

How high-tech approach may reshape the autopsy

Kevin B. O'Reilly

March 2014—Boosters of so-called virtual autopsy say it has the potential to revolutionize the practice of forensic pathology and could help increase the share of U.S. deaths subject to medical autopsy.

The technique involves the use of computed tomography, magnetic resonance imaging, and three-dimensional surface scanning technology to help resolve tricky forensic questions such as whether a woman was killed with a hammer or a bicycle wrench. The 3D scanning can help provide a “morphological footprint” to gauge against any kind of instrument that could have inflicted the damage, said Michael J. Thali, MD, chair of the Institute of Forensic Medicine at the University of Zurich in Switzerland. About 500 virtual autopsies have been conducted at the institute, Dr. Thali said in a June 8, 2013 lecture before the Royal Society of Medicine in London.



Postmortem imaging using CT and MRI—the former is better for evaluating skeletal injuries, while the latter excels with soft-tissue evaluation—can help give a 3D visualization of these blunt-force injuries, Dr. Thali said. He and his colleagues also have used the virtual autopsy approach in cases of strangulation, knife wounds, and more.

“These tools of imaging are opening a new world in forensics,” Dr. Thali added. Head-to-toe imaging is not the whole story, though. Dr. Thali’s team also has added postmortem angiography and biopsy to the mix. Inserting contrast media into the corpse, they can visualize the whole heart and lung system. One of the Swiss team’s innovations is the Virtobot, a robotic arm that can conduct a biopsy at the computer’s command. The team calls the virtual autopsy process “virtopsy.”

“Using techniques such as MRI and CT, and in addition biopsy and angiography, we can see 60 percent to 80 percent of the forensic causes of death,” Dr. Thali said. “In the future, that will change the world in forensics.”

In an interview with CAP TODAY, Dr. Thali adds that the virtual approach to autopsy can win more consents from next of kin. “Because virtopsy is nonbloody and nondestructive, relatives agree with this approach,” he says.

Postmortem imaging can help “add relevant findings to autopsy, plan the autopsy procedure, and is an excellent prescreening tool before the autopsy because you see what you have to expect,” Dr. Thali says. “Some of the forensic autopsy will be replaced by virtopsy, because you can answer the forensic autopsy questions based on virtopsy only.”

In addition to Switzerland, the virtual autopsy approach is being used in the United Kingdom, Japan, and Australia. Medical examiners from the Arab world also are showing interest, Dr. Thali says.

A recent study involving 120 adult deaths found that using a CT scan obviated the need for a traditional

autopsy 38 percent of the time. Meanwhile, using CT and coronary angiography made invasive autopsy unnecessary in 70 percent of cases (Roberts IS, Traill ZC. *Histopathology*. 2014;64(2):211–217).

Some experts believe virtual autopsy could help overcome the short supply of forensic pathologists.

“There are very few practicing forensic pathologists and the workload is far in excess of what the current workforce can accomplish,” says Bruce Levy, MD, who practiced forensic pathology for two decades and is now associate professor of clinical pathology and director of informatics at the University of Illinois at Chicago. “So the ability to screen these bodies in advance using these noninvasive or minimally invasive techniques then frees the forensic pathologists to focus on those cases that really need the attention of a physician, and in a lot of ways helps us document injuries in ways we’ve never been able to do before.”

A handful of medical examiners in the U.S. have made use of CT scanners, most widely in Maryland and New Mexico. Since 2001, pathologists in the Armed Forces Medical Examiner System have done CT scans on every fallen service man and woman before conducting a traditional autopsy.

One hope is that the use of postmortem imaging could help increase the rate of medical autopsies in the U.S. By 2010, the rate had fallen from about half of in-hospital deaths in the mid-20th century to about 10 percent, Dr. Levy said during an October 2013 Web presentation sponsored by the Association for Pathology Informatics and Sunquest Information Systems.

Dr. Levy plans to pursue a pathology-radiology collaboration at UIC “to look at how useful this virtual autopsy would be in the medical setting.”

Some U.S. health care organizations are already implementing a form of virtual autopsy. About 230 corpses have been scanned prior to autopsy during the last three years as part of a Radiological Society of North America–funded research project at Massachusetts General Hospital. The imaging can help spot a pneumothorax that is difficult to detect during a traditional autopsy, says James R. Stone, MD, director of the hospital’s autopsy service. It has helped in other instances, too.



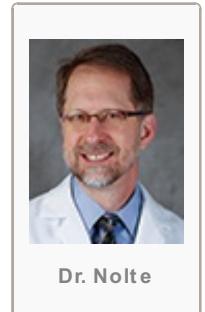
Dr. Stone

“We had a case where, for example, a nodule was recognized inside the arm—which we normally never would have even tried to find—that turned out to be a metastatic carcinoma that we wouldn’t have identified at all,” Dr. Stone says.

For now, the postmortem imaging at the hospital remains strictly a supplement to—and not a replacement for—traditional autopsy, Dr. Stone says.

“It’s less invasive, but there’s a trade-off,” he says. “Your sensitivity to making a diagnosis goes way down when you’re doing just virtual autopsy. . . . There are sophisticated questions we’re trying to answer in hospital-based, academic autopsies that go beyond what you can get with virtual autopsy. In the medical-examiner world, though, high-throughput virtual autopsy may have great value.”

What remains unclear is when, exactly, advanced imaging can serve as a useful additive to traditional forensic autopsy and when it can be used alone to answer the critical medicolegal questions at hand. That is what Kurt B. Nolte, MD, and his colleagues are trying to find out. Dr. Nolte is director of the Radiology-Pathology Center for Forensic Imaging at the University of New Mexico School of Medicine. The university also is home to New Mexico’s centralized medical examiner’s office.



Dr. Nolte

With the help of a three-year, nearly \$900,000 grant from the U.S. Department of Justice, the New Mexico team is conducting a double-blinded trial to determine the effectiveness of CT scans in assessing four kinds of cases that account for about one-third of New Mexico forensic

autopsies: blunt-force injuries, firearm injuries, pediatric trauma, and drug poisonings.

Nearly 1,000 cases are being examined in the following way, Dr. Nolte says: "The pathologists do the autopsy without knowing the CT findings, and the radiologists read the CT scans without knowing the autopsy findings." The autopsy and radiologic findings are coded and compared using the Abbreviated Injury Scale, and the radiologists and pathologists involved will then see how concordant or discordant their findings are.

"It's a complex process, but ultimately it gives us a full picture of what CT's good at, and what autopsy's good at," says Dr. Nolte, who also is executive vice president of the National Association of Medical Examiners. He hopes to report the first findings from the study at NAME's annual meeting in September.

"A lot of early studies looked at autopsy as the gold standard, but it's clear that autopsy is not the gold standard," Dr. Nolte says. "We're looking at the gold standard as being a combination of CT and autopsy. There's stuff that CT finds that autopsy doesn't, and stuff that autopsy finds that CT doesn't."

The New Mexico team also is researching the use of MRI in the medical examiner's office. The cost of acquiring the advanced imaging equipment has been shared by the state and the university. Dr. Nolte acknowledges that even slam-dunk findings to show that postmortem advanced imaging is useful and catches things missed in traditional autopsy will not necessarily speed the way toward widespread adoption of the virtual approach in forensic pathology.

"Forensic pathology and medical examiners' offices are not among the most well funded of health care organizations," Dr. Nolte says. "The question is how do medical examiners garner scanners in the future, and clearly that's going to require a combination of pressure from the courts, from attorneys, from families, and perhaps federal funding."

A blue-ribbon panel of 37 scientists, lawyers, forensics experts—including three pathologists—held its first meeting in February and could provide the impetus for more federal dollars flowing into forensic pathology. This panel—the National Commission on Forensic Science—is a joint venture of the Justice Department and the Commerce Department's National Institute of Standards and Technology, and was sparked by a 2009 National Research Council report that found big gaps in the quality of U.S. forensics ("Strengthening Forensic Science in the United States: A Path Forward"). Meanwhile, a bill introduced by Sen. Jay Rockefeller (D-W.Va.) calls for more federal funding for forensic science research.

Even as federal officials seem eager to explore the potential for advanced imaging to remake the autopsy, some pathologists argue for proceeding with caution.

"I don't see the United States—across the board—just saying, 'OK, you know, instead of doing an autopsy we're going to replace the autopsy with imaging. I don't think it's going to happen, and I don't think it should happen," says Michael A. Graham, MD, chair of the CAP's Forensic Pathology Committee and professor of pathology at Saint Louis University School of Medicine.

"Imaging isn't perfect, and it doesn't answer a lot of the questions we're asked to answer. Even with imaging, we have to do invasive things. If there's evidence of an infection, we have to go in after it in order to assess its features and identify the causative organism," Dr. Graham adds. "We have to go in after projectiles and other evidence. Important timing or aging issues can currently only be resolved using microscopy. It's not like you can completely say you're not going to autopsy anybody and just going to use all that money for MRIs. But if you look at it as yet another tool to help answer the questions we need to answer—that puts it in a little bit better perspective."



Dr. Graham

The CAP's policy, last revised in 2012, appears to leave ample room for advanced imaging as one of many methods used in the autopsy process. The policy defines the autopsy to include "examination of the decedent by one or more of several modalities including (but not limited to) surgical techniques, dissection, imaging, microscopy, and/or laboratory analysis."

Dylan V. Miller, MD, chair of the CAP's Autopsy Committee, says virtual autopsy could be a great help in mass-casualty events and can be a suitable replacement for invasive autopsy in cases such as when it can confirm suspected subarachnoid hemorrhage. The virtual approach alone "will never replace the diagnostic information obtained from a complete autopsy," adds Dr. Miller, director of the autopsy service at Intermountain Medical Center.

Whatever the potential role of advanced imaging and robot-assisted tissue sampling in autopsy may be, experts agree it is unlikely to become widely implemented overnight.

"Things move slowly in the autopsy world," Dr. Miller says.

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Dr. Miller