New FDA Software Proposals: Effect on Nuclear Medicine?

Last September the Food and Drug Administration (FDA), Rockville, Maryland, issued a draft policy for the regulation of computer software products used in medicine. Many observers agree that the policy itself, even if accepted in its present form by the FDA, will probably have a minimal effect on nuclear medicine devices. But what is much less certain is how other software-related activities of the FDA will affect the development, manufacture and ultimately the use of nuclear medicine devices that employ computers.

The prospect of additional oversight brings several competing interests to the fore. While the FDA sees a need to act to protect the public, manufacturers view this as unnecessary, and they are wary of further intrusion into research and development. For their part, physicians want the most reliable, up-to-date products possible, but at the lowest possible price. Meanwhile some software experts doubt that any FDA policy can completely protect patients from the serious consequences of software malfunctions.

Currently computer products that are part of a recognized medical device are regulated in the same way as the parent instrument, according to Donald R. Hamilton, deputy director of the division of technical development at the FDA's Center for Devices and Radiological Health.

Under the FDA's draft policy, the concept of "competent human intervention" determines what is and is not regulated. Computer products that make it impossible for a physician or nurse to intervene should something go awry are clearly regulated. Those that act as computerized textbooks or journals, or that perform general accounting functions, are not. Devices designed and used in a single medical facility, perhaps in teaching and research, and provided without charge to others, are also exempt.

Despite questions—particularly about the meaning of "competent human intervention," which even the FDA admits is still evolving—some observers believe the draft policy is too general to have much impact on imaging devices. "It gave them a hunting license, but they already had that," said a representative of the National Electrical Manufacturers Association (NEMA), Washington, DC, who asked not to be identified.

Questions 'More Intense'

Observers are less sanguine about other things the FDA is doing, however. The NEMA representative said he is aware of four documents the FDA is producing to aid in software evaluation. One of these is known as the Technical Reference on Software Development Activities, which James Howard, regulatory program manager for the General Electric Medical Systems Group in Milwaukee, Wisconsin, said reflects some of the demanding standards set for military software. Moreover, both the NEMA representative and Mr. Howard said it is widely perceived in the industry that the FDA is paying much more attention to software than previously. "In the last year or so, the questions have become more intense, more specific, more pointed and more difficult to talk about," the NEMA representative said. "Until now, the FDA looked at the manufacture of the hardware," Mr. Howard said, but lately the FDA is seeking to understand how the software operates. "The diagnostic imaging industry is seeing more of these kinds of questions, but nuclear medicine is not at all unique in this area," he added.

The FDA's recent emphasis on software may reflect a greater appreciation of the role of computers in the delivery of health care. Although no statistics on software failures are readily available from the FDA, it seems certain that more devices are computer controlled than ever before. "We see it as a potentially growing area that might have some dangers," Mr. Hamilton said. "There are systems that on their own can do all kinds of things to patients." An example is the Therac 25, a linear accelerator that was manufactured by Atomic Energy of Canada Ltd. (AECL), Ottawa, Ontario. In 1985 and 1986, the device allegedly caused three patient deaths and three injuries from radiation overdoses that were attributed to a subtle software malfunction. The error appeared only when a technician rapidly entered a specific, unusual combination of keystrokes. (AECL, which no longer manufactures linear accelerators, has corrected the software problem and installed additional safety devices.)

A gamma camera with a computer caused problems recently for Howard Dworkin, MD, chief of the nuclear medicine department at William Beaumont Hospital in Royal Oak, Michigan. Before it was finally replaced in its entirety by the manufacturer, Dr. Dworkin's new instrument experienced two malfunctions: occasionally it would show the anterior view of one patient and the posterior view of another; and, for no apparent reason, it would sometimes show im-

(continued on page 589)

(continued from page 588)
ages of the feet of different patients. Dr. Dworkin recalls first noticing the problem in January when a patient showed broken ribs from the front, but not from the back. In an attempt to rectify the problems, the company replaced the circuit boards and software, but to no avail: "Even after they made all the changes, another pair of feet popped up," Dr. Dworkin said.

Dr. Dworkin is preparing to report the incident to the FDA, and to write an article providing the details of his experience. He pointed out that the malfunction, which was never identified as being either hardware or software, could have had serious repercussions. "Certainly inappropriate therapy could have been handed out," he said. "Therapy decisions are made on the basis of bone scans, no doubt about it."

Companies have an interest in developing products that work properly. Physicians, too, have cause for concern, not only for the humanitarian reasons of good patient care but also because they can be held liable for software malfunctions that have deleterious effects, according to Vincent Brannigan, a lawyer specializing in medical computer law in Adelphi, Maryland and associate professor of law and technology at the University of Maryland.

Nonetheless, manufacturers are uneasy about heightened FDA interest in software. "They want to know particulars about the design of the software, but companies don't want to talk to anybody outside of the company about the design of the software," said the NEMA representative. He added: "This has less to do with annoyance—one more damn thing to do—than it has to do with a very great concern about having outside people being privy to sensitive information about the very innermost workings of their equipment." One fear is that inspectors will inadvertently disclose proprietary information to competitors during inspections.

George Murray, PhD, director of the division of anesthesiology, neurology and radiology devices of the FDA's Center of Devices and Radiological Health, believes these concerns are unfounded. He said the FDA has been faithful in maintaining trade secrets in other areas, and that companies needn't fear disclosure by the agency.

Effects on Cost

Additional regulation is also accused of causing costly delays. "You've got a limited pool of manpower, and whenever you add more work, you create delays," said Edward Basile, a lawyer formerly with the FDA now specializing in medical device law with the firm King & Spalding, Washington, DC. "It does slow down the process," the NEMA representative said. "I pick up lots of conversation and anguish from company members who are party to commitments from prospective buyers." This problem might arise when a manufacturer tells a potential customer on the exhibit floor of a convention that a much-wanted new product is slated to go into production at a certain time, only to experience delays caused by FDA requirements. "Just developing the data does take man hours," he said.

More stringent oversight may ultimately affect product pricing. "I'm sure you're going to add appreciably to the cost of the software," said Michael Gemignani, PhD, JD, dean of the college of arts and sciences and professor of computer science at the University of Maine in Orono. By comparison, the regulation of prescription drugs is also costly, he noted, but in that case companies have a financial incentive to provide a product that will be widely used and that can be securely protected with a patent, making it possible to enjoy good profits during the time when the company has a monopoly on the drug. With software, the market is much more limited, he said, and the product protection available is more poorly defined.

Competitive pressure among nuclear medicine device suppliers, as evidenced by mergers, takeovers and company failures, makes delays even more problematic. If fewer companies devote resources to research and development, then it may be that fewer innovations in nuclear medicine technology can be expected in the future. But Dr. Murray counters that companies that are doing a good job of software development and validation will have little difficulty meeting the FDA's expectations.

If the FDA does intend to provide thorough oversight of the software in medical devices, some are unconvinced that the agency is capable of doing so. "It's going to be one hell of a thing to do if they try to regulate software," said Dr. Gemignani. "I don't think they've faced up to the need for resources to do the task," said Mr. Brannigan. "I don't think they can really [attempt to] do too much. The question is, can they chew what they're trying to bite off?" added James Dobbins of Verilog USA, a software evaluation company based in Alexandria, Virginia.

Observers see several problems for the FDA. First, there is so much medical software of such complexity now that it would be impossible for the agency to evaluate it manually. Even if it tried, it might not prevent malfunctions. "With software you may have thousands and thousands of lines of code, and you can never be absolutely sure that it's going to run properly on another piece of hardware under different conditions," said Dr. Gemignani. "There's no way you can test for every conceivable condition that might arise."

Moreover, unlike other medical products, software is subject to signi-

(continued on page 591)

(continued from page 588)
ages of the feet of different patients. Dr. Dworkin recalls first noticing the problem in January when a patient showed broken ribs from the front, but not from the back. In an attempt to rectify the problems, the company replaced the circuit boards and software, but to no avail: "Even after they made all the changes, another pair of feet popped up," Dr. Dworkin said.

Dr. Dworkin is preparing to report the incident to the FDA, and to write an article providing the details of his experience. He pointed out that the malfunction, which was never identified as being either hardware or software, could have had serious repercussions. "Certainly inappropriate therapy could have been handed out," he said. "Therapy decisions are made on the basis of bone scans, no doubt about it."

Companies have an interest in developing products that work properly. Physicians, too, have cause for concern, not only for the humanitarian reasons of good patient care but also because they can be held liable for software malfunctions that have deleterious effects, according to Vincent Brannigan, a lawyer specializing in medical computer law in Adelphi, Maryland and associate professor of law and technology at the University of Maryland.

Nonetheless, manufacturers are uneasy about heightened FDA interest in software. "They want to know particulars about the design of the software, but companies don't want to talk to anybody outside of the company about the design of the software," said the NEMA representative. He added: "This has less to do with annoyance—one more damn thing to do—than it has to do with a very great concern about having outside people being privy to sensitive information about the very innermost workings of their equipment." One fear is that inspectors will inadvertently disclose proprietary information to competitors during inspections.

George Murray, PhD, director of the division of anesthesiology, neurology and radiology devices of the FDA's Center of Devices and Radiological Health, believes these concerns are unfounded. He said the FDA has been faithful in maintaining trade secrets in other areas, and that companies needn't fear disclosure by the agency.

Effects on Cost

Additional regulation is also accused of causing costly delays. "You've got a limited pool of manpower, and whenever you add more work, you create delays," said Edward Basile, a lawyer formerly with the FDA now specializing in medical device law with the firm King & Spalding, Washington, DC. "It does slow down the process," the NEMA representative said. "I pick up lots of conversation and anguish from company members who are party to commitments from prospective buyers." This problem might arise when a manufacturer tells a potential customer on the exhibit floor of a convention that a much-wanted new product is slated to go into production at a certain time, only to experience delays caused by FDA requirements. "Just developing the data does take man hours," he said.

More stringent oversight may ultimately affect product pricing. "I'm sure you're going to add appreciably to the cost of the software," said Michael Gemignani, PhD, JD, dean of the college of arts and sciences and professor of computer science at the University of Maine in Orono. By comparison, the regulation of prescription drugs is also costly, he noted, but in that case companies have a financial incentive to provide a product that will be widely used and that can be securely protected with a patent, making it possible to enjoy good profits during the time when the company has a monopoly on the drug. With software, the market is much more limited, he said, and the product protection available is more poorly defined.

Competitive pressure among nuclear medicine device suppliers, as evidenced by mergers, takeovers and company failures, makes delays even more problematic. If fewer companies devote resources to research and development, then it may be that fewer innovations in nuclear medicine technology can be expected in the future. But Dr. Murray counters that companies that are doing a good job of software development and validation will have little difficulty meeting the FDA's expectations.

If the FDA does intend to provide thorough oversight of the software in medical devices, some are unconvinced that the agency is capable of doing so. "It's going to be one hell of a thing to do if they try to regulate software," said Dr. Gemignani. "I don't think they've faced up to the need for resources to do the task," said Mr. Brannigan. "I don't think they can really [attempt to] do too much. The question is, can they chew what they're trying to bite off?" added James Dobbins of Verilog USA, a software evaluation company based in Alexandria, Virginia.

Observers see several problems for the FDA. First, there is so much medical software of such complexity now that it would be impossible for the agency to evaluate it manually. Even if it tried, it might not prevent malfunctions. "With software you may have thousands and thousands of lines of code, and you can never be absolutely sure that it's going to run properly on another piece of hardware under different conditions," said Dr. Gemignani. "There's no way you can test for every conceivable condition that might arise."

Moreover, unlike other medical products, software is subject to signi-

(continued on page 591)

(continued from page 590)

about five years and has been delayed, in part, by the sheer complexity of the task, according to Dr. Kirchner. "Writing in the terse review style of MKSAP (Medical Knowledge Self-Assessment Program), which is what we've modeled this after, is a considerable challenge to those who are accustomed to writing longer and less comprehensive reviews," he said. "A great deal of editing has been necessary and that has slowed down the process." Coming up with good questions has also been challenging. "The format of the questions and the level of difficulty is meant to approximate that of the board exams, but writing questions that are sufficiently rigorous to meet these demands is not easy."

The expansion of the earlier syllabus into this multicomponent educational program was directed by the Publications Committee of the SNM in 1984. Planning was fostered by C. Douglas Maynard, MD, who chaired the committee at the time, and was further supported by subsequent chairs B. Leonard Holman, MD, and Richard L. Witcofski, PhD.

Dr. Maynard is pleased with the work of Drs. Siegel and Kirchner and of the many contributors who made the project possible. "This is something all practicing nuclear medicine professionals would want to have, and I think it's a fantastic thing for the Society to do," he said. "It is something that desperately needs to be done well, and it's one of those things the SNM can do well because it has access to all the experts in the field."

[*Nuclear Medicine: Self-Study Program I* is priced at $90 for SNM members, $115 for non-members, and $75 for residents and technologists. For more information or to order a copy, contact the Society of Nuclear Medicine, Department 588J, 136 Madison Avenue, New York, NY 10016-6760, (212) 889-0717. Information can also be obtained at the SNM publications booth during the Annual Meeting, June 14–17, 1988, at the Moscone Convention Center in San Francisco, California.] ■

(continued from page 589)

ficant modifications by the user. Dr. Gemignani said there's a saying in computer science, albeit an overstatement but nonetheless revealing, that every time you correct one bug in a program you introduce another. When physicians or physicists alter program features, the result could be software that malfunctions in unexpected ways. "The FDA doesn't accommodate that," Mr. Basile pointed out. At some point, recertification may be advisable, but at what point?

Perhaps, Dr. Gemignani noted, the small risk of software malfunction in medical devices is worth taking, in the same way that society accepts the risk of airplane crashes in exchange for the convenience of air travel. The FDA shouldn't allow poorly designed software any more than it allows unsafe pharmaceuticals, he said, but regulations should be directed toward requiring manufacturers to test for the most common problems under reasonable conditions. The agency could license software separately for each individual combination of computer hardware and operating system and require the use of the available debugging devices, but beyond that, he said, "I think you've got to let it fly—either that or don't use it at all."

Currently the FDA is evaluating the positive and negative comments that have been received on the proposed policy, Mr. Hamilton said. Dr. Murray added that the agency is considering fitting the level of scrutiny of the software to the level of hazard posed to the patient by a malfunction.

The FDA is also grappling with questions about competent human intervention. For example, if a computer that transmits images over the telephone must compress the data before transmittal, making the received image less detailed than the original, then is the physician on the other end of the line competent to intervene if something goes awry? What kind of data does he or she need to make such a judgment? Or if an expert system provides a list of probable diagnoses, does it also provide enough data for competent human intervention if the computer is wrong? If output can be intelligently interpreted by an expert, then the validity of the interpretation is a scientific issue, not a regulatory one, said Harold Schoolman, MD, deputy director for research and education at the National Library of Medicine, Bethesda, Maryland, which provides support for medical computing. "If the output is accepted on faith, then the argument for regulation becomes much stronger, indeed compelling" when patient health is at stake, he added.

The FDA has accepted NEMA and the Washington-based Health Industry Manufacturers Association (HIMA)'s offer to contribute to the process of constructing a policy that best meets the goals of all parties involved. These and other industry groups have begun meeting to come to a consensus, and will be seeking the FDA's input as they work to develop a workable suggestion. FDA officials emphasize that they are not insensitive to industry's concerns, but that they feel a strong obligation to fulfill their congressional mandate. As Mr. Hamilton put it: "Our mission is to protect the public."

Karla Harby