

Inside your insides

Thanks to a revolutionary Israeli invention, it's far simpler for doctors to diagnose serious intestinal conditions. **Alexandra Roach** discovers how the PillCam is helping Australian medics examine their patients' insides.



Given Imaging's PillCam

THE doctors are, perhaps, just a little concerned. The patient is experiencing obscure internal bleeding inside the five metre-long small intestine, but the usual tests have not confirmed its source. Having exhausted the options of endoscopy, gastroscopy and colonoscopy, it's time to break out the big guns.

Or, in the case of 21st century gastroenterology, an innocuous, 26 millimetre-long plastic cylinder manufactured in a factory in northern Israel.

Equipped with a camera, this powerful pill-shaped device may be small, but in the course of a decade has revolutionised the way doctors investigate the small intestine, which has been notoriously difficult to properly examine with previous technologies.

When a patient swallows this cylinder, otherwise known as the PillCam, no invasive poking or prodding is necessary: the PillCam travels through the gastrointestinal tract, before harmlessly and naturally passing through the body's systems as food does.

And it's not just obscure gastrointestinal bleeding [that is, bleeding that has presented in the small intestine but the source of which has not been established via endoscopy or colonoscopy] that the capsule can identify. PillCam has also been utilised to find and diagnose polyps, tumours and inflammatory conditions prevalent in Ashkenazi Jews, such as Crohn's Disease.

AT Sydney's St Vincent's Hospital, consultant gastroenterologist Dr Robert Feller has

been using the PillCam for 10 years and considers the device to have been a quantum leap forward in his field.

A senior lecturer in the University of New South Wales' faculty of medicine and St Vincent's Clinical School, Feller specialises in capsule endoscopy, that is, performing these groundbreaking tests using the PillCam.

"Before the PillCam capsule, there was really no tool that provided images of the small intestine," Feller tells *The AJN*.

Although the PillCam cannot collect material for biopsy, its ability to take high-resolution images of the small intestine is highly useful as a diagnostic tool. For example, the site of an obscure bleed will most often show up quite clearly in the images the PillCam collects, and approximately three-quarters of Crohn's sufferers have lesions and other abnormalities in the intestine's mucosa.

The PillCam's high-resolution images are also highly effective in assessing disease activity and progression in the mucosa.

Before the invention of the PillCam, methods included a barium test, where patients ingest barium, an opaque powder that shows up in the digestive tract during x-ray, examining conditions including reflux and ulceration.

"A barium study doesn't show a lot of detail, so it is quite an insensitive investigative tool," Feller explains.

"Before the capsule, we also used a standard abdominal CT [computed tomography] scan or a push enteroscopy to examine the small intestine, the latter of which can only achieve a

depth of less than 10 per cent of the small intestine's length."

One of the capsule's main advantages is that, unlike with an endoscopy or colonoscopy where patients must be under a general anaesthetic, a capsule endoscopy allows the patient to go about their day as usual, without need for sedation or to spend time in hospital.

The PillCam's camera takes a constant stream of images of the inside of the small intestine as it moves through, and the PillCam sends the data back to

"The PillCam is very easy to work with as patients simply swallow the capsule as they would a vitamin pill," Feller explains.

"It's a completely painless process for the patient and the capsules are designed to be a one-use device so it does not have to be returned to us."

Feller said the capsules' batteries cannot be replaced and the capsules are also "impossible to sterilise" after going through the human body's natural passing process and are safe to flush.

on a sabbatical at the same time as an Israeli gastroenterologist, Eitan Scapa," Feller explains.

Legend has it that the two men began to discuss the imaging technology available to examine the small intestine when Scapa experienced stomach pains. "They wanted to develop something that wasn't as insensitive when looking at the small bowel mucosa or lining as barium and push enteroscopes were," Feller said.

A small camera a patient could swallow and pass effortlessly was the ultimate goal, but it was not an easy dream to achieve.

"The capsule endoscope's inventors had to overcome a number of difficulties," Feller explains. "The first was finding an imaging system small enough to swallow that could still give resolution high enough to do the job."

"A battery small enough to fit into a capsule with enough power for a high resolution imaging system to work was another hurdle. They drew on a lot of different technologies to make this happen."

When Iddan and Scapa managed it in the late 1990s, the world's premier science journal *Nature* published a paper on PillCam and its creation, a reflection of the invention's importance and impact.

And an incredible impact is most certainly what the PillCam has had: almost two million patients worldwide have used this little piece of Israeli innovation since its introduction to the market a little over a decade ago. Three other companies, including one in South Korea, have also begun to manufacture pill cameras based on the original Israeli design.

And the PillCam could further transform the medical arena, with Given Imaging continuously expanding its range of PillCams, including for exploring the oesophagus and colon.

"I think it's great that Israeli innovation and technology, as in so many other areas, has had such an impact internationally in clinical gastroenterology and patient care," Feller says.

"The PillCam was such an incredible advance in itself."

"The imaging technology inside the capsule is always evolving and improving and its latest upgrades included improving motion sensitivity, so it takes thousands of images."

Dr Robert Feller

Consultant gastroenterologist, St Vincent's Hospital

receivers via a radio frequency.

While the first PillCams had a battery life of about eight hours and required adhesive discs to be placed on the patient's chest and abdomen, advances in the technology have seen battery life increase to 13 hours and the discs replaced with a belt worn around the waist.

"The average transit time of the capsule is about three to four hours, although in one case it took only 23 minutes," Feller says.

"It's very safe and, once it passes through the stomach, it goes along with the gastrointestinal tract's natural peristalsis."

Feller says the risk of the body holding onto the capsule is only 1.4 per cent and that, even when the capsule does not pass through within the first day, it rarely requires surgical retrieval.

When the patient returns to the hospital, the images the PillCam has taken during its journey are downloaded onto a computer.

"The imaging technology inside the capsule is always evolving and improving and its latest upgrades included improving motion sensitivity, so it takes thousands of images," Feller explains.

Despite this, it only takes roughly an hour for the images to transfer from the PillCam belt to the hospital's computers.

Despite this some of Feller's patients do sometimes "very generously" return the capsules to the hospital.

"We always thank them but it's not required," Feller laughs.

THE PillCam is manufactured in a factory in the Israeli town of Yokneam Illit, which lies at the base of Israel's Carmel Mountains. It is from here that Feller and hundreds of doctors in more than 75 countries worldwide receive their PillCams.

Surrounded by green farmland, Yokneam may seem unassuming at first, not at all the type of place worthy of the moniker of the "start-up village" in a nation famed for its innovation.

But this town of 22,000 residents and more than 150 start-up companies, including the nation's highest concentration of medical research companies, produces exports of upwards of US\$5 billion annually.

It is also here that PillCam's manufacturer, Given Imaging, is headquartered, a short distance from the University of Haifa and the Technion Israel Institute of Technology, and where the PillCam first came into being.

The genesis of the PillCam is a tale of scientific cooperation and a meeting of the minds.

"Gavriel Iddan, an Israeli optical engineer, was in Boston in the 1980s



Screenshot from a Given Imaging video showing the PillCam's journey through the intestines.

Watch a Given Imaging video about PillCam
Available on the iPad app and e-paper edition