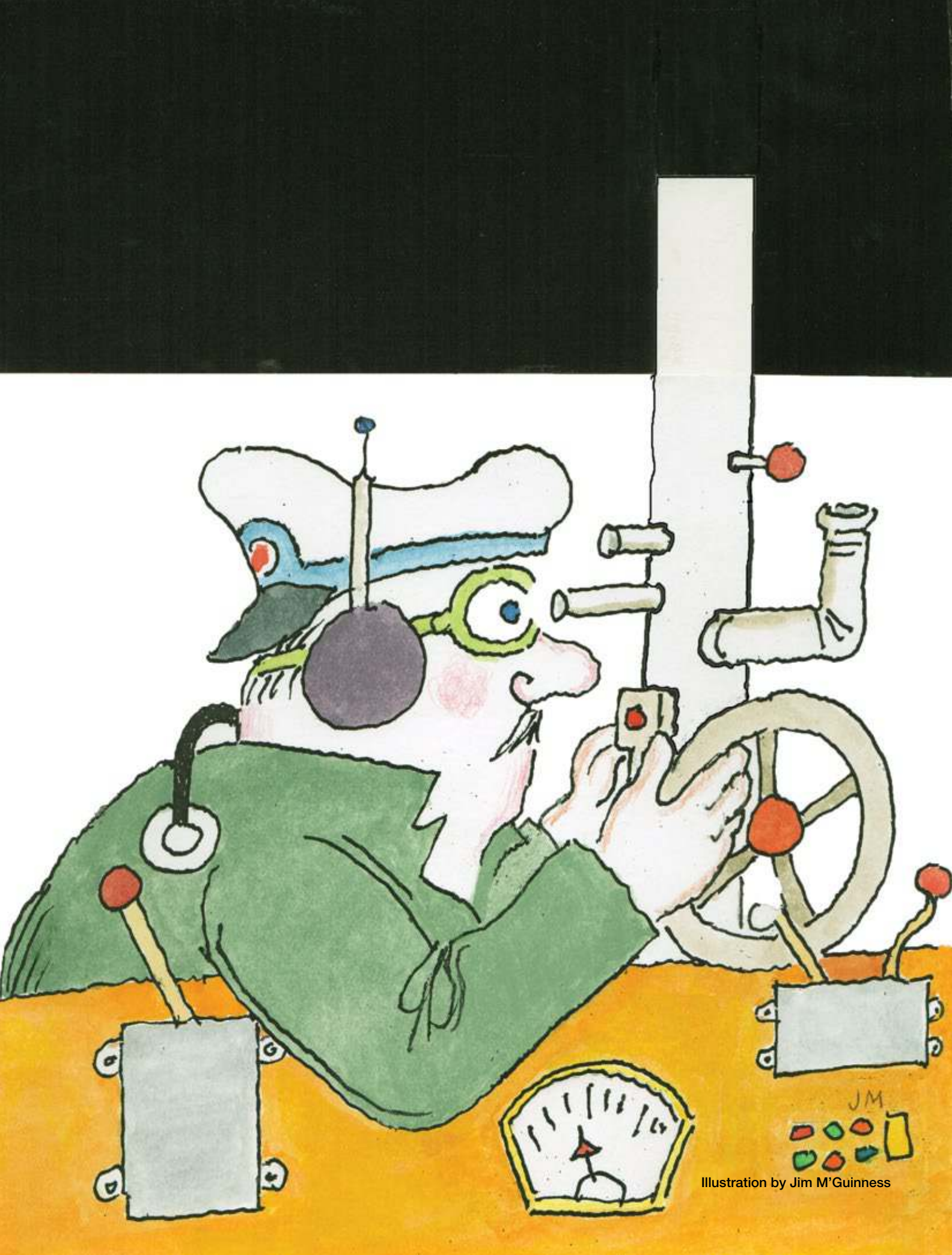

Illustration by Jim M'Guinness

"Cough, goddamn it!"

A fearful mishap leads to revolutionary advances in cardiology

Mason Sones, MD, in the submerged pit looking up at an intensified image. The circular unit on the right is the 35-mm cine camera. Photo courtesy Cook Corporation

Morton A. Meyers, MD, FACR, FACG

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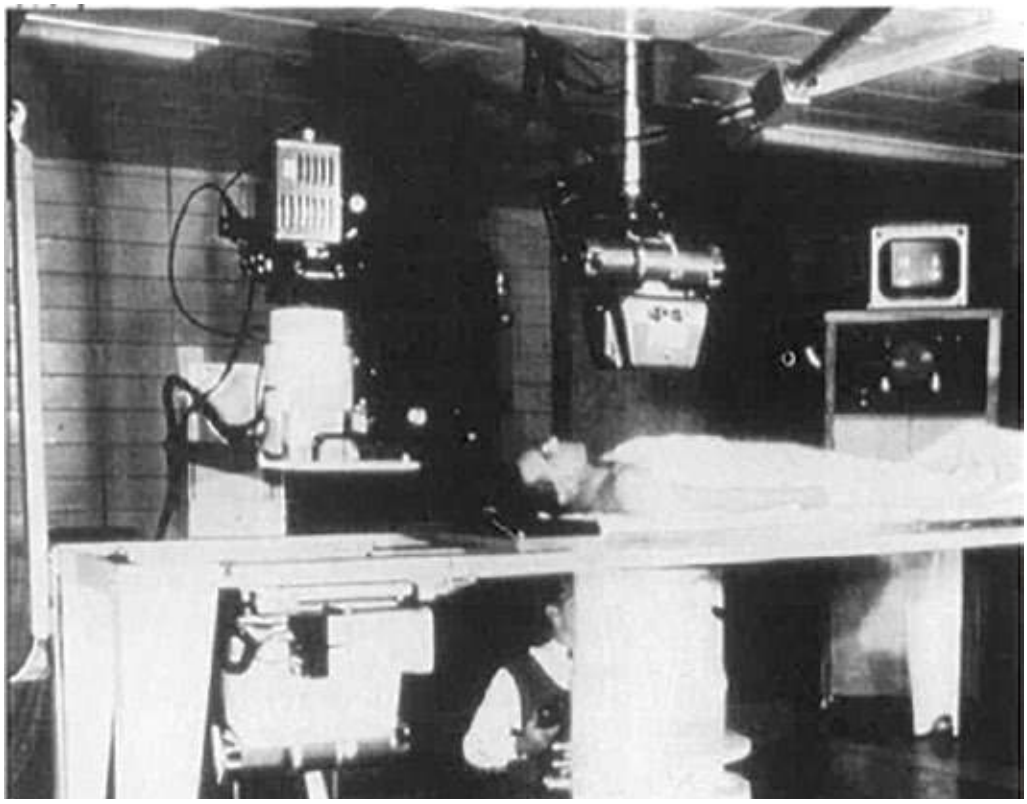
As the great vessel, the aorta, carries oxygenated blood from the contracting left ventricle of the heart, its immediate first branches nourish the heart muscle itself.

Prior to 1958, investigators had never dared to enter the openings of the coronary arteries with a catheter to introduce contrast material to enable their visualization by X-rays. This was because of two perceived calamitous effects that would deprive the heart muscle of oxygen—spasm of the coronary artery induced by the catheter, and replacement of its blood by an unoxygenated iodine-containing contrast fluid.

A host of indirect methods were attempted at numerous research centers over several years, but no investigator would attempt to selectively catheterize a coronary artery in a human. Instead, the tip of the catheter was often placed in the thoracic aorta—as close as possible to the openings of the coronary arteries—to deliver the contrast fluid.

Then, in 1959, an abstract appeared in the journal *Circulation* based on an oral presentation at the annual



The cardiac laboratory devised by Dr. Sones in the 1950s. The six-foot long instrument to amplify the fluoroscope image was placed below the table and the X-ray tube placed above the patient who is on a radiolucent table. Photo courtesy Cook Corporation

meeting of the American College of Cardiology, by F. Mason Sones Jr., MD, and associates from the Cleveland Clinic. Its opening sentence declared, "a safe and dependable method has been devised for contrast visualization of the coronary arteries to objectively demonstrate atherosclerotic lesions."[1] What stirred only a ripple of interest at the time was soon recognized as a landmark achievement.

For the first time ever, the location, number, and severity of blockages of the coronary arteries could be identified. This would advance cardiology as much as the electrocardiograph had done half a century earlier.

How Sones' method had been devised was not openly acknowledged until many years later, after the technique had been universally adopted in the revolutionary advance of reconstructive coronary surgery.

Sones, a pediatric cardiologist, had been recruited to the Cleveland Clinic to develop a cardiac catheterization laboratory, having learned the technique at the Henry Ford Hospital in Detroit. Complementing cardiac catheterization with angiocardiography, his work initially involved congenital heart disorders in children, and rheumatic heart disease in adults.

The catheterization laboratory in the basement of the clinic looked medieval. Sones had excavated a deep pit four feet beneath the floor to accommodate a six-foot-long vertical unit designed to enhance fluoroscopic images. Looking like a submarine commander peering into his periscope, he would sit within the pit at a level below the patient, who would be laid out on the X-ray table above. It was only in this manner that he could view the progress of the catheter and photograph images of the heart with the image-intensifier. Another operator would inject contrast dye into the patient's aorta or the heart chamber, carefully avoiding the opening to the coronary artery.

On October 30, 1958, Sones was working on a 26-year-old man with rheumatic heart disease. His assistant inserted the catheter into the patient's brachial artery just above the right elbow and directed it up through the aorta toward the heart with the tip of the catheter just above the aortic valve. Sones was monitoring the progress of the catheter on the fluoroscopic TV screen. From under the table he had no control of the catheter, and his assistant could not see the X-ray images.

"Inject," he called up to his assistant. From his place in the pit, Sones watched in horror as the tip of the catheter flipped around and at least 30 milliliters of dye was injected directly into the patient's right coronary artery, which was visualized superbly with all its branches. This was a frighteningly large amount of dye, never imagined for use in the human heart.

A modern day cardiac catheterization lab with highly specialized equipment that is a direct result of the revolutionary work of Mason Sones, MD. ullstein bild / Contributor

Fearing a cardiac arrest, and in a panic, Sones screamed, "Pull it out, we're killing him," as he rushed out of the pit to the patient's side and grabbed a scalpel to be able to open his chest and massage the heart.[2,3] The patient had no heartbeat for several frightening seconds, though he was still conscious. Sones then remembered that a strong cough could clear the contrast dye from the heart because of the contracting diaphragm muscles.

"Cough, goddamn it!"[3] he shouted at the patient. Startled, the man complied, letting out four hearty coughs. It worked. To everyone's relief, his heart started again, without any further complications.

The misadventure taught Sones that, contrary to views held at the time, non-oxygen-carrying fluid could safely be injected into a major coronary artery. He had discovered a technique for obtaining clear and detailed pictures of the entire coronary circulation.

> During the ensuing days I began to think that this accident might point the way for the development of a technique which was exactly what we had been seeking. If a human could tolerate such a massive injection of contrast directly into a coronary artery it might be possible to accomplish this kind of opacification with small doses of more dilute contrast agent. With considerable fear and trepidation, we embarked on a program to accomplish this objective.[4]

Sones constructed a catheter with a flexible, tapered tip that permitted easy direct entry to a coronary artery.

By 1962, he had successfully performed selective coronary arteriography with small doses of contrast—four to six milliliters—in more than 1,000 patients.

A brief paper on his technique and experience was published by the American Heart Association in its monthly leaflet *Modern Concepts of Cardiovascular Disease.*[5] Despite the enormous importance of the work, the report was written in modest style and it was only four pages long. However, its impact was explosive, leading to the rapid growth of the technique during the 1960s.

Coronary arteriography led to many new observations: spasm of coronary arteries; spontaneous coronary dissection; systolic narrowing of an epicardial segment of a coronary artery (myocardial bridges); the septal dance of left bundle branch block; the diastolic shudder of constrictive pericarditis; mitral valve prolapse; and hundreds of anatomical variations and congenital coronary anomalies.

In 1967, Sones reported that he and his colleagues had performed motion-picture coronary arteriograms (cineangiography) on 8,200 patients, representing all types of atherosclerosis. In more than 99 percent of the cases, both the left and the right coronary arteries could be seen. Branches as small as 100–200 microns were visualized.

For optimal angiographic use, Sones also constructed a rotating cradle for the table top.

Sones was a perfectionist who worked prodigiously, often 14–18 hours a day, sometimes seven days a week. All who knew him were alert to his forceful and frequently bumptious personality. He was intensely focused and scrupulously honest to the point of bluntness. A contemporary said, "The timid and lazy find him a trial; the active and dedicated, an inspiration."[6]

A small, chubby, ruddy-faced man who swore with gusto, his dominant characteristic was a zealous striving for perfection, accuracy, and truth. This was often manifested at major medical meetings as open disagreement with a lecturer making a scientific presentation. He quickly acquired a reputation for being aggressive, and even disrespectful.

Intemperate outbursts in his relentless pursuit of truth caused more than one public speaker to suffer some indignity, as he had to fight to impose his pioneering ideas to dispel myths still defended by eminent cardiologists.

In September 1983, Sones received the prestigious Albert Lasker Clinical Medical Research Award. His brief acceptance speech was characteristic of the man:

> What a fascinating time it was to develop high-speed X-ray-motion picture photography—60 X-ray pictures a second! My God, you can slow down what goes on inside the pump and even an idiot can sit there and look it over and over again and finally figure out what the hell's going on. So I'm most grateful for this experience. It's awe-inspiring.[2]

Sones' office was typically darkened as he was always reviewing angiograms—those of his own patients, those brought for consultation by his colleagues, and increasingly those referred by hundreds of cardiologists around the world.[6]

An inveterate smoker, he would use a long, sterile forceps placed on a nearby tray during catheterizations to pick up a cigarette, and have a nurse light it for him. After taking a few puffs, he would return the forceps to the tray, with the tip overhanging to keep everything sterile. He died of lung cancer, in 1985, at the age of 66.

Donald Effler, Sones' surgical colleague at the Cleveland Clinic, said, "Figuratively speaking, Sones's catheter pried open the lid of a veritable treasure chest and brought forth the present era of revascularization surgery."[7]

On May 9, 1967, another surgical colleague, René Favaloro, performed the first coronary artery graft in a 57-year-old woman with angina pectoris who had been diagnosed with a completely blocked right coronary artery.[8] Eight days later, Sones used his coronary arteriography techniques to take motion pictures of the rerouted blood flow in the woman's heart. This event revolutionized the surgical treatment of coronary artery disease.

Within three years, Favaloro and his colleagues performed 1,086 operations with an acceptably low mortality. The Cleveland Clinic became a mecca for angina patients who could benefit from surgical revascularization. By 1975, there were 18 staff physicians and 42 fellows, making the Cleveland Clinic Department of Cardiovascular Surgery the largest in the country. By 1978, six cardiac surgeons were doing almost 3,000 operations a year.

Today, about 400,000 coronary artery bypasses are done each year in the United States. Further accomplishments stemming from coronary arteriography include the interventional cardiology techniques of coronary angioplasty and stent placement.

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