Playing it smart

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Cover drone image courtesy of John Ernewein Limited.
When a farmer enters the barn, he or she hears first, then sees, then smells the environment. Nanotechnology sensors can detect all of these parameters, providing novel solutions to practical issues in poultry health.

Suresh Neethirajan is an assistant Professor and the director of the BioNano laboratory at the University of Guelph. He calls this agricultural revolution towards using nanotechnology ‘precision livestock farming’, a progressive movement over the past decade where technological advances are being used to save time - the time to test results or make management decisions.

The ultimate goal of precision livestock farming is to transmit real time data related to health parameters using a combination of mobile phones and Internet to enable the end user to monitor and track flock health to enhance the productivity and welfare of the birds. The data is then used to proactively predict and prevent disease. This strategy is made possible by using nanotechnology, which, in turn, uses tiny biomarkers to detect subclinical signs of disease at the molecular level in a non-invasive manner.

Suresh Neethirajan uses the example that preventing the spread of Avian Influenza (AI) might be the best way to keep the disease under control. Using nanotechnology, he is developing a hand-held AI virus detection tool that will be able to differentiate and classify different strains of the AI virus - information that is crucial to optimize management strategies to treat and help prevent the spread of the disease. The tool will be able to replace the current laboratory RT-PCR analysis that can take from six hours to three days.

Two types of nanotechnology are being investigated for this AI detection tool. The first type uses an optical sensor device, where light is reflected off specific nanomaterials, which bind in specific ways to proteins on the surface of the virus, fluorescing differently to allow identification of the strain of the pathogen. This information can be gathered in real time and records can
be transferred through an android app to
the entire value chain or veterinarians as
required.

Another option is an electrochemical
type of sensor, similar to a handheld
glucose meter. Just a droplet of blood can
be read immediately using nanomaterials
that focus on the virus pathogen rather
than the chemical biomarker.

Both optical and electrochemical
options are being investigated, mainly to
ease the interfacing with the smart phone
and Internet for real-time transmission of
data. Each of these modules has unique
advantages, while optical seems to be
easier to adapt, mainly because of the
presence of cameras in the phones.

At this stage the research focus is on
multiplexing - refining the biosensor to
identify multiple strains of the AI virus
from a single drop of blood.

Following a similar predictive and
preventative approach, Neethirajan is
also developing an Internet of Things
(IoT)-based poultry monitoring telemetry
system that will monitor bird health in a
non-invasive manner, looking for subtle
signs of disease that can be addressed proactively.

With this telemetry system, a loonie-sized sensor placed on the bird will detect
movement, monitor skin temperature
and other biomarkers such as relative
humidity, temperature, carbon dioxide,
methane and ammonia levels, in real
time fashion that could then become pre-
dictors of disease. This technology would
not be feasible to monitor thousands
of birds individually, but the data from
sample birds in a flock can be applied to
mathematical models to generate holistic
predictions of flock health.

Nanotechnology can also supply
micro electrical mechanical systems
(MEMS) - based sensor probes that can
monitor blood flow in a non-invasive
manner. Even sound can become a pre-
dictor of disease because the sound of a
healthy chicken differs from a bird under
any kind of stress. Integrating this vocal-
ization with movement gives a more
holistic picture of the health of the bird.

More work is needed regarding practi-
cal application before this technology
can be valid for on-farm use. For exam-
ple, wearable sensors need to be light-
weight and made of biological materials
where possible so that the birds don’t
peck at the ‘foreign’ object. Where sound
is measured, random barn noise needs
to be excluded from detection. Wireless
technology doesn’t work in all barns in
all locations, and adaptations will need
to be made to accommodate differences
between caged and cage-free systems.

Meanwhile thresholds of disease are
being better established through math-
ematical prediction models and apps for
reporting data are being refined. ■