

Girolamo Cardano

Born: 24 Sept 1501 in Pavia, Duchy of Milan (now Italy)

Died: 21 Sept 1576 in Rome (now Italy)

Girolamo or **Hieronimo Cardano**'s name was Hieronymus Cardanus in Latin and he is sometimes known by the English version of his name Jerome Cardan.

Girolamo Cardano was the illegitimate child of Fazio Cardano and Chiara Micheria. His father was a lawyer in Milan but his expertise in mathematics was such that he was consulted by Leonardo da Vinci on questions of geometry. In addition to his law practice, Fazio lectured on geometry, both at the University of Pavia and, for a longer spell, at the Piatti foundation in Milan. When he was in his fifties, Fazio met Chiara Micheria, who was a young widow in her thirties, struggling to raise three children.

Chiara became pregnant but, before she was due to give birth, the plague hit Milan and she was persuaded to leave the city for the relative safety of nearby Pavia to stay with wealthy friends of Fazio. Thus Cardan was born in Pavia but his mother's joy was short lived when she received news that her first three children had died of the plague in Milan. Chiara lived apart from Fazio for many years but, later in life, they did marry.

Cardan at first became his father's assistant but he was a sickly child and Fazio had to get help from two nephews when the work became too much for Cardan. However, Cardan began to wish for greater things than an assistant to his father. Fazio had taught his son mathematics and Cardan began to think of an academic career. After an argument, Fazio allowed Cardan to go university and he entered Pavia University, where his father had studied, to read medicine despite his father's wish that he should study law.

When war broke out, the university was forced to close and Cardan moved to the University of Padua to complete his studies. Shortly after this move, his father died but by this time Cardan was in the middle of a campaign to become rector of the university. He was a brilliant student but, outspoken and highly critical, Cardan was not well liked [4]:-

This I recognise as unique and outstanding amongst my faults - the habit, which I persist in, of preferring to say above all things what I know to be displeasing to the ears of my hearers. I am aware of this, yet I keep it up wilfully, in no way ignorant of how many enemies it makes for me.

However, his campaign for rector was successful since he beat his rival by a single vote.

Cardan squandered the small bequest from his father and turned to gambling to boost his finances. Card games, dice and chess were the methods he used to make a living. Cardan's understanding of probability meant he had an advantage over his opponents and, in general, he won more than he lost. He had to keep dubious company for his gambling. Once, when he thought he was being cheated at cards, Cardan, who always carried a knife, slashed the face of his opponent. Gambling became an addiction that was to last many years and rob Cardan of valuable time, money and reputation.

Cardan was awarded his doctorate in medicine in 1525 and applied to join the College of Physicians in Milan, where his mother still lived. The College did not wish to admit him for, despite the respect he had gained as an exceptional student, he had a reputation as a difficult man, whose unconventional, uncompromising opinions were aggressively put forward with little tact or thought for the consequences. The discovery of Cardan's illegitimate birth gave the College a reason to reject his application.

Cardan, on the advice of a friend, went to Sacco, a small village 15km from Padua. He set up a small, and not very successful, medical practice. In late 1531 Cardan married Lucia, the daughter of a neighbour Aldobello Bandarini, a captain of the local militia. Cardan's practice in Sacco did not provide enough income for him to support a wife so, in April 1532, he moved to Gallarate, near Milan. He applied again to the College of Physicians in Milan but again was not allowed membership. Unable to practise medicine, Cardan reverted, in 1533, to gambling to pay his way, but things went so badly that he was forced to pawn his wife's jewellery and even some of his furniture. Desperately seeking a change of fortune, the Cardans moved to Milan, but here they fared even worse and they had to ignominiously enter the poorhouse.

Cardan was fortunate to obtain Fazio's former post of lecturer in mathematics at the Piatti Foundation in Milan which gave him plenty of free time and he used some of this to treat a few patients, despite not being a member of the College of Physicians. Cardan achieved some near miraculous cures and his growing reputation as a doctor led to his being consulted by members of the College. His grateful patients and their relatives became whole hearted supporters and in this way, Cardan was able to build up a base of influential backers.

Cardan was still furious at his continuing exclusion from the College and, in 1536, he rashly published a book attacking not only the College's medical ability but their character [4]:-

The things which give most reputation to a physician nowadays are his manners, servants, carriage, clothes, smartness and caginess, all displayed in a sort of artificial and insipid way...

This was not the way to gain entry to the College and not surprisingly Cardan's application to join in 1537 was again rejected. However, two years later, after much pressure from his admirers, the College modified the clause regarding legitimate birth and admitted Cardan. In the same year, Cardan's first two mathematical books were published, the second *The Practice of Arithmetic and Simple Mensuration* was a sign of greater things to come. This was the beginning of Cardan's prolific literary career writing on a diversity of topics medicine, philosophy, astronomy and theology in addition to mathematics.

In 1539 Cardan approached Tartaglia, who had achieved fame in winning a contest on solving cubics, and tried to get him to divulge the method. Tartaglia eventually agreed after getting Cardan to swear an oath that he would not publish the method until Tartaglia had himself published it. Tartaglia's account of the oath sworn by Cardan was:-

I swear to you, by God's holy Gospels, and as a true man of honour, not only never to publish your discoveries, if you teach me them, but I also promise you, and I pledge my faith as a true Christian, to note them down in code, so that after my death no one will be able to understand them.

There followed a period of intense mathematical study by Cardan who worked on solving cubic and quartic equations by radical over the next six years.

One of the first problems that Cardan hit was that the formula sometimes involved square roots of negative numbers even though the answer was a 'proper' number. On 4 August 1539 Cardan wrote to Tartaglia:-

I have sent to enquire after the solution to various problems for which you have given me no answer, one of which concerns the cube equal to an unknown plus a number. I have certainly grasped this rule, but when the cube of one-third of the coefficient of the unknown is greater in value than the square of one-half of the number, then, it appears, I cannot make it fit into the equation.

Indeed Cardan gives precisely the conditions here for the formula to involve square roots of negative numbers. Tartaglia by this time greatly regretted telling Cardan the method and tried to confuse him with his reply (although in fact Tartaglia, like Cardan, would not have understood the complex numbers now entering into mathematics):-

... and thus I say in reply that you have not mastered the true way of solving problems of this kind, and indeed I would say that your methods are totally false.

In 1540 Cardan resigned his mathematics post at the Piatti Foundation, the vacancy being filled by Cardan's assistant Ferrari who had brilliantly solved quartic equations by radicals. From 1540 to 1542 Cardan abandoned his studies and did nothing but gamble; playing chess all day. During the years 1543-1552, Cardan lectured on medicine at the universities of Milan and Pavia, as war frequently forced the closure of the university in Pavia.

In 1545 Cardan published his greatest mathematical work *Ars Magna*. In it he gave the methods of solution of the cubic and quartic equation. In fact he had discovered in 1543 that Tartaglia was not the first to solve the cubic equation by radicals and therefore felt that he could publish despite his oath. Ferrari wrote in April 1547:-

Four years ago when Cardano was going to Florence and I accompanied him, we saw at Bologna Hannibal Della Nave, a clever and humane man who showed us a little book in the hand of Scipione del Ferro, his father-in-law, written a long time ago, in which that discovery was elegantly and learnedly presented.

It is to Cardan's credit that, although one could not expect him to understand complex numbers, he does present the first calculation with complex numbers in *Ars Magna*. Solving a particular cubic equation, he writes:-

Dismissing mental tortures, and multiplying $5 + \sqrt{-15}$ by $5 - \sqrt{-15}$, we obtain $25 - (-15)$. Therefore the product is 40. and thus far does arithmetical subtlety go, of which this, the extreme, is, as I have said, so subtle that it is useless.

Lucia died in 1546, but Cardan seemed not greatly saddened, being more interested in the fame he had achieved from his books which were amongst the best sellers of the day. He became rector of the College of Physicians and gained the reputation of being the greatest physician in the world. Cardan received many offers from the heads of state in Europe, anxious to receive the best medical attention, but only once was the incentive great enough to tempt him from Italy.

John Hamilton, Archbishop of St Andrews, had suffered from asthma for ten years but gradually the frequency and severity of the attacks had grown worse. The court physicians of both the French king and German emperor did their best but ultimately failed and the Archbishop of St Andrews was near death. He turned in desperation to Cardan, promising him a huge sum if he would come to Scotland. Cardan was not lecturing when he received the plea and so accepted the offer, setting out from Milan on 23 February 1552.

Cardan was at the height of his fame and, as a consequence, his journey to Scotland was remarkable in that everywhere he went scientific communities treated him as a celebrity and the world's leading scientist. He arrived in Edinburgh on 29 June and saw the Archbishop immediately. By the time Cardan left on the 13 September, the Archbishop was already recovering. Cardan accepted over two thousand gold crowns but turned down the offer of a permanent place at the Scottish court. Within two years the archbishop let Cardan know that he had made a complete recovery.

On his return, Cardan was appointed professor of medicine at Pavia University and, with many wealthy patients, he was a rich and successful man. But as Cardan was at the height of his fame, he received what he called his "crowning misfortune". Cardan's eldest son, Giambatista, had qualified as a doctor in 1557 but he secretly married Brandonia di Seroni, a girl whom Cardan described as [4]:-

a worthless, shameless woman.

Cardan continued to support his son financially and the young couple moved in with Brandonia's parents. However, the di Seronis were only interested in what they could extort from Giambatista and his wealthy father, whilst Brandonia publicly mocked her husband for not being the father of their three children.

These taunts drove Giambatista to poison his wife and, following his arrest, he confessed to the crime. Cardan recruited the best lawyers but at the trial the judge decreed that to save his son's life, Cardan must come to terms with the di Seronis. They demanded a sum which Cardan could never have found. Giambatista was tortured in jail, his left hand was cut off and, on 13 April 1560, he was executed.

This was a blow from which Cardan never recovered. He could not forgive himself for failing to avert the disaster and the terrible sufferings of his favourite son haunted him constantly. As the father of a convicted murderer, Cardan became a hated man. Realising he had to move, Cardan applied for a professorship of medicine at Bologna and was appointed to the post. Cardan's time in Bologna was full of controversy. His reputation, in addition to his arrogant manner, ensured he created many enemies. He humiliated a fellow medical professor in front of his students by pointing out errors in his lectures. After a few years Cardan's colleagues tried to get the Senate to dismiss him, by spreading rumours that his lectures were practically unattended.

Cardan had further problems with his children. His remaining son Aldo was a gambler and associated with individuals of dubious character. Cardan writes, in his autobiography, of his four greatest sadnesses in his life [4]:-

The first was my marriage; the second, the bitter death of my son; the third, imprisonment ; the fourth, the base character of my youngest son.

In 1569 Aldo gambled away all of his own clothes and possessions in addition to a considerable sum of his father's money. In an attempt to get money Aldo broke into his father's house and stole a large amount of cash and jewellery. Cardan sadly reported Aldo to the authorities, and Aldo was banished from Bologna.

In 1570 Cardan was put in jail on the charge of heresy. He had cast the horoscope of Jesus Christ and written a book in praise of Nero, tormentor of the martyrs. These may have been a deliberate attempt on Cardan's part to gain notoriety - he wrote a whole chapter in his autobiography on wishing to "perpetrate his name" - and thus gain a place in history. It is strange for in all other respects Cardan gave the church his full support. However the inquisition was looking to make examples of prominent men whose commitment could be questioned and Cardan fitted the bill nicely.

Cardan was treated leniently, perhaps because public opinion was that he had been treated harshly and so he was only imprisoned for a few months. On his release, he was forbidden to hold a university post and barred from further publication of his work.

On his release Cardan went to Rome, where he received an unexpectedly warm reception. He was granted immediate membership of the College of Physicians and the Pope, who had now apparently forgiven Cardan, granted him a pension. It was in this period that his autobiography [4] was written, although it was not published. It was published in Paris in 1643 and Amsterdam in 1654. Italian translations were published in Milan (1821 and 1922) and Turin (1945). A German translation appeared in Jena in 1914, and a French translation in Paris in 1936. The reference [4] is the English translation of the autobiography.

Cardan is reported to have correctly predicted the exact date of his own death but it has been claimed that he achieved this by committing suicide. Despite being reconciled with Aldo, Cardan wrote in his will that he:-

... had shown himself a youth of such evil habits that I should prefer to have all I own pass to my grandson by my eldest son.

Cardan had adopted his grandson on the death of both parents.

In addition to Cardan's major contributions to algebra he also made important contributions to probability, hydrodynamics, mechanics and geology. His book *Liber de Ludo Aleae* was published in 1663 but the book on

games of chance was probably completed by 1563. Cardan makes the first ever foray into the, until then untouched, realm of probability theory. It is the first study of things such as dice rolling, based on the premise that there are fundamental scientific principles governing the likelihood of achieving the elusive 'double six', outside of mere luck or chance.

Cardan is also credited with the invention of the *Cardan joint* a type of universal joint in a shaft that enables it to rotate when out of alignment.

Cardan also published two encyclopaedias of natural science. Giliozzi [1] says that they:-

... contain a little of everything, from cosmology to the construction of machines, from the usefulness of natural sciences to the evil influence of demons, from the laws of mechanics to cryptology. It is a mine of facts, both real and imaginary, of notes on the state of sciences, of superstition, technology, alchemy and various branches of the occult.

The picture above is from the title page of the first edition of his *Ars Magna*.

Article by: *J J O'Connor* and *E F Robertson*

June 1998