intima a journal of narrative medicine

NON-FICTION | FALL 2016

A Billion Heartbeats

By Rod Tanchanko

On that clear October day in 1958, seventeen-year old Hakan wondered why they were in a frantic rush to reach the Karolinska Hospital. His father, Dr. Rune Elmquist, told him that they must bring an invention to the hospital. He explained what it was and that an identical device was implanted into a dying man just the day before, but then it had failed after the surgeon used an electrical cautery tool during surgery. They were now trying to deliver the only existing spare.

Arne and Else Marie

It was a prosperous era in boomtown Stockholm as Sweden emerged an economic powerhouse after World War II. One of its enterprising businessmen was Arne Larsson, a self-employed engineer blessed with the physique of Scandinavian lumberjack and was as comfortable with ski poles as he was with technical manuals. He had founded Marine Montage, a company that maintained electrical systems in merchant ships. He was a man in the right industry at the right time; an unstoppable, hard-driving entrepreneur.

Dinner-dances were the rave in the city and Arne was blessed with a dancer's grace as well. One evening in 1946, he met a beautiful woman who shared his love for dancing. Else-Marie, a 23-year old strong-willed secretary with a gentle face, graceful, almond eyes, and statuesque elegance, enjoyed spending time with friends for an occasional night on the town. On that evening when she met Arne, Else-Marie found him interesting enough; he could even dance.

Arne owned a Mercedes Benz, and more importantly—had access to gasoline—a privilege he had earned by virtue of his essential occupation in Swedish trade. He offered to drive Else-Marie home. As he dropped her off, Arne asked her if she would like to go for another ride someday. She said yes, and they never looked back. A year later, they were married. Their first-born Malou was born in 1948; baby Bjorn in 1954. The Larssons seemed to be charmed: blessed with beautiful children, a growing business, and an idyllic family life.

On a typical business meeting in the spring of 1956, Arne brought his clients to one of the fine restaurants in the port city of Gothenburg. He ordered oysters, an expensive delicacy served only in the finest establishments. He concluded the business trip and went home to Stockholm to prepare for yet another trip. On his way out, Else-Marie noticed something different. "You look very strange. The whites of your eyes are yellow," she said.

Arne brushed it off, "It's nothing."

Not long after, hundreds of people fell ill after dining in the same restaurant where Arne had entertained his clients. They had contracted hepatitis from a suspected bad batch of oysters. It erupted into a major scandal in the newspapers, and it was the beginning of a long ordeal for this once robust athlete and businessman.

March 23, 1958, Stockholm

It had been an otherwise ordinary Sunday and the Larsson family was winding down their weekend. Bjorn and Malou were already tucked in their beds. Arne was on the telephone and Else-Marie was about to retire for the evening. There were no warning signs. Arne simply collapsed.

Else-Marie dashed to her husband, grabbed the telephone and called their doctor. An ambulance crew raced to the Larsson home. Arne regained consciousness as the emergency team was whisking him away. He was alert enough to tell Else-Marie, "I think it's my heart."

Arne was right. He had a high-grade atrioventricular (AV) block - a disruption of the electrical impulses that drive a heart's contractions. These signals emanate from a special tissue called a sinoatrial (SA) node, and then travel to a gateway (AV node), triggering a precise sequence of heart contractions. Arne's heart rate went as low as twenty beats a minute – too slow to propel enough oxygen-rich blood to his brain.

At the Karolinska hospital, the doctors speculated that Arne's bout with hepatitis exacerbated a pre-existing AV block. The next morning, the doctors informed Else-Marie that the situation was serious. Arne spent the next six months in and out of the hospital, never recovering, and suffering more attacks. By summer's end he was back in the hospital, bedridden, a cardiac cripple, helpless against the unpredictable spells and slow heart rates.

All the treatment measures failed. The attacks were now occurring almost hourly, with each episode lasting up to twenty seconds. Arne's doctor finally told Else-Marie, "I am so awfully sorry, but I must tell you that your husband can't stand these attacks much longer, and we have tried everything." Else Marie was crushed. When the doctors were treating Arne with drug after drug, there was a sustaining hope that the next remedy might help; that if one treatment failed they could always try another. But now there were no more options. For Else-Marie, that was worse than the disappointment of all the treatment failures.

Early September, 1958, Stockholm

Between her vigils at Arne's bedside and looking after Bjorn and Malou, Else-Marie allowed herself a simple indulgence – she went to her hair salon. The parlor stacked its usual fare of magazines to keep its clientele preoccupied as they considered coiffures. On this particular day Else-Marie happened to pick up an American pulp. She flipped through the pages and paused to glare at an incredible photograph.

It was a picture of a doctor carrying a baby who had just undergone heart surgery and was tethered to a machine supplying electricity to her heart. It was in a hospital somewhere in Minnesota. Else-Marie never dreamed that this was possible. This was the answer! She knew immediately what she had to do: she must bring Arne to Minnesota.

Dr. Ake Senning

Young Ake Senning wondered why his table lamp was buzzing. He noticed that the sound became louder every time he touched the metal base. Intrigued, he grabbed the wire with his bare hand. The shock jolted him backwards. Ake felt as if his heart had stopped for a long time. It was his first encounter with an arrhythmia.

Years later, instead of working on his college application to an engineering school, he spent the summer exploring Europe on a motorbike. By the time he returned, he had already missed the deadline. The medical school, fortunately, was still accepting candidates. On a

frigid January morning in 1936, twenty-one year old Ake Senning enrolled at the Uppsala University to begin his medical studies.

He first learned of heart pacemakers in 1951 when he met a Canadian surgeon, Dr. Bigelow, who was conducting experiments on the use of hypothermia during cardiac surgery. Bigelow told Senning that his group had developed an artificial pacemaker to restore contractions when the heart went into ventricular fibrillation following exposures to such extreme cold.

When he returned to Sweden, Senning collaborated with a medical technology company, Elema-Schonander, to design a device that not only defibrillated, but actually induced ventricular fibrillation—a crucial step he developed to prevent air emboli when operating on an open heart. The old desk lamp in must have crossed his mind a few times as he developed this technique.

In 1957, Senning travelled to Minnesota and observed Dr. Walt Lillehei –America's famed 'father of open-heart surgery,' operate on a child with a congenital heart defect. It was one of those surgeries that inevitably produced a complete AV block. Lillehei connected the child's heart to an external pacemaker while the heart healed and resumed its normal conduction. Once Senning returned to Stockholm, he also began to work on transcutaneous pacing of the heart. He again enlisted help from Elema-Schonander and its head of development of medical electronics, Dr. Rune Elmquist.

September, 1958, Stockholm

After she discovered the magazine article, a re-energized Else-Marie approached Senning whom she heard was the best thoracic surgeon at the Karolinska Institute. She entered his lab unannounced, and told the surprised Senning of her plan to fly Arne to the United States. Senning expressed his opinion with typical forthrightness - it was impossible; Arne could never survive such a trip.

Else-Marie mentioned the article that she had read at the salon. Couldn't Arne get the same machine? Senning explained that the problem with external pacemakers is that the wire electrodes always got infected. Senning knew this from his own patients' experiences. He experimented with different skin locations and wire lengths, but virtually all his patients developed an infection. Senning, however, did not turn Else-Marie down and then simply walk away. He brought her to a small park within the hospital grounds. He wanted to show her the dogs.

She didn't know what was going on. Else-Marie saw the dogs running around with little parcels on their backs. Senning explained that the dogs were part of an experiment on a portable pacemaker, using batteries as the source of electricity. The research was still in the very early stages, and they were still finding it impossible to keep the wires clean.
Senning already knew that implanting a self-contained pacemaker was the next logical step. He had already broached the idea to Elmquist even before they became aware of Arne's condition, but their research was far from complete. Senning told Else-Marie that they did not even have a prototype. Else-Marie watched the dogs in the yard, scurrying around with their little backpacks. The technology was right there in Stockholm, at the very hospital where Arne lay dying.

"So make one!" blurted Else-Marie.

"That is the idea, but that will take a long time before we could do it."

"We don't have that time! My husband will die! You must do it now!"

Senning stood quietly. He knew that they were not ready.

Else-Marie was undeterred. The following days she pestered Senning tirelessly. The besieged surgeon probably realized that Else-Marie had no intention of stopping. He called Arne's cardiologist, Dr. Lagerlöf , to ask about Arne's condition. Lagerlöf told Senning that if Arne lived a few more days, it would be a wonder. Else-Marie begged Senning to reconsider. The unflappable surgeon finally relented. Senning told her to talk to the inventor, referring to Elmquist, who was yet to produce a prototype.

Dr. Rune Elmquist

He would flash an impish grin as if he was up to something. With his thick, squarish eyeglasses, softly tussled hair, and requisite bowtie, he looked destined to be an inventor. Born at the turn of the twentieth century in the southern city of Lund, he was inspired by the engineering advancements of his day. Like Senning, he wanted to be an engineer. Unfortunately, Elmquist happened to live in a small city with no technical schools. Like Senning, he became a doctor instead.

By 1957, Elmquist and Senning were in the midst of testing external, portable pacemakers on the dogs that Else-Marie had seen in the hospital garden. But Elmquist was not developing the human prototype. Senning later learned the reason for the delay: the cardiologists were 'absolutely against it'. The opposing doctors had warned Elmquist of how dangerous a pacemaker was and that there was no use for such a device. The clergy were also appalled that man would revive a heart that 'God had stopped.'[31]. The hospital authorities did not allow Elmquist to create a prototype.

Mid-September 1958, Karolinska Hospital

When Arne's condition became increasingly desperate, the hospital finally conceded to allow Elmquist to produce one pacemaker. The two men, accompanied by Else-Marie, delivered the news to Arne.

"Let's do it," Senning said with such conviction that Arne felt that there was no choice but to accept it[15]. Arne's life now lay at the brains and hands of a self-taught engineer and an intrepid surgeon.

October, 1958, Stockholm

At a small corner of the medical electronics lab, Elmquist sat hunched before his cramped workstation; eyeglasses off, his left hand clutching a soldering iron. He was smiling the smile of a boy left to play with all the toys he ever wanted. Before him sprawled an impossible tangle of cables, bottles, instruments, components, and more cables. This was where Elmquist turned idea into invention This was Elmquist's domain.

Amidst the clutter Elmquist wired and soldered his invention to make it fit inside a KIWI-brand shoe polish can. When he completed the prototype, he kept on working. The hospital director allowed Elmquist to build only one pacemaker. He built two.

On October 8, the surgical crew quietly wheeled Arne into the operating theater. Concerned with attracting attention, Senning scheduled the operation late at night. Senning opened Arne's chest wall and exposed the heart. He then sutured two stainless steel electrodes into the heart muscle. The pacemaker was implanted underneath Arne's abdominal muscles.

Arne awoke from the anesthesia sensing more vigorous heartbeats. For the first time in months he felt that the heart block was gone.

But the euphoria did not last. The brisk heartbeats began to dwindle. Three hours after the prototype was implanted, the pacemaker stopped pacing. Senning was livid. He phoned Elmquist right way. "Now this damn pacemaker is dead!".

Senning broke the news to Else-Marie and reassured her that they had a second device. Elmquist would bring it in and Senning would operate in the morning. There was still some hope.

The second implantation was more successful. Arne was awake as he heard Senning cut, solder, and sew in the new unit. Arne again sensed the strong heart contractions. This time the beats did not fade. It was the first sign that Arne might survive.

The Elmquist home was inundated with phone calls after newspapers reported the operation. Despite the attention, Elmquist didn't think the pacemaker would amount to anything. He considered it as a mere engineering curiosity. When the telephone kept ringing off the hook, his son Hakan asked him if the invention would be a great thing.

"This will never be big." Elmquist replied.

Arne's heart block was never cured. By 1961, he was back in the operating theater where Senning implanted a new pacemaker. The unit worked well for a year before it was again replaced in 1962. Over the next four decades, he underwent twenty-four surgical procedures as pacemaker technology evolved.

Arne quickly learned the limitations imposed by the new technology on his daily life. Routine tasks now required planning. Driving was forbidden. Bjorn and Malou were not even allowed to hug their father. Eventually, Arne was able to resume working and returned to run his company. Much to Else-Marie's joy, he even managed to dance again.

Elmquist pursued more innovations, filing his last patent in 1978 when he was 72 years old. He celebrated his last birthday on December 1st 1996, surrounded by family and close friends. Two weeks later, on December 15, he died at the age of 90. For a man with a boundless passion for his work, he knew how to take things in stride. "One should take what one does seriously," he would say, "but never one's self."

Three years after Arne's first implantation, Senning moved to Zurich and established the first specialized intensive care unit in Switzerland - the first in Central Europe, in fact. He introduced the surgical correction of transposition of the great vessels (The Senning Procedure), and other techniques. He retired in 1985. On July 21, 2000, following a long illness, Ake Senning passed away in Zurich. He was 86 years old. The would-be engineer who never intended to be a doctor, engineered the development of multiple life-saving surgical techniques.

2000, Stockholm

Set against an ochre, ivy-draped stucco wall, Arne and Else-Marie sat together in their yard, enjoying the soft sunlight as they shared some biscuits. Else-Marie looked younger than her 77 years; ever poised and graceful. She glanced at Arne as they talked, flashed a coy smile, appearing content with the simple pleasure of a simple day with her husband.

Arne was 85 years old now, his movements more measured, his voice tinged with a slight tremor as he retold the story that he must have told countless times. On this day, it was for a film crew from the Karolinska Institute.

"So my wife read this," referring to the magazine article Else-Marie had read in 1958, "and went to find Ake Senning, and told him that 'Now is the time for the doctor to make the impossible possible, and make sure that my husband's heart works properly again!'"

He drove his point even further, "Then Ake Senning said both in speech and writing that without Else-Marie Larsson the pacemaker would never have emerged that fast like it did, it would have perhaps taken several more years. So she was the woman behind it all!".

Arne was not well as they filmed the video in 2000. But it had nothing to do with his heart. Sometime in the early nineties his doctors diagnosed him with melanoma. They said he had two years to live. Almost 10 years later, he had beaten the odds yet again. He passed away peacefully at home on December 28, 2001. He succumbed to the cancer, not his long damaged heart.

Else Marie always considered herself and Arne to be fortunate that Senning and Elmquist were at the Karolinska in 1958. She remembered their kindness, patience, and courage in taking a great risk to save her husband. She remembered how Senning publicly spoke of her, graciously attributing Arne's salvation and the precocious birth of the modern pacemaker to her determination to help her husband. She remembered how great friends they all had become, sharing birthdays, attending the many pacemaker conferences, tributes and awards, or simply getting together for an occasional dinner. She remembered the harrowing night in 1958, how thin the thread was between life and death, and how Arne relished his new life. Expected to die at 43, Arne instead lived twice as long, propelled by his own love for life, saved by the talents of an imaginative engineer, a gifted surgeon, and an utterly devoted wife.

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