

HIFU Treatment of Abscesses

- Narrator:** A new application for high intensity focused ultrasound (HIFU): non-invasive, painless treatment of infected fluid collections within the body.
- Keith Chan:** A lot of what we are talking about are abscesses. These are fluid-filled cavities within the body that are walled-off collections filled with bacteria.
- Narrator:** A typical abscess can develop after surgery and may require antibiotics and more surgery.
- Keith Chan:** The way this has been treated over the last 2000 years is that if you have a lot of bacteria in the body, you have to get rid of it by draining it.
- This is an example of one such drain. This would sit inside the abscess cavity inside the body. All these holes are inside. And then the tube would protrude from the outside of the body and we attach it to a bag like this. And this bag is oftentimes strapped to a patient's leg.
- Narrator:** Unwieldy, uncomfortable drains can take weeks to work. Inserting drains can pose risks to organs, cause bleeding or introduce secondary infections.
- This led Dr. Keith Chan of the University of Washington Medical School to ask Tom Matula of APL-UW's Center for Industrial and Medical Ultrasound:
- Chan:** Is there a way where we can eliminate all the bacteria without the need for a drain?
- Narrator:** And without the need for invasive surgery.
- Tom Matula:** We just kind of had a brainstorming session sitting around my table. And he came up with this idea — he said he was often having to treat abscesses.
- Narrator:** Dr. Chan and his UW colleagues employ surgery and catheter drainage to treat abscesses on a daily basis.
- Matula:** And so we thought this was a really interesting application for HIFU because mostly HIFU was being used to disintegrate tissues or destroy cancer cells in tumors.
- Chan:** It just naturally came to us to say 'wait a second', we often see these abscesses and treat them by using ultrasound to place a drain. What if we turn up the energy of the ultrasound so much that we could destroy the bacteria within the abscess just like we destroy cancer cells within a tumor?
- Matula:** Under HIFU conditions, the idea is to focus ultrasound to a location inside the body the way you would do with a light and a magnifying glass to burn a hole in a piece of paper. In ultrasound you can do the exact same thing but you can focus sound waves through the intervening tissue to the spot that you're trying to heat. And that's typical HIFU: that you're generating a temperature increase — enough to kill the cells.

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Matula: What we hypothesize is that we could double the affect of the HIFU by not only heating the bacteria in the abscess, but also generating intense cavitation — a one-two punch. Some heat, some cavitation to effectively kill the bacteria quickly and without pain to the patient.

Narrator: Cavitation: the generation of bubbles that collapse.

Matula: Generating high shear stresses. Basically ripping the material apart next to the focus of the HIFU and the material would be cells — bacteria cells.

Andrew Brayman: We know pretty much what we need to do to treat these fluid collections. And that's to introduce violent bubble activity that will kind of chew up the bacteria. We have conducted these experiments with some vigor and with a considerable number of replications. We can essentially drive bacteria to extinction.

A 10-minute treatment wipes 10^9 bacteria essentially down to zero bacteria. So, this is pretty impressive.

Chan: You hold the probe there for 5 or 10 minutes and the bacteria are destroyed — and that's it. No sterilization of the skin, no bringing them to a surgical suite. In fact, you don't even need a clean environment. So you can do this right in the emergency room, right on the gurney. Or maybe even better, we can do this as an out-patient in the doctor's clinic thereby eliminating the cost of hospitalization.

Narrator: And researchers hope HIFU will, for the first time, enable treatment of abscesses smaller than 3 cm.

Matula: What we can do with HIFU is treat these small abscesses instead of having the patient sick and waiting for the abscess to grow big enough so that they can be treated by drainage.

Chan: We're really hoping that 10 years from now that this is now the universally accepted standard for how abscesses are treated. And we're going to be able to look back at how we did open surgery or even catheter draining and think, "gosh, you know, we've come a long way."

This is APL **The Applied Physics Laboratory at the University of Washington in Seattle.**