



Werner Forssmann, the Man Behind the Self-experiment, and the Nobel Laureate: A Historical Note

Martin Schott¹ and Zahid Hussain Khan^{2,*}

¹Department of Anesthesiology, Intensive Care and Pain Medicine DIAKOVERE Friederikenstift Hannover Hannover, Germany

²Department of Anesthesiology Tehran University of Medical Sciences Tehran, Iran

*Corresponding author: Department of Anesthesiology Tehran University of Medical Sciences Tehran, Iran. Email: kanzh51@yahoo.com

Received 2021 August 30; Accepted 2021 August 30.

Keywords: Cardiac Catheterization, Self-experiment, Heart

Cardiac catheterization and central venous access are now two essential practices of modern medicine. The story behind the arrival of any new diagnostic or therapeutic modality may raise new ideas among pioneers of science to explore the limitation boundaries. In this paper, we present a brief biography of Werner Forssmann, who first brings heart catheterization into use following his self-experiment.

In 1956, Werner Forssmann, André Cournand, and Dickinson W. Richards shared the Nobel Prize in Physiology or Medicine for their scientific discoveries in the field of heart catheterization and its impact on circulatory physiology. It was first of all surprising that Forssmann, who had been practicing urology in relative anonymity in Bad Kreuznach, Germany, was suddenly awarded the Nobel Prize. His investigations to catheterize the heart simply and safely, mainly in his self-experiments, formed the foundation on which Cournand and Richards established this procedure as a standard approach for cardiac diagnostic and treatment procedures.

Education in the early 20th century

Werner Theodor Otto Forssmann was born in Berlin on August 29th, 1904, the only child of a lawyer and a housewife. His family name 'Forssmann' comes from his paternal Swedish family in the Swedish part of Finland. Born at the start of the 20th century, the lifestyle and patriotism of the German empire formed the background of his early childhood. In contrast, his youthhood was later affected by World War I following his father's death in a combat in 1916. Afterward, he faced the hardships, inflation, and disillusionment of post-war Germany. Despite his daunting and formidable condition, following his father's last wishes, he received a humanistic education at the Askaniische Gym-

nasium in Berlin, studied medicine at the reputable Charité University in Berlin, and graduated in February 1929. His graduation was followed by a residency at the Auguste-Viktoria Hospital under the supervision of Richard Schneider in Eberswalde, 45 km northeast of Berlin.

Over here, just 25 years of age, he performed the first series of his pioneering self-experiments to catheterize the right side of his own heart. He was fascinated by the idea of directly understanding the circulation and cardiac function using such invasive techniques. Furthermore, this idea culminated in an alternative therapeutical approach to admit pharmacologic agents such as adrenaline or strophanthin straight into the heart. The first findings were published in *Klinische Wochenschrift* (Figure 1), one of the leading international and reputable German medical journals, in 1929 (1).

Shortly later, Forssmann accepted an unpaid appointment in the surgical department at the Charité under the supervision of Germany's famous leading surgeon professor, Ferdinand Sauerbruch. However, instead of looking for an opportunity to pursue an academic career, he received no response and no support for his research from Sauerbruch. His superiors, including Sauerbruch and the main academic community, expressed harsh criticism and disbelief, unsuccessfully charged him with plagiarism, and merely ridiculed him. Dismissed by Sauerbruch, he returned to his former mentor Schneider in Eberswalde less than three months later. After a second 'intermezzo' at the Charité in 1931/32, he found no opportunity to continue his research and thus decided to pursue a career as a practicing surgeon.

A practicing surgeon and urologist

Subsequently, he continued as a resident at the Univer-

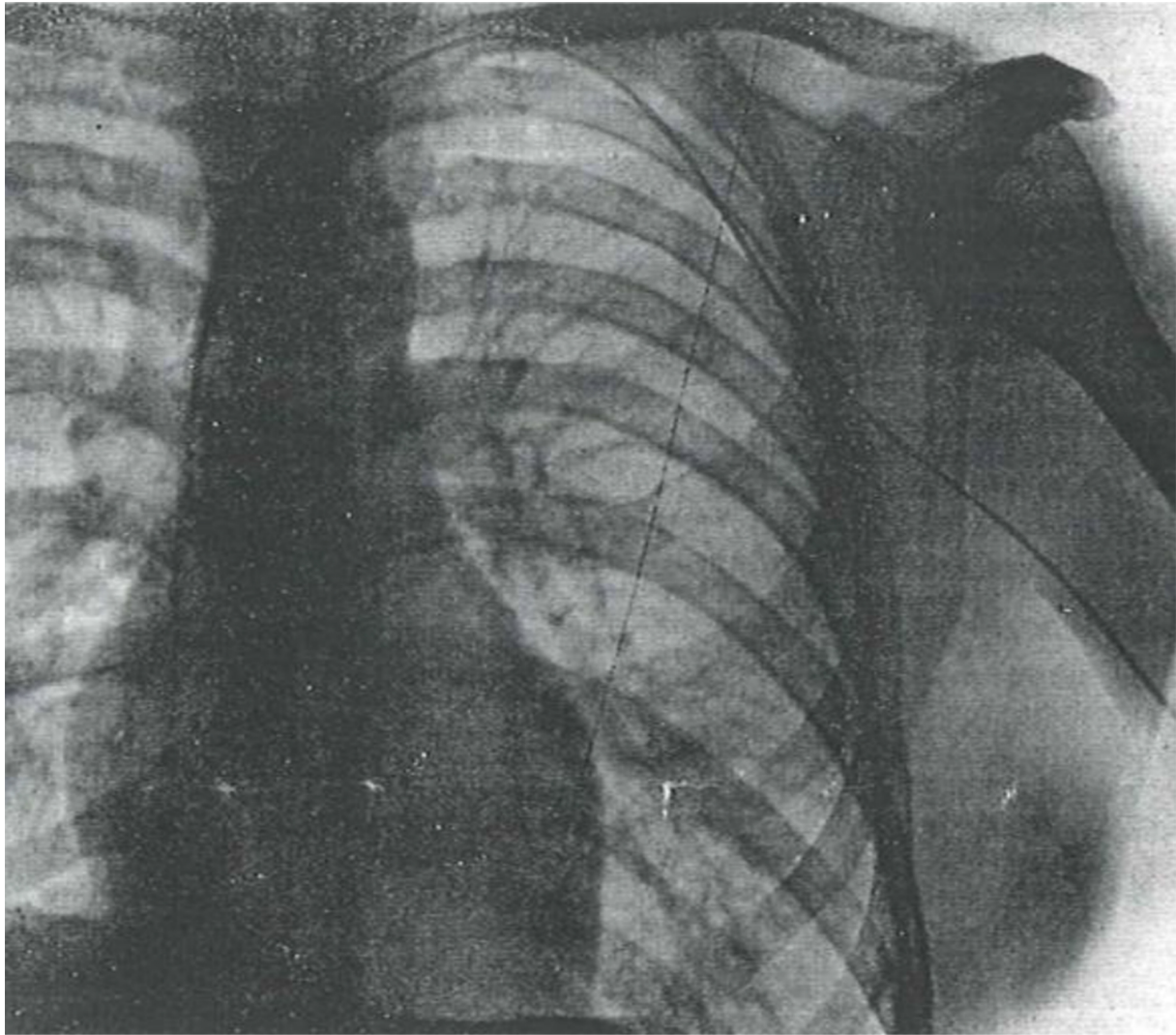


Figure 1. Original chest X-ray of Werner Forssmann, documenting the first heart catheterization in man in 1929. The tip of the urethral catheter is lying in the right atrium of the heart (1).

sity Hospital in Mainz. In 1933, Forssmann married his colleague, Elsbet Engel, who was later among the first female urology specialists in Germany. They raised six children. In late 1933, he received an appointment as a chief urology resident at the Rudolf Virchow Hospital in Berlin, where his superior Karl Heusch had opened Berlin's first specialist urological department. After completing his urological training in October 1936, he became the chief resident of the surgery department at the Municipal Hospital in Dresden, under the supervision of professor Albert Fromme, until July 1938. This was the largest surgical clinic in Germany at the time. He, now a specialist in both surgery and urology, returned to Berlin to start his academic career

once more and worked as the chief resident of surgery at the Moabit Hospital, Berlin, under the supervision of professor Kurt Strauss until the beginning of World War II.

Shortly after starting his work in Berlin, he was elected as the surgeon of the reserve army for a maneuver in 1939 (i.e. the start of World War II). He served as a medical officer in the German army in Poland, Norway, and Russia. His profound deepest impression was the battles of Demjansk, where he carried out an exhausting job as a surgeon under the constant threat of the loss of his own life. Later, he was constantly under the strain of an overload in military clinics, especially in Neuruppin, at the end of the war. At the very end, he escaped from the eastern part of Germany,

knowing that his family had safely retired to the Black Forest. However, he was imprisoned by the French military in 1945 for six months as the allied prisoner of war. Released at the end of 1945, he was a broken man dismembered and deeply influenced by his tragic experiences of the war and imprisonment.

Released from prison, Forssmann started practice in the Black Forest, where his wife had served as a general practitioner during the war. Together with his wife in Wambach, a small village in the Black Forest, they continued to serve the people in the valley. From 1950 onwards, he practiced as a urological specialist with his wife at Bad Kreuznach, wherein in 1956, he performing a nephrectomy was informed that he had been awarded the Nobel Prize. A year before being awarded the Nobel Prize, he was honored in receiving the Leibniz Medal of the German Academy of Sciences, East Berlin, and innumerable other coveted honors and awards. From 1958 to his retirement in 1969, he was the Chair of the surgical division of the Evangelist Hospital at Düsseldorf.

Self-experiment

As a medical student, Forssmann had been deeply impressed by the French physiologists Bernand, Chauveau, and Marey (2). About 70 years ago, these scientists inserted a finger-thick tube via the jugular vein into animals' hearts to measure the intracardiac pressure conditions. He was convinced that a similar approach must be more accessible and safer for human, compared to the conventional intracardial puncture with its inherent risks of pneumothorax, coronary vessel injury, and fatal cardiac tamponade. Furthermore, he was certain that such a technique would enrich the common 'subjective' diagnostic procedures, including physical examination, X-ray, and electrocardiogram. A principal advantage should be the 'objective' data received directly from the heart without falsifying general anesthesia. Forssmann's superior, Schneider, agreed with his ideas; however, he did not permit him to perform such experiments on patients or himself. This was, while Forssmann disobeyed and performed secretly on himself the first heart catheterization in man, as described in his own words:

"... Because venipuncture with a thick needle in oneself appeared technically too tricky, I made a venesection after local anesthesia in my left elbow and introduced the catheter without resistance for its whole length, 65 cm. This distance appeared to correspond to the path from the left elbow as far as the heart. During the introduction of the catheter, I had the feeling of a gentle warmth only during the sliding along the wall of the vein, similar to the feeling during intravenous injection of calcium chlo-

ride. By intermittent movement, the catheter beat against the upper and rear wall of the clavicula vein, I noticed an especially intense heat beat behind the collarbone under the insertion of the muscles of rotation the head; at the same time, probably through irritation of vagal branches, there was a gentle cough. The position of the catheter was proven by X-ray, and indeed I observed the tip of the catheter itself in a mirror held in front of the illuminated screen by a nurse. [...] The trip from the operating room to the X-ray department is an unusually long distance in our establishment and during which I had to ascend stairs, covering the distance on foot with the probe lying in the heart, was not associated with unpleasantness" [Forssmann (1) translated by Morris and Schirmer (3)].

Schneider being afraid of the danger of such experiments reprimanded Forssmann severely for his disobedience; however, he recognized the potential of the discovery. Later, he strongly supported Forssmann in publishing the experiment and acquired for him a position at the Charité. Both of them were aware of the ethical skepticism in the scientific community at this time concerning such a self-experiment. In his publication in 1929, Forssmann, therefore, emphasized the therapeutical aspect of the procedures and compared it with the opportunity to study cardiac physiology directly for diagnostic purposes.

In the next step, he demonstrated the value of catheterization as a safe diagnostic tool using a contrast medium. Thus, he was the first who demonstrated that central circulation tolerates hypertonic contrast medium in dogs and humans (4). Furthermore, these experiments formed the early basis for the foundation of hypertonic and nutritional solution administration via the central vein catheter. The findings were presented to the Eberswalder Society of Physicians in November 1930 and to the Conference of the German Surgical Society in 1931.

To sum up, he catheterized his own heart nine times with no complication. However, it was highly challenging to obtain adequate, exact images in man using a single film technique. At this early stage, the rapid film cassette changer had not yet been invented.

"You might get your habilitation by these experiments in a circus, but never in a respectable German university," remarked Sauerbruch (5). This statement represents the response of the leading German scientific community to Forssmann. The criticism was mainly based on the unsubstantiated belief in the danger of his unconventional procedure. He attempted twice to enter an academic career; however, disillusionment and opposition soon followed the first time, and World War II destroyed his intentions the second time. Subsequently, Forssmann gave up pur-

suing these studies and chose to be a practicing surgeon, mainly to ensure his family's survival.

The beginning of modern cardiac catheterization

In 1930, Otto Klein, Prague, measured the cardiac output in 11 patients using the Fick principle for the first time. He successfully used Forssmann's technique to obtain the blood samples directly from the right auricle (6), and this was followed by scientists from Spain, Cuba, and the USA.

Dickinson Richards and André Cournand, at Bellevue Hospital, Columbia University, N.Y., USA, along with various co-workers studied the pulmonary functions under different physiologic and pathologic conditions in the early 1930s (7). These scientists had taken up Forssmann's technique to measure the mixed oxygen content. Consequently, they developed the heart catheterization step-by-step into a practicable systematic method for clinical applications with proved safety and usefulness. Cournand explicitly acknowledged Forssmann's pioneering achievements in his first publication regarding this new method at the beginning of his article as under "The German Forssmann was the first, who ..." (8). Due to Richard and Cournand's work, international interest in his experiments grew and resulted in many invitations and honors, mainly abroad, and last but not least, in being awarded the Nobel Prize in 1956.

In December 1956, Forssmann delivered his Nobel lecture entitled "The role of heart catheterization and angiography in the development of modern medicine." Twenty-seven years after his original two-page publication, the topic became a classic in the medical literature.

Forssmann as a "leading fossil"

Forssmann became the 'originator,' so-called by Cournand, and his pioneering self-experiments provided the essential stimulus for an exact understanding of cardiac physiology and the modern invasive cardiology and heart surgery. As a practicing surgeon and urologist, he remained aloof from academic research and clinical cardiology for a long time. In this regard, he commented that he was now just a "leading fossil" (5). However, he remained embittered and disillusioned by his early harsh rejection by the German academic community: "In my youth, I tried to plant a lovely garden, and now as an old man I was forced to watch over the hedge as others picked the apples" (5). To conclude, he never totally overcame the tragic facts of his life, including not only the non-recognition of his work but also his defeat to serve under the Nazi regime (9).

During the last years of his life, Forssmann took an active and emotional part in medico-ethical discussions. For example, in a polemic and controversial speech, he criticized the first cardiac transplantation performed by Chris-

tian Barnard in South Africa in 1968 (10). In his opinion, transplantation surgery, together with euthanasia and the death penalty, contradicts the moral principles anchored in the Hippocratic oath, philosophy, and religion (11). However, the main concerns were that the time was not ready for transplantation due to the many unresolved problems. As a surgeon himself, he got in conflict with 'nil nocere,' the superior commandment of surgery in favor of patients. Forssmann passed away in June 1979 at the age of 74 years.

Footnotes

Authors' Contribution: Each author contributed in compiling the manuscript.

Conflict of Interests: The authors declare no conflict of interest.

Funding/Support: None.

References

1. Forssmann W. [Probing the right heart]. *Klinische Wochenschrift*. 1929;**8**(45):2085-7. German. doi: [10.1007/bf01875120](https://doi.org/10.1007/bf01875120).
2. Chauveau A, Marey E. *Cardiographic Devices and Experiences. Memoirs of the Imperial Academy of Medicine*. XXVI. Paris; 1863.
3. Morris JB, Schirmer WJ. The "Right Stuff": Five nobel prize-winning surgeons. *Br J Surg*. 1990;**77**(8):944-53. doi: [10.1002/bjs.1800770833](https://doi.org/10.1002/bjs.1800770833).
4. Forssmann W. [On contrast demonstration of the chambers of the living right heart and the pulmonary artery]. *Münch Med Wschr*. 1931;**78**:489-92. German.
5. Forssmann W. [*Experiments on myself: Memoirs of a surgeon in Germany*]. Düsseldorf: Droste Verlag; 1972. German.
6. Klein O. [Analysis of the cardiac output in humans by the Fick principle]. *Münch Med Wschr*. 1930;**77**:1311-2. German.
7. Goldring RM. Cournand and Richards: The nobel prize. *Ann Am Thorac Soc*. 2018;**15**(Suppl 1):S1-3. doi: [10.1513/AnnalsATS.201710-773KV](https://doi.org/10.1513/AnnalsATS.201710-773KV). [PubMed: [29461886](https://pubmed.ncbi.nlm.nih.gov/29461886/)].
8. Cournand A, Ranges HA. Catheterization of the right auricle in man. *Exp Biol Med*. 1941;**46**(3):462-6. doi: [10.3181/00379727-46-12029](https://doi.org/10.3181/00379727-46-12029).
9. Packy LM, Krischel M, Gross D. Werner Forssmann - A nobel prize winner and his political attitude before and after 1945. *Urol Int*. 2016;**96**(4):379-85. doi: [10.1159/000444648](https://doi.org/10.1159/000444648). [PubMed: [27007661](https://pubmed.ncbi.nlm.nih.gov/27007661/)].
10. Forssmann W. [Loss of Moral Substance]. *Frankfurter Allgemeine Zeitung*. 1968. German.
11. Forssmann-Falck R. Werner Forssmann: A pioneer of cardiology. *Am J Cardiol*. 1997;**79**(5):651-60. doi: [10.1016/s0002-9149\(96\)00833-8](https://doi.org/10.1016/s0002-9149(96)00833-8).