**TV Script Alain Carpentier: Implantable artificial heart**

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| **Production company:** | Bilderfest factual entertainment |

**TC: 00:01**

**Paris on the eighteenth of December, 2013. A team of cardiac surgeons is performing an operation that is a definite world-first: 76-year-old Claude Danu is being given a new heart. Not a donor heart, however – instead, it's the world's first artificial heart, beating entirely autonomously in the seriously ill cardiac patient's chest without any external connections.**

**TC: 00:31**

**Also in the operating theatre: the creator of the new artificial heart, legendary surgeon Alain Carpentier.**

**TC: 00:40**

**Carpentier has already written medical history. Today, thanks to him, more than 150,000 heart patients are leading largely carefree lives – thanks to artificial heart valves that are biocompatible.**

**TC: 00:56**

**Carpentier is now opening a new chapter in medical history. From the point of view of the research community, it's a technological miracle – but from the creator's point of view it actually sounds quite simple at first:**

*TC: 01:08 Professor Alain Carpentier - Cardiologist*

*Well, in the fine words of the famous physiologist Claude Bernard, "Whether the poets like it or not, the heart is nothing but a pump."*

**TC: 01:21**

**The human heart – nothing but a pump?**

**TC: 01:30**

**The inventor uses one of his first prototypes to explain what he means:**

*TC: 01:36 Professor Alain Carpentier - Cardiologist*

*The blood flows in here, through these two openings, and flows back out here, from these two openings. Here is the pulmonary artery, which arises from the right ventricle. And here is the aorta, which comes from the left ventricle. So, exactly the same structure as that of a normal heart.*

**TC: 01:59**

**Well, it's not quite as simple as that! The success story began in 2008.**

**TC: 02:07**

**Here. To develop his super prosthesis, Alain Carpentier brings a rather unusual partner on board: an aircraft manufacturer.**

**And the new super-implant is indeed built exclusively by aircraft engineers at first - for good reason:**

TC: 02:22 Dr. Piet Jansen - Carmat

*„Because when you involve people from the medical device development, you get opinions and influences. And the idea of Professor Carpentier was to start from scratch to built an idea and a design and when the device and the design is ready for clinical implementation, at that point we involve clinicians.“*

**TC: 02:43**

**Carpentier's mission is ambitious: he wants his artificial heart to be the first one to function completely autonomously - without any connection to the outside.**

**TC: 02:52**

**The vision looks like this: the entire diseased organ is surgically removed. A human heart has a total of 4 large chamber connections. The new heart has to copy them perfectly.**

**TC: 03:11**

**First, a kind of junction is sewn onto the vena cava and the pulmonary vein. The surgeons then attach the high-tech pump to it. Immediately afterwards, it is connected to the two main arteries. The heart can then resume its function, and pump again. 24 hours a day - without interruption.**

**TC: 03:34**

**The housing of the artificial heart is indeed made of simple plastic, but its interior is anything but "simple" - motors, sensors, cables and lots of built-in electronics control the pump autonomously.**

**TC: 03:53**

**Using a kind of test stand, the researchers 'reconstruct' the human body as it were. When developing the new heart they can thus expose it to a variety of stress situations that the body also experiences in everyday life.**

*TC: 04:07 Marc Grimmé – Technical Manager, Carmat*

*The artificial heart is connected to the atria, this is the aorta, and this is the pulmonary artery. This is the venous compartment and this is the systemic compartment. Thanks to the computer, we can change the individual vascular parameters of the patient. Then we look at how differently the artificial heart reacts to these impulses. The idea is to then determine, together with the**doctors, whether the reaction caused corresponds to how a normal heart would react in such situations.*

**TC: 04:44**

**The artificial heart is powered by two storage-battery-driven hydraulic motors.**

**TC: 04:56**

**Sensors constantly determine the stress condition of the patient. They pass this information on to the motors.**

**TC: 05:07**

**These pump the patient's blood through his body - but not merely in the steady stream familiar from a garden pump. Instead, they increase and decrease the pressure in the two ventricles hydraulically - on a membrane between the pump and the ventricle.**

**TC: 05:22**

**The result: the heart beats, and generates a proper pulse – just like a real heart.**

**TC: 05:30**

**The power supply is all that remains on the outside. It's wireless, though – batteries that patients can carry with them constantly recharge the accumulators in the body. By means of induction - like an electric toothbrush.**

**TC: 05:45**

**Carpentier has also tackled one of the most difficult problems when transplanting artificial hearts: namely that the surfaces of artificial transplants, unlike organic ones, can cause life-threatening blood clots.**

**TC: 06:01**

**However, for Alain Carpentier this is a very familiar problem. Hundreds of thousands of people are already carrying its solution around inside them.**

*TC: 06:10 Professor Alain Carpentier - Cardiologist*

*I have found that if one uses heart valves from animals, it can prevent the formation of blood clots. Of course, once you solve one problem, the next arises – in this case, an immunological reaction. But fortunately I managed to resolve it by means of chemical treatment. So I thought – why not use the same material for my artificial heart?*

**TC: 06:41**

**Carpentier's solution: all surfaces exposed to the human bloodstream are lined with animal tissue - from cows.**

TC: 06:55 Dr. Piet Jansen - Carmat

*So we expect the reaction of the human body against this material is milder than with plastic materials or artificial materials which means that those patients can take less anticoagulation, so the risk for clinical events – bleeding, thrombosis, etc. could be less also.*

**TC: 07:19**

**But although the new artificial heart comes from Paris - the city of love – there's at least one respect in which it cannot compete with a real heart – and that is in "matters of the heart".**

TC: 07:31 Dr. Piet Jansen - Carmat

*„I mean, if you are excited or if you have a change in emotions... if you have a machine, your heart beat will stay the same. That`s the main difference, we cannot change. “*

*TC:07:42 Professor Alain Carpentier - Cardiologist*

*Everyone knows that the heart responds to emotions. In that regard, it's one of our most precious organs.*

**TC: 07:55**

**So far, the new heart has been tested on three more critically ill patients in addition to Claude Danu. It extended Danu's life by 74 days, and those of the others by up to 9 months.**

**TC: 08:06**

**An initial success. But the ultimate objectives are far more ambitious.**

TC: 08:12 Dr. Piet Jansen - Carmat

*What we intend to do is to provide an alternative for heart transplantation on the long term. If we are able to show, that we have very good results and that the quality of live of the patients improves, than the market will adopt this therapy and then the gates may go open for many patients that today have no access to a heart transplants.*

**TC: 08:38**

**Ambitious plans. But if Alain Carpentier's vision really does become reality, it could be that no-one in future will have to worry about suddenly dying - while waiting for a donor heart. And a heartbeat could suddenly sound like this...**

Text-Inserts

Alain Carpentier, finalist, European Inventor Award 2016

Alain Carpentier, cardiologist

Piet Jansen, medical device executive, Carmat

Marc Grimmé, technical manager, Carmat