7	$1.47 \pm 3.07 \times 10^6$§	<0.01	$0.75 \pm 1.95 \times 10^2$	1

MRSA, methicillin-resistant *S. aureus*; CFU, colony-forming units.
* Wound healing score was calculated according to the scale specified in the Materials and Methods section.
† The *p* value for comparison of each variable to data for model rats of same group (see Table 2).
‡ Samples were from retrieved implants.
§ Samples were from surgical pockets.

Figure 3: Results from having layer of Vancomycin surround breast implants to combat staph infections.
Arad E., Navon-Venezia S., Gur E., Kuzmenko B., Glick R., Frenkiel-Krispin D., Kramer E., Carmeli Y., & Barnea Y. (2013). Novel Rat Model of Methicillin-Resistant Staphylococcus aureus-Infected Silicone Breast Implants: A Study of Biofilm Pathogenesis Plastic Reconstructive Surgery, 131(2), 205-214, DOI: 10.1097/PRS.0b013e3182778590.

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Discussion and Conclusion:

Based on the results from the literature review of research it seems as though there is a potential of having a thin layer of antimicrobial agents around a breast implant. And that this layer of antimicrobial agents can be effective in combating staph infections. However, further research is still needed in discovering the amount of antibiotics best suited to surround the implant without harming the patient yet still be effective in combating staph infections in its early stages. In addition, further research needs to be completed where human subjects are involved. Also, further research needs to be completed in addressing possible complications if this were to ever be marketed into the medical field. Lastly, future implications that can be used from this research is to compare it with other implants to see if it too is possible to create an implant with an antimicrobial layer to combat common infections present in those implants.

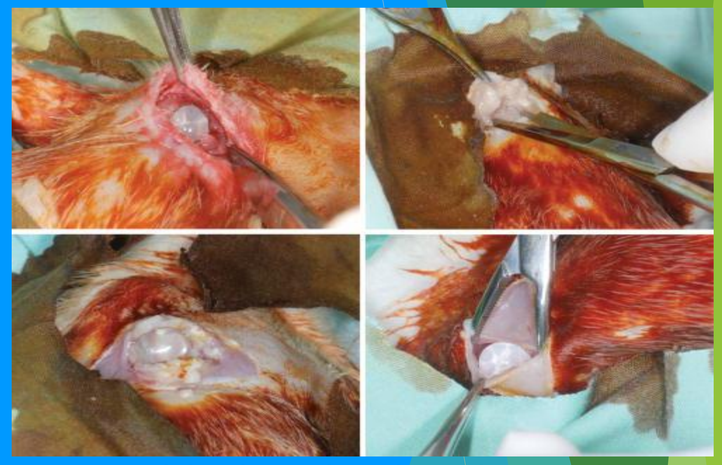

Figure 4: Removal of mini-breast implants with a coat of Vancomycin from rats.
Arad E., Navon-Venezia S., Gur E., Kuzmenko B., Glick R., Frenkiel-Krispin D., Kramer E., Carmeli Y., & Barnea Y. (2013). Novel Rat Model of Methicillin-Resistant Staphylococcus aureus-Infected Silicone Breast Implants: A Study of Biofilm Pathogenesis Plastic Reconstructive Surgery, 131(2), 205-214, DOI: 10.1097/PRS.0b013e3182778590.

References:

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- Arad E., Navon-Venezia S., Gur E., Kuzmenko B., Glick R., Frenkiel-Krispin D., Kramer E., Carmeli Y., & Barnea Y. (2013). Novel Rat Model of Methicillin-Resistant Staphylococcus aureus-Infected Silicone Breast Implants: A Study of Biofilm Pathogenesis Plastic Reconstructive Surgery, 131(2), 205-214, DOI: 10.1097/PRS.0b013e3182778590.
- Esposito, M., Grusovin, M.G., Loli, V., Coulthard, P., & Worthington, H.V. (2010). Does Antibiotic Prophylaxis at implant placement decrease early implant failures? A Cochrane systematic review European Journal of Oral Implantology, Vol. 3(2), pp.101-110.
- Flemming K., Klingenberg C., Cavanagh J.P., Sletteng M., Stensen W., Svendsen J.S., & Flaegstad T. (2008). High in vitro antimicrobial activity of synthetic antimicrobial peptidomimetics against staphylococcal biofilms. Journal of Antimicrobial Chemotherapy, 63(1), 136-145, doi: 10.1093/jac/dkn464
- Gosau M., Burgers R., Vollkommer T., Holzmann T., & Prant L. (2012). Effectiveness of antibacterial copper additives in silicone implants Journal of Biomaterials Applications, 28(2), 300-313, doi: 10.1177/0885328212441957
- Heerde J.V., Turner M., Hoffmann D., & Moolman J. (2007). Antimicrobial coating agents: can biofilm formation on a breast implant be prevented? Plastic, Reconstructive, and Aesthetic Surgery, 65(5), 610-617, doi: 10.1016/j.bjps.2007.09.044
- Phillips B.T., Bishawi M., Dagnum A.B., Khan S.U., Bui D.T. (2013). A Systematic Review of Antibiotic Use and Infection in Breast Reconstruction: What is the Evidence? Plastic and Reconstructive Surgery, 131(1), 1-13. doi: 10.1097/PRS.0b013e3182729c39.
- Townley W.A., Baluch N., Shaghayegh B., Maass S.W.M.C., O'Neill A., & Zhong T., Hofer S.O.P. (2014). A single pre-operative dose is as effective as continued antibiotic prophylaxis in implant-based breast reconstruction: A matched cohort study Journal of Plastic, Reconstructive & Aesthetic Surgery, 68(5), 673-678.