Werner Forssmann: A Pioneer of Cardiology

Renate Forssmann-Falck, MD

Werner Forssmann, André F. Cournand, and Dickinson W. Richards were awarded the Nobel Prize in 1956 for seminal work on heart catheterization, Forssmann for his pioneering self-experiment, and Cournand and Richards for establishing heart catheterization as a standard diagnostic and treatment procedure in cardiology. Forssmann's self-experiment pushed the boundaries of medicine into a new era and opened the door of modern cardiology. This historical study depicts Forssmann's life narrative and the forces, political and personal as well, that shaped his personality. His upbringing in Berlin, his career as a physician, the self-experiment, and his life as a Nobel Laureate will be reviewed. His preoccupation with euthanasia, and in the scientific community a rather unknown aspect of his intellectual productivity in his late life, will also be evaluated.

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. . .''It is a duty to maintain one's life; and, in addition, everyone has also a direct inclination to do so. But on this account the often anxious care which most men take for it has no intrinsic worth, and their maxim has no moral import. They preserve their life as duty requires, no doubt, but not because duty requires. On the other hand, if adversity and hopeless sorrow have completely taken away the relish for life; if the unfortunate one, strong in mind, indignant at his fate rather than desponding or dejected, wishes for death, and yet preserves his life without loving it — not from inclination or fear, but from duty — then his maxim has a moral worth.''[1]

Werner Forssmann wrote in his memoirs,[2] ''I became increasingly aware of how my own life . . . was influenced, even determined, by political events. I witnessed the Wilhelmian Empire, after that the Weimar Republic, and then National Socialism. Now I am a citizen of the Federal Republic of Germany.'' If he still were alive, he would have lived in a unified Germany, an event he certainly would have welcomed, because it brought freedom to his beloved Berlin. He also would do what he did so many times when he grew older; he would speak out and warn his countrymen of the possible perils a unified Germany might bring.

Forssmann's life was shaped by political events, just as it was determined by his personality: a daring man who struggled with his passions, an adventurer who searched for pure reason, a tragic man who believed it was his duty to do what he thought was right to do regardless of the consequences, a despairing man who could not mediate the opposing forces of his character. He should have lived in the 19th century, as his idealizing romanticism, so typical of him, made it difficult to deal with the chaos of the 20th century.

From the Virginia Commonwealth University, Richmond, Virgina 23220. Manuscript received May 31, 1996; revised manuscript received and accepted October 8, 1996.

Address for reprints: Renate Forssmann-Falck, M.D., 406 West Franklin Street, Richmond, Virginia 23220.

GROWING UP IN A CHANGING WORLD

Forssmann was born in Berlin on August 29, 1904, the only child of a lawyer and a housewife. The paternal family, mostly merchants and professors, originated in Finland. These ancestors lived in England, Holland, and Finland, but primarily in Northwestern Russia. The maternal side of the family were ''locals'' who had their roots in Prussia. They came from a middle-class background until the grandfather, a superb businessman, made money. Life for Forssmann took the usual course of a boy who grew up in Berlin embraced by a family that valued education above everything else. Disaster struck the family in August of 1914, and ended this idyllic scenario. His father received his military deployment order and left for the Eastern front. He died in action 2 years later. Forssmann, then 12 years old, grew up under the wings of his mother and grandmother, two powerful women who influenced him deeply. An uncle, a physician in a small town nearby, could not provide the necessary father figure, but tried to mentor his career.

Following his late father's wishes, Forssmann went to the Askanische Gymnasium, one of Berlin's best schools, to receive a humanistic education. Objectives of that education were to assimilate values of western civilization based on Greek and Roman heritage, to incorporate the notion of freedom of thought, and to strengthen character. Learning became a life-long task, and he acquired broad knowledge in history, anthropology, theology, literature, and philosophy, especially of the 18th and 19th centuries. He also loved nature and was an avid gardener.

Forssmann's Prussian upbringing was as significant as his humanistic education. He fiercely adhered to the Prussian virtues, which served him as guiding principles. Honesty, respect for the law, and surrender of self-interest to the common good were highly esteemed values; but above all reigned duty. These values were deeply ingrained in his personality and, remembering his father's lessons of Prussian virtues, he would tell his children the story of how he was

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severely reprimanded for using a pencil from his father's desk. Not only did he not ask his father's permission, he also used State property for personal purposes. The classical education and the authoritarian Prussian standards formed his character, but he knew too well that people were defined by their imperfections. His attempts to reconcile these high ethical standards with his passionate personality, his rebelliousness and disregard for conventions caused him unrelenting anguish. When he really needed to rely on these guiding principles, they failed him. This existential dilemma, combined with the many disappointments he experienced, eroded his belief in the goodness of mankind and turned into despair in his late life.

THE PHYSICIAN

Although the basic sciences played a secondary role in the Askanische Gymnasium, Forssmann was fortunate enough to take a 3-year-long elective in the basic sciences before he graduated in 1922. The same year, he entered the School of Medicine at the famous Friedrich-Wilhelms University in Berlin, known after World War II as the Humboldt University. The school consisted of various teaching sites and hospitals, among them the world famous Charité.[3] Students had considerable freedom to chose by whom and where they wanted to be taught. Blessed with great intellectual curiosity and a brilliant mind, Forssmann took advantage of the abundant opportunities for a first-rate medical education.

During the semester, Forssmann went out of his way to learn from the best and, indeed, profited from the excellent academic training that was available. The professors of the Berlin School of Medicine were the crème de la crème of German academic medicine, and many of them were famous around the world. The late 19th century changes in medicine from emphasizing structure to investigating function fell on fertile ground and greatly influenced his thinking and scientific curiosity. When he graduated in the Spring of 1928, he had a well-grounded medical education, and the seeds for his later attempts to push the frontiers of medicine ahead were already laid.

Guided by his uncle, Forssmann welcomed every opportunity to acquire clinical skills. He spent every spare minute with his uncle to learn the basics of medical practice. This experience shaped him into an excellent clinician who was far ahead of his peers at the time of graduation. His uncle also instilled into him those attitudes that make a caring and compassionate physician. True to the principle of duty, when it came to the welfare of his patients, no matter where they came from or who they were, he would do what was needed to help them. This behavior caused him to risk his position and his livelihood on more than one occasion.

Throughout his career, Forssmann always tried to look at his work with the keen eyes of the clinician and scientist as well. He truly deserved to be called a clinician-scientist. He expected residents and colleagues to write about their clinical knowledge, even though they had no interest in academic medicine.[4] He practiced what he preached, i.e., committing one's ideas to paper was an essential part of being a good clinician.[5–39]

THE EXPERIMENT

Forssmann learned as a first-year medical student of the experimental work of the French physiologists Bernard, Chauveau, and Marey. Chauveau and Marey[40] had earlier measured the intracardiac pressures of horses and other animals by inserting catheters directly into the heart, but Bernard used the technique regularly in his laboratory. Fascinated by those experiments revealed to him in Bernard's book, Leçons de Physiologie Operatoire,[41] published in 1879 and partially translated into English by Buzzi,[42] Forssmann wondered about the applicability to humans. During the clerkship and later internship in medicine, he questioned the value of available diagnostic procedures such as percussion, auscultation, x-ray, and electrocardiogram, and suggested that they were inherently inaccurate and subjective. He wanted to study cardiac physiology directly for diagnostic purposes,[43] although he emphasized the therapeutic aspect in his seminal publication of 1929.[44] The results of the experiments by the French physiologists made him believe that inserting a catheter into the human heart was as safe for humans as it was for animals. The idea of heart catheterization was born, and with it he opened the door to a new chapter in medicine and built the foundation of modern cardiology. As a first-year resident, just 25 years old, Forssmann was ready to make his dream come true at the Auguste-Viktoria Hospital in Eberswalde, a small town nearby Berlin.

After graduation from medical school in the Spring of 1928, Forssmann hoped for a residency in medicine while obtaining a degree in chemistry. These career plans were reflected in his doctoral dissertation studying the effects of overfeeding healthy subjects with liver extract (Figure 1).[45] The famous internist Georg Klemperer was his advisor. He promised Forssmann a salaried residency position after the completion of an internship in Anatomy and Medicine, but did not keep the promise. Salaried residencies were scarce at that time, and Forssmann, who had worked since graduation from high school in order to make ends meet, needed such a position. By default, he began a residency in surgery at the Auguste-Viktoria Hospital in Eberswalde, hoping to switch to medicine as soon as the opportunity arose, a common phenomenon among German residents. The job was a lucky find, but more important was his relationship with Richard Schneider, Chair of Surgery. Schneider stood by Forssmann, when he rose ephemerally into the spotlight and fell into oblivion, remaining there until the American researchers, André Cournand and Dickinson W. Rich-

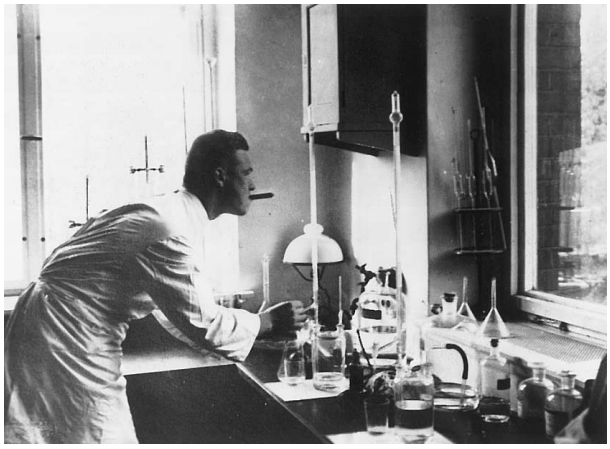

FIGURE 1. Forssmann doing research on his doctoral dissertation in 1928.

ards read of his work and established heart catheterization as a standard diagnositc procedure in medicine.

Forssmann, in the summer of 1929, began to examine his ideas about heart catheterization with colleagues and, eventually, with Schneider. He comprehended Forssmann's vision, but anticipated strong resistance from the academic community. A young and unknown man was to violate a taboo by leapfrogging tradition and breaking into one of medicine's most precious sanctuaries — he was not even an academician. Nevertheless, he encouraged Forssmann to do the preliminary but necessary animal research to document the safety of the procedure. Forssmann, headstrong and intense, believed that the experiment was absolutely safe and, grandiloquently, performed the catheterization on himself without prior research.

In the 1929 publication,[44] Forssmann described the self-experiment as follows: with the help of a coworker, Peter Romeis, he punctured his left cubital vein, inserted a well-lubricated, 4 Charrieres-thick, ureteral catheter into the vein and pushed the catheter about 35 cm up. As Romeis thought the experiment would become too dangerous, they broke it up. A week later, Forssmann repeated the experiment by himself. Again, he inserted the catheter through a vena sectio of the left cubital vein and pushed it up to about 65 cm — the estimated distance to the right heart. He experienced a sensation of warmth on the wall of the vein when he moved the catheter and a slight cough, which he attributed to stimulating the vagus nerve. With the catheter in his heart, he walked from the operating room downstairs to the x-ray room. He took x-rays while moving the catheter with the help of a nurse. This nurse held a mirror in front of Forssmann so that he could observe the position of the catheter and take x-rays when the tip of the catheter passed the axilla and entered the right atrium, respectively. He could not continue to move the catheter forward into the right ventricle because the catheter was not long enough.

But there is also a story to be told. After many discussions with Schneider and colleagues, especially Peter Romeis, he indicated his readiness to perform experiments. When Schneider refused to give permission for experiments without prior research, Forssmann suggested that he would do the experiment on himself. Schneider strictly forbade any self-experiment, but Forssmann was set to go ahead with the self-experiment. He quite ingeniously deceived the scrub nurse, Gerda Ditzen. To get the instruments for the vena sectio, he made her an accomplice by sharing his dream with her. One day, he had successfully persuaded her to help with the vena sectio, just to see how it worked. She, however, became suspicious and insisted on being the subject. In a moment of inattentiveness, he tied the nurse to the operating table, then pretended to do a vena sectio on her when actually he was doing it on himself. Then, he proceeded as described in his seminal paper. In the x-ray room, further hurdles had to be overcome. While in the midst of observing the catheter move through his vein, Romeis appeared and tried to stop him, but to no avail, and Forssmann completed the self-experiment. Within 1 hour the hospital knew what had happened. Schneider reprimanded Forssmann severely for his disobedience; yet, he understood the far-reaching consequences of the experiment and decided to help Forssmann.

When Forssmann discussed publication with Schneider, the latter suggested that the manuscript be written from a therapeutic rather than a diagnostic perspective, in the hope of deflecting some of the expected uproar. Thus, he permitted the catheterization of a woman who was in shock and dying of puerperal sepsis. The purpose was to observe the immediate response to the intracardiac application of suprarenin (adrenalin) and strophantin (a digitalis preparation), thereby underscoring the therapeutic value of the procedure. The seminal article[44] was published in November of 1929 and created havoc in the Berlin press.

Emphasizing the therapeutic aspect of the procedure may not have been the best strategy. After publication, Forssmann was charged with plagiarism by Ernst Unger, Chair of Surgery at the Rudolf Virchow Krankenhaus, one of the teaching hospitals of the Berlin School of Medicine. He claimed priority in such experiments because he and 2 collaborators had already published results of intra-arterial application of medication in 1912.[46–48] Fortunately, and unbeknownst to Forssmann, the chief editor of the *Klinische Wochenschrift* had searched the literature, before publishing Forssmann's manuscript. He wanted to be sure that Forssmann was, indeed, the first to perform heart catheterization on a human being. He assured Forssmann that he knew of Unger's publication and that Forssmann's claim of priority was accurate. His priority was once again, unsuccessfully though, questioned by Ernst Derra, Chair of Surgery, Heinrich Heine University, Düsseldorf, shortly after Forssmann was already awarded with the Nobel Prize.

EARLY APPLICATIONS OF THE FORSSMANN TECHNIQUE

Until Forssmann's discovery, cardiac output could not be measured by the direct Fick principle in humans even though it was already used by Gréhant and Quinquad in animals in 1886.[49] Baumann,[50] a German physician, apparently unaware of the new technique of cardiac catheterization, measured cardiac output in humans by direct cardiac puncture in 1930. After Forssmann's experiment, a number of reports during a period of approximately 3 years were published using catheterization for cardiac studies. In Prague, Klein[51] used the cardiac catheterization method to obtain mixed venous blood and studied cardiac output in 30 patients. Thomas,[52] a physiologist in Leipzig, studied the glucose metabolism of animals by using heart catheterization. In Spain, Estalla,[53] Jimenez Díz and Sanchez Cuenca,[54] and Calvo Melendro[55] reported experiments with heart catheterization. Perez Ara[56] published about the technique and application of catheterization in Cuba. In Argentina, Padillo, Cossio, and Berconsky[57–59] also experimented with heart catherization and described their results in a number of publications. However, catheterization for angiographic studies preceded its use for physiologic and diagnostic studies of the heart.

In 1931, Forssmann tried to visualize the heart by injecting an iodide preparation into the right atrium during radiographic screening, but was unable to obtain adequate images.[60,61] Other investigators followed suit as the moment was ripe for this major breakthrough and confirmed the usefulness of the Forssmann method for angiocardograms. Moniz et al[62] injected a more concentrated solution of sodium iodide and obtained the first clinically useful angiocardiogram. Estella[63] conducted angiographic studies. In 1933, Conte and Costa[64] reported on the angiographic use of catheterization. Beginning in 1937, Castellanos and Pereiras,[65] performed angiographic studies in Cuba. They demonstrated the visualization of the heart in children and laid the foundation for the retrograde aortography. In the same year, Robb and Steinberg[66] in New York City showed that this method could be applied to adults as well.

In the 1938 edition of Macleod's Physiology in Modern Medicine, Bazett[67] described the progress of hemodynamic study in the years immediately following Forssmann's publication. Arterial pressure could be directly measured from a needle inserted in a large artery. The use of Forssmann's technique to measure intracardiac pressure accurately awaited the development of Wiggers' optical manometer toward the end of the decade. The coupling of Forssmann's technique with Wiggers' manometer opened a new page in the history of cardiac physiology, but not everyone believed in the Forssmann technique. Grollman,[68] the inventor of the acetylene rebreathing method, thought it was too traumatic. He wrote in his book on the measurement of cardiac output that Forssmann's technique was

"... not only dangerous to the subject but useless so far as cardiac output determinations are concerned. The formation of thrombi which is very likely with the introduction of a foreign body into the blood stream renders the method too hazardous for its possible future use. The nature of the operation also precludes its use as a means of determining cardiac output for the unavoidable psychic effect accompanying the procedure will elevate the cardiac output considerable and thus vitiate any results obtained. This method must thus be considered merely as a clinical curiosity."

One wonders whether Grollman's comments in this widely read book influenced researchers in this country. Cournand[69] also made reference to Grollman discrediting the method. It took another 10 years after Forssmann's self-experiment for Cournand and his co-workers to prove that heart catheterization was not "merely a clinical curiosity," but a safe and sound procedure to study cardiac physiology.[69]

ATTEMPTS TO ENTER ACADEMIC MEDICINE

Despite Forssmann's disobedience, Schneider supported the project the best he could. While the publication was underway, Schneider tried to get Forssmann a position in the Berlin School of Medicine. First, he approached Wilhelm His. His met with Forssmann, who proposed that the heart catheterization could be useful for intracardial electrocardiographic studies. His disagreed with Forssmann's contention, but thought that catheterization might be of value to surgeons. The conservatism of the aged physiologist delayed intracardiac His bundle recording for 40 years! Schneider then spoke with the famous surgeon August Bier. As Bier was to retire soon, he recommended Forssmann to Ferdinand Sauerbruch, the Chair of Surgery at the Charité. Hoping for an academic career, Forssmann took an unpaid job at the Charité in October 1929. When Forssmann's pioneer article was published 1 month later, it received widespread coverage in the news media. Sauerbruch summoned Forssmann and fired him immediately, saying that he could lecture in a circus, but never in a respectable German university. In January 1930, Forssmann went back to Schneider.

During the brief intermezzo at the Charité, Forssmann met Willi Felix, who became the Chair of Surgery at the Neukölln Krankenhaus in Berlin. Felix encouraged Forssmann to continue with the project and made the hospital facilities available to him. The hospital had state-of-the-art x-ray equipment, which Forssmann needed for further experiments. He planned to demonstrate the value of catheterization as a diagnostic tool by using methods of contrast angiography. For the animal experiments, he first used rabbits, but conceded in 1951 that if he had started experimenting with rabbits, he would never have experimented on himself.[70] When the tip of catheter touched the rabbit's endocardium, the electrocardiogram showed temporary cardiac arrest. He continued the studies with dogs and demonstrated

that angiography was a safe and useful diagnostic procedure. While doing these animal studies, he catheterized himself 9 more times, hoping to get a publishable angiograph of himself, but to no avail. As before, the response of the academic community ranged from laughter and disbelief to admiration.[60,61]

Forssmann acknowledged that he had reached the limits of doing research on his own. In another, yet futile attempt to enter academe, he turned once more to Klemperer, but made an unforgivable mistake. Klemperer shared with Forssmann his current research on storing thoratrast, a radioactive substance with a very long half-life time, in the liver and spleen for better radiographic demonstration. Forssmann questioned the use and safety of this procedure. Criticizing a superior in German academe was and still is a cardinal sin, and Klemperer dismissed him.

Sauerbruch, however, offered Forssmann a position in 1931, promising the opportunity for research. Forssmann was excited, but disillusionment followed soon. Although he was a staff surgeon at his previous job, he functioned now as an intern at the Charité. His energies were consumed by clinical work and little time was left for research. Attempts to change the situation were unsuccessful. In the summer of 1932, he was fired again because he was not productive as a researcher. This ended the dream of an academic career in cardiology. He pursued instead a career in surgery and urology.

In 1951, Forssmann collaborated with a team of researchers at the University of Cologne studying pulmonary angiographic methods.[71–74] Forssmann was asked to join the faculty of the School of Medicine of Cologne University, but declined. He believed he could not financially support a wife and 6 children with a university salary, although his wife was a physician in private practice. Perhaps he felt he could not risk a third try. In retrospect, it seemed a wise decision. The combination of having spent 2 decades of his professional career as a surgeon, problems with fitting into the rigidly authoritarian structure of German academe, shattered beliefs resulting from the demise of the Third Reich, Germany's defeat after World War II, and experiences as a prisoner of war may have made it impossible to start all over again in his late 40s.

THE ''ZEITGEIST'' AND ITS BITTER CONSEQUENCES

Historically, German nationalism had its roots in the 19th century. When Bismarck created the German nation, nationalism gained power while serving as a counterbalance to the growing influence of socialism and communism in Germany. The lost World War I resulted in severe economic depression, and the so-called ''humiliation of Germany'' generated a vacuum and a fertile soil for Hitler's fanatic program of nationalistic ideas. Tensions between nationalism, Nazi ideology, and socialism exploded during the 1920s, and violent street fights and riots were common, particularly in München and Berlin. Antisemitism came into the open and grew. Surprisingly, Forssmann did not address the political chaos in Berlin in his memoirs, although he discussed the national-socialistic influence and the growing antisemitism in the university.

Forssmann followed the tide and joined the National Socialist Party (NSDAP) in 1932. He paid dearly for this mistake, and poor judgment was a lifelong source of grief and anguish. As a man of principle, he waived his responsibility. As a man who was taught that freedom overrides oppression, he failed. He could not come to grips with his failings nor could he forget or forgive himself for having joined the party. He could not rid himself of guilt feelings for succumbing to the national-socialistic influence. In his memoirs, he suggested that the motivating force for joining the NSDAP was his search for the lost father. Although this might be true, there were also other reasons: the promise of a strong, economically sound Germany and the hope of making a career for himself.

When it came to his physicianhood, his actions were clear and definite. In 1937, Forssmann became the Vice Chair of Surgery at the Moabit Hospital in Berlin. The Chair, Kurt Strauss, a high-ranking officer of the Staatssicherheitspolizei (SS), introduced Forssmann to Karl Gebhardt, Himmler's personal physician. Gebhardt, later sentenced for unethical medical experimentation during the Nuremberg trial,[75] offered to help Forssmann with his research by providing subjects. Forssmann quickly declined. A year later he got himself into real trouble with Strauss. The medical staff of Moabit Hospital was not permitted to treat Jews unless there was a life-threatening situation. Despite this decree, Forssmann attended to every Jew who asked for treatment. Upon the advice of his father-in-law, he enlisted in the German Wehrmacht in 1939 and was on active duty until the end of World War II. Joining the Wehrmacht was perceived as internal emigration. The assumption was that soldiers, especially officers, were safe from harassment or persecution of the SS. The Wehrmacht had a separate power structure and was lead by generations of Prussian officers, who supposedly were honest, fair, and loyal to their men. What a delusion it was.

When Forssmann returned home from a prison camp in October 1945, he was a broken and severely depressed man. He was not permitted to work as a physician because of his membership of the NSDAP. He had to rely on his wife, who was the general practitioner for a rural community in the Black Forest. It took 3 more years for him to go back to work. In 1948, the French Occupation Administration cleared him of his past.[76] When he tried to find a job as a surgeon in the Black Forest community where he and the family lived, he was denied employment because he was Prussian. Because he could not get a loan to open a private practice, he finally accepted an offer to become the chair of a small Department of Urology in Bad Kreuznach. In 1950, the family moved to that small, quiet town hoping to find a new home. The tranquility found there was brief. Life for

the entire family turned upside down once again in 1956, when he, Cournand, and Richards were awarded the Nobel Prize for developing catheterization of the heart—he for pioneering, and the Americans for developing and refining the procedure.

THE NOBEL PRIZE

One day in late October 1956 had lasting consequences, unforeseeable at the time. A family struggling with piecing together its past was thrown into the glaring spotlight of fame. Actions and behaviors changed and all family members were measured accordingly since then. Expectations and achievements of the children were always judged by others in the light of that defining moment in the family history. It did not make a difference if the expectations were those of the children or those of others, there was always the comparison!

For weeks the press had interfered with daily life, and after Forssmann decided to take the whole family with him to Stockholm, everyone was busy with the preparation for the trip (Figure 2). The children had never been in a foreign country, nor did they walk the paths of the upper society or nobility. The younger ones were bombarded by the older ones with advice on how to behave themselves, as if the older ones had always had the opportunity to socialize with royalty. Klaus and Knut, the 2 oldest sons, seemed to take the matter coolly and calmly, probably as expected and instructed by their father. Jörg, in his usual manner always ready for a skeptical remark, watched from a distance wondering how the ''old man'' would handle this situation. Wolf courted Cournand's daughter, but what was a small town boy to do with a beautiful girl from New York. Bernd went along quietly and observingly. The daughter Renate, just 13 years old and a tomboy, was expected to grow up in a split second and conduct herself as a young lady (Figure 3).

The ceremony was moving and overwhelming. My father while giving his Nobel address[77] struggled with emotions and was close to tears when he received the award by the Swedish King. What went through his mind then, he never revealed. He was well received by his 2 co-laureates (Figure 4) and struck up a friendship with Cournand. The only shadow over the celebration was the decision of the Swedish King to have only a ''modest dinner'' instead of the usual magnificent banquet because of the Soviet invasion of Hungary.

Forssmann would not talk much about what it meant to receive the Nobel Prize for what seemed an ephemeral enterprise as a young man. Like so many other situations that were extremely important to him, he hesitated to talk about his self-experiment with me. In all fairness, I did not ask much about it either. It was hard enough to be a physician in my own right and to be confidant that my achievements were the results of my efforts rather than his reputation. In his memoirs, though, he compared receiving the Nobel Prize with a parish priest who suddenly

FIGURE 2. Forssmann in his study in the Fall of 1956.

FIGURE 3. The Forssmann family before the ceremony in Stockholm. Forssmann and his wife Elsbet sitting in the front and standing behind them the children Renate, Bernd, Jörg, Knut, Wolf Georg, and Klaus.

became the pope overnight. He rarely expressed his feelings about being perceived as an internationally renowned and honored scientist, while having been a private practitioner in a small town. Seldom would he speak of his disappointments about his faltered hopes of having an academic career. However, after being awarded the most coveted prize in science, being a Nobel Laureate became his second profession.

In 1958, Forssmann was appointed as the Chair of Surgery at the Evangelische Krankenhaus, a large hospital in Düsseldorf, where he worked as a general and trauma surgeon until his retirement in 1969.

LIFE AS NOBEL LAUREATE

The churning political events in postwar Germany and the rapid changes in the medical sciences in the 1960s and 1970s once again challenged Forssmann's value system. Beginning in 1965, he wrote and spoke about the ethics of the death penalty, euthanasia, and organ transplants. The thread and com-

FIGURE 4. The Nobel Laureates Forssmann, Richards, and Cournand chatting with Professor Sten Friberg of the Karolinska Institute, Stockholm, Sweden (from left to right).

mon denominator were his struggle with the 5th commandment, ''Thou shall not kill,'' and, perhaps, his unresolved conflicts with the Nazi past and his memories of being on active duty in the German Wehrmacht from 1939 through 1945. His ideas were controversial and polemic, but must be viewed in the context of his experiences: (1) as an adolescent, he learned of the execution of an innocent man, which horrified him; (2) World War II had made him a passionate pacifist; and (3) terrorism that swept through Europe in the 1960s and 1970s resulted in a heated public debate over the reinstatement of the death penalty in Germany. He dreaded the possible return of a Nazi mentality and believed that tight moral controls were the only way of dealing with this menace. He took the unequivocal position that killing in any form was a priori wrong and a capital sin. Because death is the definitive end of life, it is not the domain of man, but of a higher power. In his opinion,[78] the death penalty is morally wrong, violates humanity, and does not help prevent crimes, but harms. His most powerful argument was that 1 single error of justice can kill an innocent man. Because human nature is liable to err, one has to assure that such an irreversible mistake does not occur. Curiously, Forssmann interpreted the blindfolded Justitia as representing man's blindness to justice rather than as evenhanded justice, and the justice of law rather than of man. It is also interesting that his writings or lecturing on this subject do not mention abortion, which was the subject of heated debate at the same time.

Concern over the practice of euthanasia became the centerpiece of his intellectual productivity and moral struggles in his late life. The preoccupation was triggered by the report of a hemicorporectomy of a patient in the United States that made headlines throughout the world and by the first heart transplant in 1967. At the 16th Annual Meeting of Nobel Laureates at Lake Constance in 1966, he spoke out against it and was subsequently interviewed by the press. In strong words he stated: mercy killing is reprehensible; a physician's duty is to heal and preserve life; these moral principles are anchored in the Hippocratic oath, philosophy, and religion, and they overrule the right of freedom of choice.[79] Years later he softened his categorical statements by distinguishing between active and passive euthanasia, but he still maintained that ethical decision-making concerning euthanasia was solely the physician's domain. Lawyers, theologians, and ethicists were just helpers for physicians in providing guidelines governing morally justifiable actions. As a passionate deontologist, Forssmann would have taken issue with the prevailing trend of looking at ethical problems from a utilitarian view point. In the current debate regarding assisted suicide, he would have condemned Dr. Kervorkian.

In the 1970s, Forssmann's writings centered on euthanasia.[80–87] He defined active euthanasia as the termination of life upon the patient's request or purposefully ending treatment because of the hopeless outcome of an illness. Because active euthanasia is killing, it is morally wrong. Even when the family requests euthanasia or participates in the decision-making process, it is still morally wrong. He perceived the dyadic nature of the physician–patient relationship as untouchable and not to be violated. He elaborated on this idea in relation to organ transplants. The necessity of a donor brings a third party into sacred physician–patient relationship and transforms the dyadic into a triadic relationship with all the dangers and uncertainties of such implied triangulations. For the definition of passive euthanasia, Forssmann relied on the German word ''Sterbehilfe.'' Its meaning is ambiguous and refers to helping someone die either emotionally through counseling and pastoral care or by medical actions for the purpose of alleviating pain. These definitions imply a thin line between active and passive euthanasia: active euthanasia signifies termination of life, whereas passive euthanasia denotes the alleviation of suffering. Based on these assumptions, he proposed 3 stages of dying. The first stage is the terminal illness; the second stage is the preagonal stage or process of dying. The third stage is the agonal phase or death. He strongly advocated treatment for the first and second stage according to Hippocratic principles. Moreover, he called for research into treatment strategies for the process of dying, proposing a science of physiologic thanatology. He hoped that such a science could solve the core problem of defining the physiologic boundaries between the second and third stage, thus enabling the physician to distinguish between active and passive euthanasia and to act within the bounds of the Hippocratic oath.

In the final analysis, his arguments did not address the moral dilemma proposed by euthanasia. Active and passive euthanasia are both based on the same actions, although at different points of the process. The actions have the same goals, i.e., accelerating dying, and the actions have the same outcome, i.e., death. The difference between active and passive euthanasia are the intentions and motivations that govern the actions. The intent and the motivation

FIGURE 5. The hospital in Eberswalde where Forssman performed the first catherization.

must be justifiable and morally sound at that moment of truth when a patient's life is ended. The impervious ambiguity of this moral conflict must have tormented Forssmann, as he looked for a Kantian answer. Nor would it have quieted his fears of the return of the Nazi horrors in medical science.

Forssmann's discourse on euthanasia must be viewed further in light of his existential doubts as to whether man is trustworthy and moral or is driven by emotions, grandiloquence, misguided ambitions, and power. Because of the ambiguity of man's character, he had apocalyptic visions of a future without morals. He contended that the 20th century was characterized by the decline of human values and the advancement of science without morals. To restrain the temptation implied in such a constellation, he called for a revitalization of a broad humanistic education. The prime purpose of education would be to reaffirm value systems and humanitarian principles. He regretted the widening gulf between the basic sciences and humanities. He spoke out for a blend of the basic sciences with the humanities, believing the latter could remind scientists of man's limitations and the needed renouncement of Promethean temptations. The true value of freedom, he believed, is the negation of our self-interest for the sake of the common good. Freedom implies limits, obligation, and duty.

With the advent of the organ transplants, Forssmann had the golden opportunity to be that mentor he never had as a young man. When he looked dispassionately at organ transplants and drew from the wealth of his clinical wisdom, he had made some important recommendations, as did others: (1) further research to make transplants a safe clinical procedure, (2) increased understanding of immune biology, and (3) the need for an ethical foundation to prevent abuses of donors and recipients. However, he became carried away by his passions, denounced the organ transplants vehemently, and lashed out at its proponents. His response was paradoxical and incomprehensible, considering his own experience. In 1966, he wrote ''we find ourselves at the end of the second era of modern surgery and on the threshold of the third.''[88] But, when Christian Barnard reported the first successful heart transplant a year later, Forssmann ripped him to pieces, suggesting that this operation is so monstrous that he felt obliged by his responsibility as a Nobel Laureate for cardiology to speak out against it. In the newspaper editorial, ''Loss of Moral Substance'' (Verlust an sittlicher Substanz),[89] he made his most controversial points: (1) the need for organs is a temptation to broaden the concept of euthanasia and invite immoral actions; (2) the outlawed death penalty in Europe might be reinstated to provide organ donors; (3) the ethical dimensions of the physician–patient relationship will be profoundly changed in that the physician functions as healer in 1 case and as killer in the other; (4) the competition for organs will lead to arbitrariness, caprice, and recklessness; (5) combined with the wish for fame the medical profession will be corrupted; and (6) the sanctity of the dead body will be violated. The opinions professed in this editorial repeated the mistakes of his past, but this time with reversed roles. Forssmann, with a voice that was listened to, gave away an opportunity to welcome groundbreaking progress in medicine, while pointing out that new and undiscovered territory in science has the potential for scientific and ethical wrongdoings. Perhaps he also waved an opportunity to redeem the failings and disappointments in his career. He chose instead to act as a bitter, disappointed, lonely man who was wondering what had happened to the world he knew.

EPILOGUE

After retiring in 1969, Forssmann moved back to the little village in the Black Forest, where he found some solace after World War II. He died there of a myocardial infarction in a small country hospital on June 2, 1979. He and his wife, who died in 1993, are buried in the country cemetery of Wies. His wife was among the first women physicians in urology when she received her board certification in 1954. Forssmann left 2 legacies: he was the godfather of modern cardiology and the father of 6 children to whom he passed on the firm belief that learning is the essence of life. He did not demand of them that they become outstanding, but he expected them to treasure knowledge, humanity, and the search for justice. All 6 children have tried to accomplish these goals in unique ways. Although all of his 6 children excelled in their careers, his son, Wolf Georg, has become an internationally renowned peptide researcher, and his son Bernd developed the lithotrypter. After the unification of East and West Germany, the Auguste-Viktoria Hospital was renamed as Werner Forssmann Krankenhaus (Figure 5). The operating room, where he opened his vein and inserted the catheter, and the x-ray room, where the x-rays were taken, are still in use today. During a visit a few years ago, it was an uncanny experience to walk from one room to the other — it was a long walk from the ground floor to the basement.

FIGURE 6. Renate Forssmann-Falck presenting a scientific article on the treatment of the borderline patient in Athens, Greece.

Acknowledgment: I am indebted to my husband, Hans S. Falck, PhD, for his steadfast encouragement to write this manuscript and his help refocusing my thoughts, when needed. Most of his family perished in the concentration camps of Europe.

BIOGRAPHICAL NOTES

The author Renate Forssmann-Falck, M.D., F.A.P.A., is Werner Forssmann's youngest child and his only daughter (Figure 6). She is currently a Clinical Associate Professor of Psychiatry and Affiliate Clinical Professor of Psychology at Virginia Commonwealth University, Richmond, Virginia. She received her medical degree from the University of Düsseldorf, Germany in 1968. After completing a residency in medicine in Germany, she entered psychiatric training at the prestigious Menninger Foundation in Topeka, Kansas. In 1978, she joined the Department of Psychiatry at Virginia Commonwealth University. Although she left a full-time faculty position in 1988, she has maintained a close affiliation with the university. From 1992 to 1995, she was Director of the Office of Women in Medicine, where she developed programs for women faculty. Since 1994, she has served as psychiatric consultant to the Department of Psychology.

Being in private practice has enabled her to broaden her scholarly activities and the article about her father is a result of this independent scholarship. Her professional interests range from psychoanalytic theory, the treatments of severe personality disorders, psychotherapy process research to women's health with an international emphasis, gender differences, and counseling for women's issues.

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