Plastic and Aesthetic Nursing

I Have a Question!

Biofilm

Sharon Ann Van Wicklin, PhD, RN, CNOR, CRNFA(E), CPSN-R, PLNC, ISPAN-F, FAAN

Plastic and Aesthetic Nursing (PAN), *the official journal of the International Society of Plastic and Aesthetic Nurses (ISPAN) publishes this column to provide evidence-based answers to practice questions from plastic and aesthetic nurses.*

Question: What is a biofilm?

Answer: A *biofilm* is an organized, microbial community comprised of bacteria, fungi, or protozoa embedded within a slimy, extracellular, self-produced matrix made of proteins, *polysaccharides* (i.e., carbohydrate molecules), extracellular DNA (eDNA), and *lipids* (i.e., fatty acids). The matrix surrounds, supports, and provides structure for the biofilm. The cells within the biofilm stick to each other and also adhere to surfaces (Chiaie, 2023; Convery et al., 2021; Dumitraşcu & Georgescu, 2013; Funt & Pavicic, 2013; Hee & Messina, 2018; Heydenrych et al., 2018; Kim et al., 2020; Urdiales-Gálvez et al., 2018; Witmanowski & Blochowiak, 2020). See Figure 1 for a description of the five phases of biofilm development.

Infections such as cystic fibrosis, native valve endocarditis, otitis media, periodontitis, and chronic prostatitis are caused by biofilm-associated microorganisms (Chiaie, 2023). A large variety of indwelling medical devices have also demonstrated the ability to harbor biofilms (Chiaie, 2023). Because of the slow penetration of the antimicrobial agent through the extracellular matrix and into the heart of the biofilm community, infections caused by biofilms are extremely resistant to antimicrobial agents (Chiaie, 2023; Dumitraşcu & Georgescu, 2013.

Question: Why should I be concerned about biofilm when injecting dermal fillers and biostimulators?

Answer: When dermal fillers or biostimulator agents are injected through the stratum corneum (i.e., the outermost layer of the *epidermis*, the most superficial layer of the skin) the resident microorganisms (e.g., *Staphylococcus aureus*) can be introduced into the deeper layers of the skin. When a filler is injected through the skin or subcutaneous tissue, it can become coated with bacteria that can possibly lead to the formation of a biofilm (Chiaie, 2023). Davies et al. (2021) found that the presence of as few as 100 *S. aureus* microbes could initiate a serious biofilm infection.

The development of a biofilm is a rare event; however, if a biofilm develops on an injected dermal filler or biostimulator, it can lead to the formation of nodules, abscesses, and delayed healing. A biofilm can develop within weeks of a filler injection. The nodules can be tender, leading to patient discomfort and anxiety, and they can persist for months (Aesthetic Advancements Institute, n. d.).

A biofilm can form after any injection with a dermal filler or biostimulator. Factors such as the immune status of the patient, injection technique, immune-triggering events, and bacterial contamination may all contribute to the development of a biofilm. Some schools of thought suggest that biostimulator agents and permanent fillers pose the greatest risk for biofilm formation (Chiaie, 2023; Ledon et al., 2013). Although hyaluronic acid dermal fillers and other biostimulator agents are considered nonpermanent fillers, the persistence of these fillers to remain in vivo for months to years makes them a welcoming host for biofilms (Kim et al., 2020).

Biofilms are seeded at the time of injection, but in most cases, they require a secondary event to become activated. Secondary events that may trigger biofilm activation include low immunity, dental infection, hemolytic contamination, virus or bacterial infection, uncomplicated urinary tract infection, vaccine (of any kind), sinus infection, surgery, and/or further cosmetic injections. Once the biofilm has been activated, the microbes will cause either a local or systemic infection or generate an inflammatory or granulomatous response (Chiaie, 2023; Funt & Pavicic, 2013; Hee & Messina, 2018; Philipp-Dormston et al., 2020).

Aesthetic injectors must understand that a biofilm can reside beneath a granuloma, cold nodule, abscess, delayed hypersensitivity reaction, and any acute infectious process. An important consideration related to biofilms is the potential for cross-layering over another injector's work. The first injector may have planted the bacteria and

Sharon Ann Van Wicklin, PhD, RN, CNOR, CRNFA(E), CPSN-R, PLNC, ISPAN-F, FAAN, is the Editor-in-Chief, *Plastic and Aesthetic Nursing*, and is a Perioperative and Legal Nurse Consultant, Aurora, CO.

Sharon Ann Van Wicklin is the Editor-in-Chief of *Plastic and Aesthetic Nursing* and was excluded from the peer review process for this article.

The author reports no conflicts of interest.

Address correspondence to Sharon Ann Van Wicklin, PhD, RN, CNOR, CRNFA(E), CPSN-R, PLNC, ISPAN-F, FAAN, 8256 South Shawnee St, Aurora, CO 80016 (e-mail: sharonvwrn@ispan.org).

DOI: 10.1097/PSN.0000000000000527

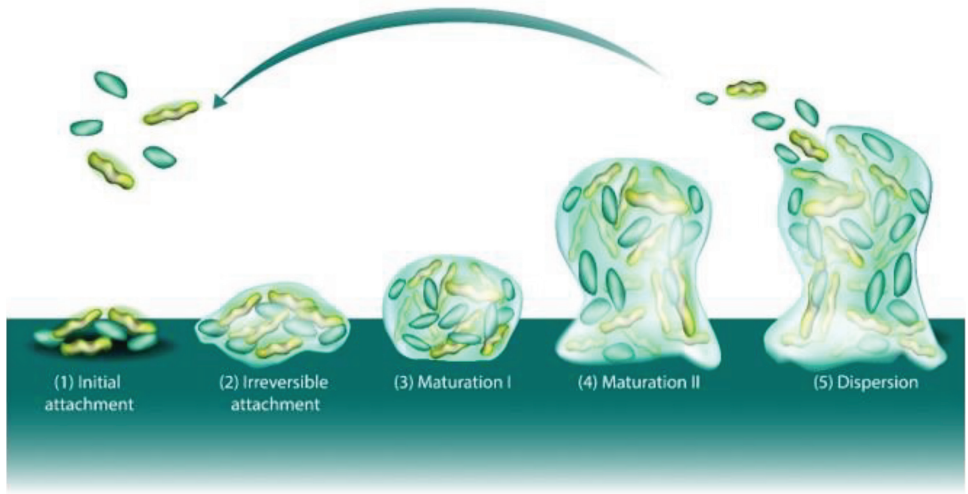

FIGURE 1. Biofilm formation. Sakurra/Shutterstock.com. *Note.* (1) Biofilm begins to form when bacteria are deposited on a surface. (2) The microorganisms begin to multiply and form an irreversible attachment to the surface using bacterial adhesions such as *fimbriae* (i.e., hairlike appendages present on the cells of gram-negative bacteria) and *lipopolysaccharides* (i.e., large toxic molecules consisting of a lipid and a polysaccharide present in the outer membrane of gram-negative bacteria). (3) The bacteria continue to multiply and form a supporting structure made of proteins, *polysaccharides* (i.e., carbohydrate molecules), extracellular DNA (eDNA), and *lipids* (i.e., fatty acids) that envelops and protects the bacteria. (4) The microorganisms residing within this mature biofilm are protected by a thick, sticky, substance similar to dental plaque that is not easily removed, penetrated, or killed by antibiotics. (5) The mature biofilm releases colonizing cells to form new biofilms on other surfaces. This figure is available in color online (www.PANjournal.org).

the low-lying undetectable biofilm infection hides without symptoms until a second injector penetrates the skin and disrupts the biofilm's extracellular matrix (Chiaie, 2023).

Question: How can I know if my patient has developed a biofilm infection?

Answer: Diagnosing a biofilm is challenging and there is no standardized protocol for this type of diagnosis (Silva et al., 2021). The European Society for Clinical Microbiology and Infectious Disease (ESCMID) has published a guideline to assist health care professionals in the diagnosis of infections associated with biofilms. The ESCMID provides recommendations for specific clinical and laboratory procedures to facilitate diagnosis as well as to make patient treatment faster and more effective (Høiby et al., 2015). According to the ESCMID, the most frequent clinical signs of an infection associated with biofilms consist of inflammatory reactions, redness, pain, loss of function, and fever. In addition, the patient must have a history of predisposition to infection (e.g., a medical implant), an infection that persists for more than 7 days, or failure of antibiotic therapy. Regarding biofilm laboratory diagnosis, the ESCMID suggests using electron microscopy and polymerase chain reaction (PCR), where it is possible to identify microbial aggregates around the inflammatory cells and the presence of mucoid or small cells in positive cultures, indicating antibiotic recalcitrance (Kamaruzzaman et al., 2018).

Differentiating between inflammation caused by a low-grade biofilm infection and a low-grade hypersensitivity reaction is also challenging; however, recent literature suggests that a biofilm is most often the underlying cause (Chiaie, 2023; Funt, 2022; Funt & Pavicic, 2013). Some of the dermal filler complications believed to be caused by allergic reactions may actually be the result of a biofilm that has developed on the injected material. This is supported by the fact that the reported "allergic reactions" had no associated formation of antibodies. For this reason, nodules that develop after hydrophilic filler injections are now thought to be due to biofilms (Aesthetic Advancements Institute, n.d.).

Kim et al. (2020) suggested that biofilms are likely caused by methicillin-resistant *S. aureus* or nontypical tuberculosis and should be cultured and then treated with quinolone and a third-generation macrolide, hyaluronidase, and fluorouracil, and if excision is possible, it should be performed after the initiation of antibiotics. Funt (2022) suggests that any erythematous and indurated area appearing at any time after facial filler treatment should be considered to be a biofilm and treated accordingly.

Question: When injecting dermal fillers and biostimulators, what actions can I take to help prevent the formation of biofilm?

Answer: To help prevent the formation of biofilm, aesthetic injectors must use meticulous technique when preparing the patient's skin for injection and when injecting dermal fillers and biostimulators.

SKIN PREPARATION

There are approximately 1 million microorganisms residing on each square centimeter of the surface of the skin

(Davies et al., 2021). Normal skin flora is composed of transient and resident microorganisms. The *transient* organisms reside in the superficial layers of the skin and are much easier to remove than the *resident* microorganisms, which are seated in the deeper layers of the skin (Wood & Conner, 2021).

The purpose of using a skin antiseptic to prepare a patient's face before injecting a dermal filler or biostimulator is to reduce the risk for infection by removing soil, skin oils, and resident and transient microorganisms from the patient's skin (Dumville et al., 2013). The goal of skin antisepsis is to reduce the microbial count on the skin as much as possible, in the shortest time possible, with the least amount of tissue irritation possible, and to prevent subsequent rebound microbial growth (King, 2019).

Using skin antiseptics correctly and effectively to prepare the skin for dermal filler or biostimulator injections is extremely important; however, it is impossible to completely sterilize the skin because approximately 20% of the microorganisms on the skin are resident microorganisms living in the deep layers of the skin where antiseptic solutions are unable to penetrate (Convery et al., 2021; Davies et al., 2021).

After taking into consideration any sensitivity issues a patient may have, removing all makeup or other topical products from the patient's skin, and applying ice (if desired), the aesthetic injector should thoroughly cleanse the patient's skin with an antiseptic preparation and allow the antiseptic preparation to completely air dry on the skin. Keep in mind that ice may be a potential source of contamination (Rodriguez et al., 2013).

There are no clear, evidence-based guidelines regarding which antiseptic skin preparation is best for use in aesthetic practice. While each preparation has its advantages and disadvantages, any of the commonly used antiseptic solutions (e.g., chlorhexidine gluconate) with *residual activity* (i.e., the capability of an antiseptic solution to continue to produce a reduction in the number of viable microorganisms present on the skin for a defined period of time following application) will perform adequately if used in accordance with the manufacturer's instructions. However, using 70% isopropyl alcohol alone is not recommended because of its lack of residual effect (Davies et al., 2021). For further information about the correct use of skin antiseptics, including chlorhexidine gluconate, please see Van Wicklin (2022).

SAFE INJECTION PRACTICES

Safe injection practices are intended to prevent transmission of infections between one patient and another or between a patient and a health care professional (Siegel et al., 2007). Safe injection practices include preparing injections, preparing the injection site, administering the injection, and disposing of the items used for injection. Injection practices specifically identified for preventing biofilm formation include frequent needle changes when injections are penetrating the oral mucosa, not touching the needle or cannula to the skin except where the needle enters, and not touching the needle or cannula to gauze, hair, or gloves (Chiaie, 2023). For additional information about safe injection practices for dermal fillers and biostimulators, please see Van Wicklin (2021).

***If you have a question about plastic and aesthetic nursing that you would like to see addressed in the* I Have a Question!** ***column of* PAN, *or if you would like to provide an answer to a particular practice question, please contact Sharon Ann Van Wicklin, Editor-in-Chief, PAN, at sharonvwrn@ispan.org*.**

REFERENCES

Aesthetic Advancements Institute. (n.d.). *What role do biofilms play in complicating filler injections?* https://aestheticadvancements.com/post/what-role-do-biofilms-play-in-complicating-filler-injections

Chiaie, T. D. (2023). All about biofilms. *Perspectives in Aesthetics*, S16–S18. https://lsc-pagepro.mydigitalpublication.com/publication/?m=62673&i=789927&p=16&ver=html5

Convery, C., Davies, E., Murray, G., & Walker, L. (2021). Delayed-onset nodules (DONs) and considering their treatment following use of hyaluronic acid (HA) fillers. *Journal of Clinical and Aesthetic Dermatology*, *14*(7), E59–E67. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8570356/

Davies, E., Vaghela, D., Convery, C., Walker, L., & Murray, G. (2021). Guideline for the prevention, diagnosis, and management of acute bacterial soft tissue infections following nonsurgical cosmetic procedures. *Journal of Clinical and Aesthetic Dermatology*, *14*(9, Suppl. 1), S29–S35. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8562943

Dumitraşcu, D. I., & Georgescu., A. V. (2013). The management of biofilm formation after hyaluronic acid gel filler injections: A review. *Clujul Medical*, *86*(3), 192–195. https://pubmed.ncbi.nlm.nih.gov/26527945

Dumville, J. C., McFarlane, E., Edwards, P., Lipp, A., & Holmes, A. (2013). Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. *Cochrane Database Systematic Reviews*, (3), CD003949. https://doi.org/10.1002/14651858.CD003949.pub3

Funt, D. K. (2022). Treatment of delayed-onset inflammatory reactions to hyaluronic acid filler: An algorithmic approach. *Plastic and Reconstructive Surgery Global Open*, *10*(6), e4362. https://doi.org/10.1097/GOX.0000000000004362

Funt, D. K., & Pavicic, T. (2013). Dermal fillers in aesthetics: An overview of adverse events and treatment approaches. *Clinical, Cosmetic and Investigational Dermatology*, *6*, 295–316. https://doi.org/10.2147/CCID.S50546

Hee, C., & Messina, D. (2018). Role of bacteria on the in vitro immune response to hyaluronic acid fillers. *Journal of the American Academy of Dermatology*, *79*(3, Suppl. 1), AB248. https://doi.org/10.1016/j.jaad.2018.05.988

Heydenrych, I., Kapoor, K. M., De Boulle, K., Goodman, G., Swift, A., Kumar, N., & Rahman, E. (2018). A 10-point plan for avoiding hyaluronic acid dermal filler-related complications during facial aesthetic procedures and algorithms for management.

Clinical, Cosmetic and Investigational Dermatology, *11*, 603–611. https://doi.org/10.2147/CCID.S180904

Høiby, N., Bjarnsholt, T., Moser, C., Bassi, G. L., Coenye, T., Donelli, G., Hall-Stoodley, L., Holá, V., Imbert, C., Kirketerp-Møller, K., Lebeaux, D., Oliver, A., Ullmann, A. J., Williams, C.; & ESCMID Study Group for Biofilms and Consulting External Expert Werner Zimmerli. (2015). ESCMID guideline for the diagnosis and treatment of biofilm infections 2014. *Clinical Microbiology and Infection*, *21*(Suppl. 1), S1–S25. https://doi.org/10.1016/j.cmi.2014.10.024

Kamaruzzaman, N. F., Tan, L. P., Yazid, K. A. M., Saeed, S. I., Hamdan, R. H., Choong, S. S., Wong, W. K., Chivu, A., & Gibson, A. J. (2018). Targeting the bacterial protective armour; Challenges and novel strategies in the treatment of microbial biofilm. *Materials (Basel)*, *11*(9), 1705. https://doi.org/10.3390/ma11091705

Kim, B.-J., You, H.-J., Jung, I., & Kim, D.-W. (2020). Ophthalmoplegia with skin necrosis after a hyaluronic acid filler injection. *Journal of Cosmetic Dermatology*, *19*(6), 1307–1310. https://doi.org/10.1111/jocd.13403

King, C. A. (2019). Infection prevention and control. In J. C. Rothrock, D. R. McEwen, & S. A. Van Wicklin, (Eds.), *Alexander's care of the patient in surgery* (17th ed., pp. 53–102). Elsevier.

Ledon, J. A., Savas, J. A., Yang, S., Franca, K., Camacho, I., & Nouri, K. (2013). Inflammatory nodules following soft tissue filler use: A review of causative agents, pathology and treatment options. *American Journal of Clinical Dermatology*, *14*(5), 401–411. https://doi.org/10.1007/s40257-013-0043-7

Philipp-Dormston, W. G., Goodman, G. J., De Boulle, K., Swift, A., Delorenzi, C., Jones, D., Heydenrych, I., De Almeida, A. T., & Batniji, R. K. (2020). Global approaches to the prevention and management of delayed onset adverse reactions with hyaluronic acid-based fillers. *Plastic and Reconstructive Surgery Global Open*, *8*(4), e2730. https://doi.org/10.1097/GOX.0000000000002730

Rodriguez, J. M., Xie, Y. L., Winthrop, K. L., Schafer, S., Sehdev, P., Solomon, J., Jensen, B., Toney, N. C., & Lewis, P. F. (2013). *Mycobacterium chelonae* facial infections following injection of dermal filler. *Aesthetic Surgery Journal*, *33*(2), 265–269. https://doi.org/10.1177/1090820×12471944

Siegel, J. D., Rhinehart, E., Jackson, M., Chiarello, L.; & Health Care Infection Control Practices Advisory Committee. (2007). Guideline for isolation precautions: Preventing transmission of infectious agents in health care settings. *American Journal of Infection Control*, *35*(10, Suppl. 2), S65–S164. https://doi.org/10.1016/j.ajic.2007.10.007

Silva, N. B. S., Marques, L. A., & Röder, D. D. B. (2021). Diagnosis of biofilm infections: Current methods used, challenges and perspectives for the future. *Journal of Applied Microbiology*, *131*(5), 2148–2160. https://doi.org/10.1111/jam.15049

Urdiales-Gálvez, F., Delgado, N. E., Figueiredo, V., Lajo-Plaza, J. V., Mira, M., Moreno, A., Ortíz-Martí, F., Del Rio-Reyes, R., Romero-Álvarez, N., Del Cueto, S. R., Segurado, M. A., & Rebenaque, C. V. (2018). Treatment of soft tissue filler complications: Expert consensus recommendations. *Aesthetic Plastic Surgery*, *42*(2), 498–510. https://doi.org/10.1007/s00266-017-1063-0

Van Wicklin, S. A. (2021). Safe injection practices. *Plastic and Surgical Nursing*, *41*(2), 105–107. https://doi.org/10.1097/PSN.0000000000000379

Van Wicklin, S. A. (2022). Best practices for using all skin antiseptics and for using 4% chlorhexidine gluconate. *Plastic and Aesthetic Nursing*, *42*(1), 15–17. https://doi.org/10.1097/PSN.0000000000000421

Witmanowski, H., & Blochowiak, K. (2020). Another face of dermal filler. *Postepy Dermatologii i Alergologii*, *37*(5), 651–659. https://doi.org/10.5114/ada.2019.82859

Wood, A., & Conner, R. L. (2021). Guideline for hand hygiene. In E. Kyle, (Ed.), *Guidelines for perioperative practice* (pp. 267–291). AORN Inc.