



Point of Care Bacterial Identification: Quorum Sensing Molecules as the New Standard in Veterinary Medicine.

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Identification of bacterial species has been a requirement for successful antimicrobial therapy since the beginning of modern microbiology. Despite the advances in diagnostics over the past seventy-five years, doctors still predominantly rely on cytological examination and laboratory culture techniques, first developed in the 19th century, for this critical information. In today's veterinary practice, the standard of care is for veterinary professionals to perform point of care subjective cytology and to send out for bacterial culture and sensitivity testing when dealing with infection. The delay in obtaining culture results and the variability in cytology interpretation has resulted in the misuse of antibiotics, poor clinical outcomes, and prolonged patient discomfort. The reality is that veterinarians are only able to send out cultures in a small percentage of cases and are often treating serious infections based on subjective, unreliable data.

In 2019 it was reported that approximately 16% of all veterinary visits involved ear issues and was the third most common diagnosis (otitis externa and media) during veterinary visits (1). Many of these cases involve yeast (*Malassezia* species) or parasitic (*Otodectes* mite) infections, and there are various underlying causes such as atopy, allergic dermatitis, and conformation predilections. When bacteria are noted, the most common type of coccoid bacteria found in the ears of dogs with otitis externa is *Staphylococcus pseudintermedius*, and the most common type of rod bacteria is *Pseudomonas aeruginosa*. We find *Pseudomonas aeruginosa*, commonly in ear infections, however it is also found in wounds, urinary tract infections, sputum, and other areas of infection.

There are numerous therapies for treating otitis. However, when *Pseudomonas* is suspected, in more chronic or severe cases of otitis externa (or otitis media), additional and more complex therapy is required. Topical therapies are often augmented by deep ear flushes under sedation, at home ear cleaning/topical therapy, and systemic antibiotic and glucocorticoid therapy. The cycle of infection and inflammation, secondary to a chronic *Pseudomonas* infection and biofilm formation, creates the pathological changes that result in calcification of the ear canal, hyperplasia, fibrosis, hearing loss, including the potential for surgical intervention to provide comfort (TECA – total ear canal ablation) (2).

Due to the chronicity of some of these cases, and how previous therapies confound culture and sensitivity results, some experts claim that this information is unreliable and, in many cases, not helpful (3). Again, the veterinarian is relying on subjective data to determine therapeutic choices and monitor duration of treatment.



There is now an in-house, fast, and accurate option available for bacterial species identification. This technological advance utilizes the scientific concept of quorum sensing. Quorum sensing molecules (QSMs), also known as autoinducers, are molecules that bacteria, and other organisms, create that are unique and specific to each species. The process of secretion and detection of QSMs between cells is called quorum sensing. Bacterial cells measure the concentration of various QSMs using receptors on their surfaces, and when the concentration goes above a set threshold, cellular functions are altered, such as up or down expression of genes (4). The signaling is similar to a red light/green light for various bacterial cell processes in the environment.

QSMs were first discovered in the late 1960s. However, only recently, have they been demonstrated to work as biomarkers for diagnostic testing through the work of Dr. Ed Goluch, Founder and CEO of QSM Diagnostics, Inc. QSM Diagnostics has created an instrument capable of utilizing this technology for point of care bacterial identification and quantification. This test can be run in your hospital, quickly, on a device the size of a ROKU or Firestick device.

The QSM Diagnostics instrument, called the "OTTER eQ" (named after an energetic, curious animal that utilizes tools), uses this technology. In as little as 2 minutes, you can take a sample, place it on a specific bacterial detection cartridge, and have not only the species of bacteria identified, but also determine the concentration of various related biomarkers in your sample.

The cartridges are designed to detect specific bacterial species. The first cartridge designed by QSM Diagnostics, detects the presence of *Pseudomonas aeruginosa* in samples. The quorum sensing molecule detected by a sensor on the cartridge for this species of bacteria is called pyocyanin. Pyocyanin is a redox-active molecule. These types of molecules are characterized by their ability to transfer electrons, with reduction and oxidation going on side-by-side. Several organic molecules have this ability to transfer electrons without decomposing, which can be exploited to detect their presence via electrochemical measurements. The OTTER eQ utilizes specially programmed electronic components to detect and quantify the amount of pyocyanin in a sample. Importantly, the electrochemical sensing platform utilized in the OTTER eQ can be easily adapted to detect other molecular biomarkers associated with other pathogenic infections. The results often faster and potentially more reliable than those currently available from any other device (5).

The cartridges do not contain proteins, antibodies, or any other materials derived from cellular systems, therefore storage does not require refrigeration and there is no special handling. This device will allow a veterinarian to know immediately whether rod-shaped bacterial observed on cytology results are a *Pseudomonas* infection or not. Another key component of this technology is that pyocyanin is only produced by living, or bioactive, *Pseudomonas* bacteria. This activity cannot be discerned with in-house cytology. The



presence of pyocyanin in a sample indicates to the veterinarian that the bacteria noted on cytology is alive and pathogenic.

With QSM technology, the veterinarian can determine if *Pseudomonas* is present, quantify the amount, and know if it is bioactive. The OTTER eQ with the Pseudomonas cartridge not only assists with the initial diagnosis, but also provides value at subsequent checks by gauging response to therapy. Now, the veterinarian can partner with the client to provide a more focused and successful treatment regimen. This can result in shorter duration of patient discomfort, better therapeutic response, better antibiotic stewardship, increased compliance, and client satisfaction.

As previously noted, the OTTER eQ platform is not limited to the detection of *Pseudomonas aeruginosa*. In the near future, QSM Diagnostics will be expanding the catalog of pathogens that can be detected on each cartridge. QSM Diagnostics is developing a cartridge detecting seven bacterial species simultaneously, identifying the species commonly noted in urinary tract infections. The presence of quorum sensing molecules and the ability to detect them reliably through this technology is only now being fully explored. These advancements could potentially revolutionize our ability to detect, quickly identify, and responsibly treat infections in our patients.

1. State of Pet Health 2019 Report, Banfield Pet Hospital.
2. Sandra Koch, DVM, MS, DACVD, The Challenge of Chronic Otitis in Dogs: From Diagnosis to Treatment; Today's Veterinary Practice, Apr 30, 2017.
3. Tim Nuttal, DVM, Successful management of otitis externa, In Practice, April 2016 .
4. E. Lerat and N. Moran. The Evolutionary History of Quorum-Sensing Systems in Bacteria, Molecular Biology and Evolution, Volume 21, Issue 5, 2004, Pages 903-913.
5. Edgar D. Goluch. Microbial Identification using Electrochemical Detection of Metabolites, Trends in Biotechnology, Volume 35, Issue 12, 2017, Pages 1125-1128.