

# THE KEY IN THE LOCK

## Cardiac catheterization

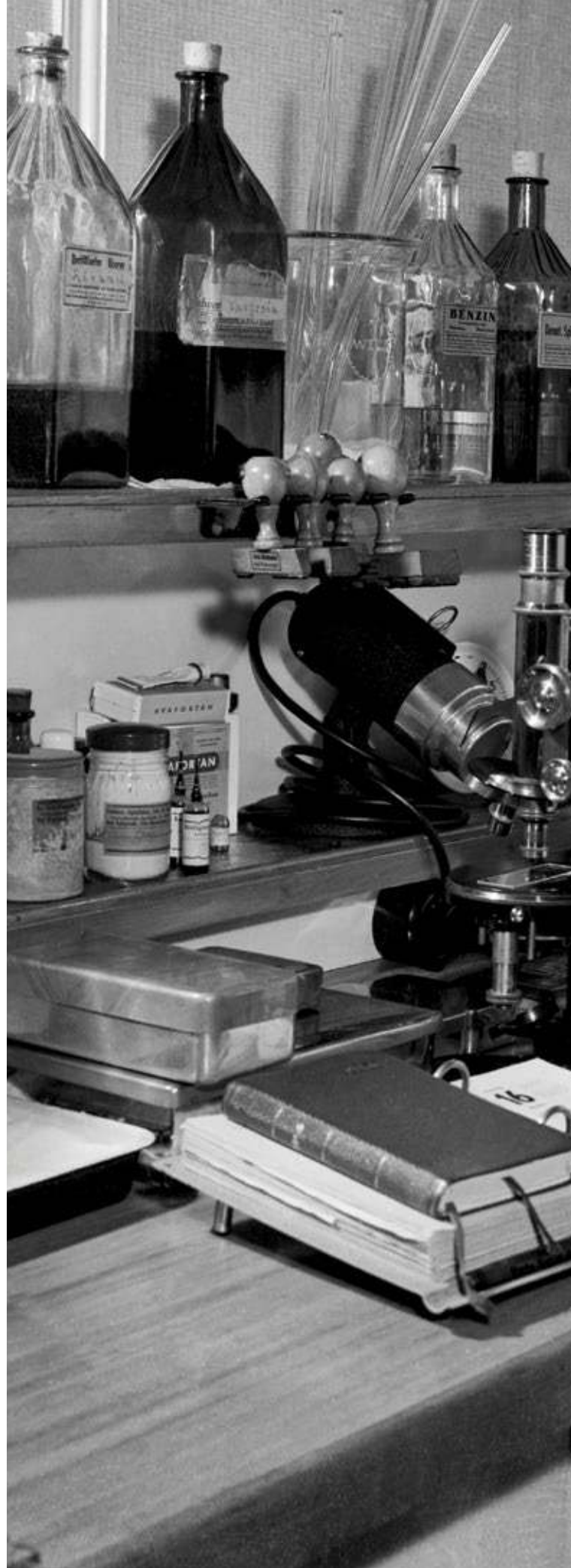
### Morton A. Meyers, MD, FACR, FACG

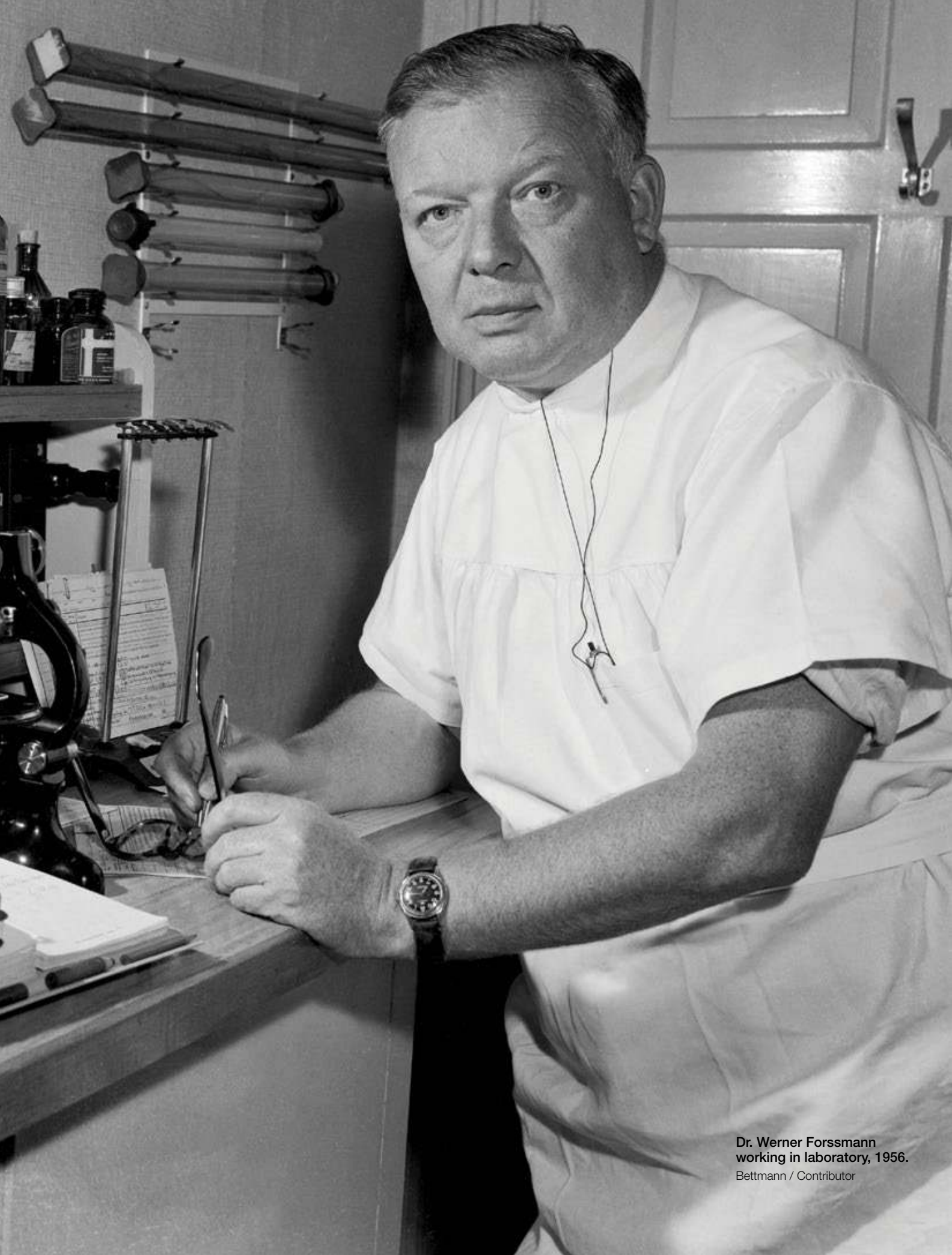
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**W**eighing less than a pound and about the size of a clenched fist, the heart is a marvel to behold. A healthy heart beats 48 million times a year, 2.6 billion times in a lifetime. Little wonder that mythology considered it the soul of man, and early surgeons viewed it as too formidable to intervene. An 1880 warning against surgery involving the heart was trumpeted by Theodor Billroth, the renowned Viennese surgeon, “A surgeon who tries to suture a heart wound deserves to lose the esteem of his colleagues.”<sup>1</sup>

That warning fell to a 25-year-old German surgical intern, Werner Forssmann, who famously performed the first human cardiac catheterization in 1929—on himself!

In medical school, Forssmann had been inspired by a study undertaken by two French physiologists in 1861.





Dr. Werner Forssmann  
working in laboratory, 1956.  
Bettmann / Contributor

Étienne Marey and Auguste Chauveau had inserted a thin tube into the jugular vein of a conscious, standing horse and guided it into its heart to the depths of the right ventricle, from which they recorded pressure readings of the heart's chambers. This pioneering procedure was accomplished without disturbing the horse's heart.<sup>2</sup>

The print from an old engraving depicting the event captured Forssmann's imagination. He was surprised that this simple technique had not been tried on humans, and was determined that it should be possible to transfer this procedure to man. A dream had taken hold.

Forssmann received his medical degree from the University of Berlin in 1929, followed by an internship in surgery at the Auguste Viktoria Home, a Red Cross hospital in Eberswalde, 50 miles outside Berlin. He pleaded with his superiors for approval to try a new procedure—to inject drugs directly into the heart—but was unable to persuade them of his new concept's validity. Even with the offer of doing it on himself first, the risk was considered too great.

Undaunted, Forssmann proceeded on his own. His goal was to improve on the delivery of drugs rapidly and safely to the heart in an emergency; at that time, the best but unsafe technique was to inject directly through the chest wall.

The circumstances of the dramatic incident on November 5, 1929, revealed by Forssmann in his autobiography *Experiments on Myself*,<sup>3</sup> reflect his determination, will power, and extraordinary courage.

Over several weeks, he gained the trust of the surgical nurse who provided access to the necessary instruments. So carried away by Forssmann's vision, she volunteered herself to undergo the historic experiment. Pretending to go along with her, Forssmann strapped her arms and legs to the table in a small operating room while his colleagues took their afternoon naps. When she wasn't looking, he anesthetized his own left elbow crease. Once the local anesthetic took effect, Forssmann quickly performed a surgical cutdown to expose his antecubital vein and boldly manipulated a flexible ureteral catheter through the hollow needle 30 centimeters toward his heart. He then released the nurse, saying "It's done." Realizing immediately that she had been duped, she was furious but nevertheless continued to assist him.

They then walked down two flights of stairs to the X-ray department, where he fearlessly advanced the catheter into the right atrium of his heart, following its course on

a fluoroscopic screen with the aid of a mirror held by the nurse. The tubing was too short to be pushed into his heart. He documented his experiment with an X-ray.

Forssmann recounted:

News spreads like wildfire in a hospital. Suddenly [a fellow intern] burst in, half asleep and his hair all tousled: 'You idiot, what the hell are you doing?' He was so desperate he almost tried to pull the catheter out of my arm. I had to give him a few kicks in the shin to calm him down.<sup>3</sup>

Forssmann successfully repeated his experiment on himself five more times over the next four weeks.

His report in the German medical journal *Klinische Wochenschrift*<sup>4</sup> garnered him fierce professional criticism and scorn, and a Berlin tabloid newspaper sensationalized and distorted the technique as that of a medical daredevil. And, in response to a senior physician who claimed undocumented priority for the procedure, Forssmann was forced to provide an addendum to his report. Rigid dogmatism and an authoritarian hierarchy characterized the German medicine of that day. The human heart, as the center of life, was still considered inviolable to instrumentation and surgery.

Forssmann's surgical career was subsequently severely curtailed. Desperate to get a lectureship in a university hospital, he was advised by an influential surgeon that he might lecture in a circus but not in a respectable German university.

But, he was a man on a mission, and continued his experimental pursuits with injection of X-ray dyes through a catheter into dogs, and on his own body. Hospitals at that time did not have accommodations for experimental animals, so Forssmann's mother cared for the dogs in her home. Forssmann would sedate the dogs, place them in a potato sack, and transport them on his motorcycle to the hospital.

As in the experiments that had been conducted by the French physiologists, Forssmann would insert a catheter through a vein in the dog's neck and into its heart. He would then inject dyes and attempt X-ray documentation. In the hope of documenting the rapid flow through the heart's chambers, the X-ray exposures had to be made quickly but without precise timing. By placing a number of them in sequence, he was thrilled to see they illustrated the heart's action.<sup>5</sup>

Forssmann had assured himself of the safety of the iodine-containing contrast solution in humans by pressing

it against the lining of the inside of his mouth for several hours, without reaction.

On subsequent experiments on himself, the catheter tip deflected into a neck vein rather than toward the heart. When the contrast dye was injected after proper positioning of the catheter, he felt only a mild irritation of the nasal membranes, an unpleasant taste in his mouth, and a transient dizziness. Unfortunately, he was unable to document the flow of contrast dye in himself.

Forssmann entered a catheter into his heart nine times. It was said that he stopped his self-experimentation only when he had used all of his veins with seventeen cutdowns.

When he presented the results of his studies at the annual meeting of the German surgical society in Munich in April 1931,<sup>6</sup> he received an icy response. There was no applause and no discussion.

In 1932, Forssmann joined the Nazi Party, a year before they came to power, which facilitated his obtaining positions at a number of hospitals through the decade.<sup>7</sup> Around 1937, Heinrich Himmler's personal physician offered to help Forssmann with his research by providing subjects, but he quickly declined. "To use defenseless patients as guinea pigs was a price I would never be prepared to pay for the realization of my dreams."<sup>3</sup>

In 1939, Forssmann enlisted in the Wehrmacht, served as a surgeon on the Eastern front in Russia, and became a prisoner of war under the Americans in 1945.

Because of his Nazi associations, after the war, he was forbidden from practicing medicine. However, in the 1950s, the order was rescinded and he was able to practice urology in a small hamlet in the Black Forest.

It was not Forssmann but two New York physicians, André Cournand and Dickinson Richards, who, in 1940, advanced cardiac catheterization of the right heart in humans. In a long-term project, catheters with pressure gauges, and a device to collect samples of blood gases enabled further study of cardiac and pulmonary function in both health and disease.

Cournand readily acknowledged Forssmann's explorations, and years later, contributed the preface to Forssmann's autobiography. He described Forssmann as, "not lacking in pride of self, a man at once disputatious, full of resources and will power, and endowed with physical courage, if not with great political perspicacity."<sup>3</sup>

In 1956, the Nobel Committee for Physiology or Medicine announced it would award that year's Nobel Prize to Forssmann, Cournand, and Richards. Plucked out

of obscurity a quarter century after his exploits and told of the news, Forssmann, then a country doctor in the Black Forest, told a reporter, "I feel like a village parson who just learned that he had been made bishop."<sup>3</sup>

Cournand stated in his Nobel lecture that, "the cardiac catheter was...the key in the lock."<sup>8</sup>

With the presentation to Forssmann, it was stated that he "was not given the necessary support; he was, on the contrary, subjected to criticism of such exaggerated severity that it robbed him of any inclination to continue. This criticism was based on an unsubstantiated belief in the danger of intervention, thus affording proof that—even in our enlightened times—a valuable suggestion may remain unexploited on the grounds of a preconceived opinion."<sup>9</sup>

## References

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