Spying on Bacteria for Rapid Diagnostic Applications

We spoke with Dr Edgar Goluch, the CEO and founder of QSM Diagnostics, about why his company is developing a new diagnostic platform and how it is working with Aptamer Group's Optimer™ technology to achieve this.

Why did you establish QSM Diagnostics and what do you hope to bring to the diagnostics market with your technology?

QSM Diagnostics was established to revolutionize how infections are diagnosed. The technology behind QSM Diagnostics provides actionable information about specific bacteria in biological samples in less than 2 minutes.

QSM stands for Quorum Sensing Molecules, which are unique molecules produced by all living bacterial cells. Bacteria use QSM as a form of communication. They secrete the molecules into their local environment and express receptors on their surfaces to detect other bacteria's signals in return. A whole array of quorum-sensing molecules exist that bacteria rely on to survive and thrive in their natural environments. Interestingly, each bacterial species has evolved its own QSM, similar to human languages.

At QSM Diagnostics, we have developed extremely sensitive molecular sensors that can detect and identify bacterial infection instantly at the point-of-care. This prevents treatment delay, allows guided and targeted treatment to ensure it meets the patients' needs and is easy to perform, increasing uptake in the clinic by busy clinicians.

We are initially using the platform for veterinary diagnostics, addressing ear infections in dogs caused by *P. Aeruginosa and* expect our first product to ship in the second half of 2020. Following this, we will continue to investigate other such veterinary infections to offer a multiplexed diagnostic platform to vets for simple, rapid disease diagnosis and increased targeted treatment.

Why did you see a need for a new diagnostic platform?

Today, when a patient visits a clinic needing treatment or an animal is taken to the vet, doctors and vets can test for bacterial infections.

They take a blood, urine, wound, or sputum sample and send it to a centralized lab where the sample is cultured, bacteria identified, and results returned. Most outpatient clinics don't have a lab,

so it can take hours or days just for the lab to receive the sample. This whole process can take 24-72 hours depending on the test, sophistication of the lab facilities, and severity of the patient's problem. A lot can go wrong with a critically ill patient in 72 hours, so doctors will often prescribe antibiotics or other treatments without knowing the full results. Partially because of these inefficiencies in diagnosis, tests are performed less than 30% of the time for patients.

Due to practices like these, an estimated 20-30% of prescribed antibiotics are not actually needed and do not treat the underlying problem. This increases the potential for patient complications arising from the administration of the wrong treatment and the development of antibiotic resistance.

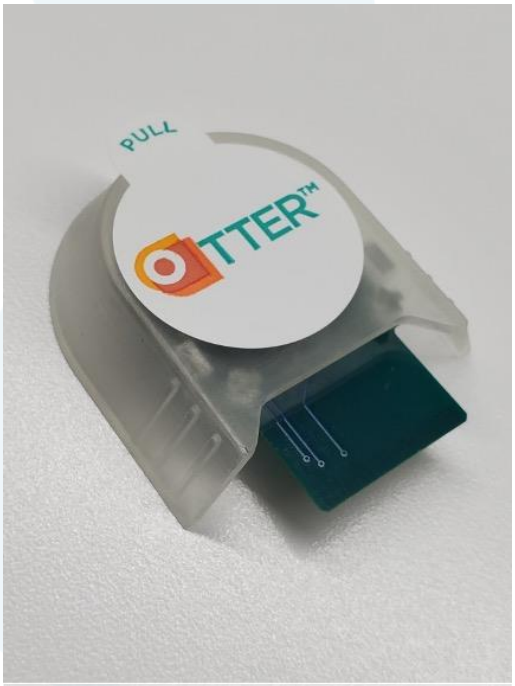
Antibiotic resistance is a topic that is receiving increased interest, with the rise of the 'superbug' and rightly so. Antibiotics are one of the most commonly used medicines to treat and manage disease. If bacterial resistance to our current antibiotics continues to grows, soon simple medical issues, such as a cut on the arm, will become life-threatening situations, as new treatments are not being developed quickly enough to keep pace with the emergence of resistance.

At QSM Diagnostics, we think that the development of antibiotic resistance can be slowed dramatically with simple measures. Our diagnostics are built to deliver rapid results in a simple, easy-to-use format that will allow clinicians to diagnose better and provide targeted treatment for the benefit of patients and healthcare systems.

How does your platform work to detect different disease biomarkers?

Our unique technology identifies bacteria, fungi, and parasites in samples by detecting QSMs that are secreted by these organisms. These micro-organisms have each evolved their own distinct QSMs over millennia. For example, *Staphylococcus aureus* is commensal on human skin, but mutations in this bacteria on cats and dogs have led to a new species called *S. pseudintermedius.* This species is uniquely distinguishable from the human *S. aureus* by the quorum-sensing molecules it produces. Distinguishing specific bacterial strains in this way gives us a really high level of resolution for the diagnosis of specific bacterial infections.

Our instrument, called the OTTER™ eQ for veterinary use, is similar to a glucose meter. It is a small reader with a USB port for attaching to a computer. It accepts disposable cartridges that are unique for each test type, and once the swab or a drop of fluid from the animal is placed onto the cartridge, the vet will receive information of the specific bacteria present, as well as the level at which it is present, within two minutes. This is a big differentiator for how the vet proceeds with treatment and follow-up.



The team's first test diagnoses ear infection with P.aeruginosa in the veterinary market.

Based on electrochemical sensors the system is low cost, simple to use, and allows multiplexed detection. As I mentioned, the test that is being manufactured analyses *Pseudomonas* infection

in dog ear wax samples. *Pseudomonas* secretes a quorum-sensing molecule called pyocyanin. We have tuned our electrochemical sensors to be able to detect and quantify this biomarker, with no interference from any other molecules in the sample. This is a perfect biomarker for the presence of *Pseudomonas* in a sample.

For other tests that we are investigating, we have tuned the electrochemical sensor platform to be able to selectively measure the quorum-sensing molecules for the relevant pathogens, and are exploring multiplexed analysis using seven sensors on the same platform, where multiple strains of bacteria need to be considered in parallel, such as urinary tract infections.

QSM Diagnostics tests will use aptamer-based technology bring rapid diagnostics to clinics for improved patient healthcare.

Why do you work with aptamers to detect the different biomarkers you are looking for?

We use aptamers as the capture element on our electrochemical sensors. They provide target-specific capture for the detection of each of the specific quorum-sensing molecules that we need to detect and quantify in our diagnostic tests.

We need to use aptamers in our electrochemical platform because of the physics involved in detecting the binding event. Unlike other electrochemical sensors, whose response changes based on the amount of surface that is blocked, our platform measures the movement of the aptamers that are immobilised on the sensor surface. Aptamers, as single-stranded DNA molecules, are relatively flexible, bending and twisting in solution. When a target molecule binds to them, their movement changes significantly, which the instrument detects. Larger affinity molecules, like antibodies, move much slower and are less flexible, and therefore do not work as well on our platform.

Additional benefits that aptamers bring to the platform are the consistent, scalable, and cost-efficient manufacture. Once we have developed a test, being able to reliably and reproducibly scale that up to deliver accurate, sensitive diagnostics on a large scale to our customers at the best price possible is important to us and something that we considered from the outset.

How have you found working with Aptamer Group?

We really enjoy working with Aptamer Group. They are just as passionate about technology and innovation as us. Both companies realise the synergy that exists between good aptamers and a robust diagnostic platform. We have been able to demonstrate excellent initial results using specific aptamer provided to us by Aptamer Group. A particular benefit is their ability to supply very pure materials with the unique functional groups that are required on the aptamers for use in our platform. I'm looking forward to working with Aptamer Group for several years to come.

Your first product is for the veterinary market. Can you apply this same technology to the human healthcare market and do you have plans to move into this space?

Absolutely! We intend to enter the human healthcare market with this platform. Many of the same bacteria that cause infections in dogs and cats cause infections in humans, and could be used similarly to guide treatment by doctors.

Being able to prescribe the right antibiotic as soon as possible is key to faster recovery, reduced costs, and preventing bacterial resistance to retain the efficacy of existing antibiotics.

We have approached the veterinary market with our initial offering as the barriers to entry are substantially lower. This strategy will allow us to prove the technology, iron out any issues with functionality, and raise funds, whilst we work on the longer-term initiative to access the human market. There is huge potential and a real need for faster, accurate diagnostics to improve patient treatment and slow the developing problem of antibiotic-resistance.

With antibiotic-resistance on the rise, many companies are pivoting away from antibiotics. Why did you feel it was important to pursue this field and why do you feel antibiotic stewardship is key to the future?

For now, antibiotics are the medicines we have to treat a host of diseases. Many labs and researchers are exploring alternatives that may prove better, or essential, in the future if we cannot protect the current antibiotics. But right now, those alternatives are in fledgling stages and patients need treatment and protection from disease today. Our technology will continue to be valuable even when the medicines become available, as diagnosis and monitoring of treatment response will still be necessary.

There is only a limited supply of antibiotics to which bacteria have yet to develop resistance. It is crucial that the antibiotics available are used judiciously so that researchers have time to develop and test new treatment and preventative measures. If we can limit from the emergence of resistance and use antibiotics effectively, we can make an enormous difference in global healthcare, not just in advanced nations. To do this and retain the use of our medicines for patients today and in the future, we need to utilize existing antibiotics in a more targeted way. That requires better, earlier diagnostics to support clinicians.

At QSM Diagnostics, we have developed a way to deliver fast and precise diagnostic answers that can help clinicians offer targeted treatments to patients. This is better for the patient and better for the future of medicine.

Find out more at **aptamergroup.com**

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