Navigating through Anesthesia

A pilot needs to know not only the plane's current position but also whether it is on a collision course with a dangerous obstruction ahead. Anesthesiologists are faced with a similar task when monitoring patients during an operation, which is why Dräger has developed an **INTELLIGENT DISPLAY** that is based on the idea of the moving maps used in aircraft navigation.

INFORMATION TECHNOLOGY has become part of the very fabric of modern life. It enables us to store huge amounts of data, for example, and to stay in touch at any time and any place. Many people can still vividly remember their first text message. For the anesthesiologist and scientist PD Dr. Thomas Bouillon, it was the encounter with digital navigation systems in the late 1990s that left an abiding impression. Dr. Bouillon had just started a fellowship at the University of Stanford in California, and was taking advantage of the sunny climate to train for his pilot's license. "It was my first experience of moving maps," he recalls. "Back then, they were just being introduced into aircraft cockpits."

A lesson from the cockpit

Obviously, moving maps are a great help when it comes to navigation—just think of GPS applications. In addition, they also enhance safety. For a pilot, it is crucial to not only know the plane's present position; he or she must also ensure that the aircraft isn't on a collision course with a dangerous obstruction ahead. The pilots do this by projecting the aircraft's coordinates—obtained from the GPS—onto a topographic chart showing the aircraft in its surroundings. The limits of high mountains or closed airspace appear so early in the display that the pilot has ample time to react.

Thomas Bouillon was perhaps not the first flying anesthesiologist to recognize the potential of moving maps for the operating room. For him, the similarities are obvious: after all, isn't it the anesthesiologist's job to pilot a patient safely through anesthesia? Indisputable, however, is the fact that he was one of the very first anesthesiologists to do something about exploiting the potential of this technology for the benefit of his profession. "The aim," he explains, "was to develop a real-time visualization of the actual state of anesthesia that would help the anesthesiologist in the operating room to administer the correct dosage of drugs without the need for any in-depth understanding of pharmacokinetics or pharmacodynamics."

In the fall of this year Dräger is set to introduce such an intelligent display to the market, which will be launched under the name of SmartPilot View. Dr. Bouillon, who today works as a senior expert in the Modelling and Simulation department at the pharmaceuticals company Novartis in Basel, Switzerland, is one of numerous scientists, engineers, doctors and managers who have contributed toward the development of this high-tech device.

The key question at the start of the development work was how to describe the real-time state of anesthesia in such a way that it could be captured and mapped on a two-dimensional graph. The problem is that during anesthesia, a variety of hypnotics and opioids are used. These are administered either intravenously or as a gas; their effects last for different lengths of time. Most importantly, they have an influence on one another. Some drugs reinforce, while others diminish, the effect of other drugs. Despite such complexity, developers were able to devise a model that graphically shows the interaction between hypnotics and opioids during anesthesia. This was the first step toward the creation of an anesthesia map. The x-axis shows the concentration of opioids, the y-axis the concentration of hypnotics. The current level of anesthesia is represented on this graph as a point of light that moves within the graph. Taking into account parameters such as age, weight, and gender, a change in the opioid concentration is represented by a movement of this point of light along the y-axis, and a change in the hypnotics concentration by a movement along the x-axis. As the operation comes to an end, the anesthesiologist must alter the dosage of drugs in such a way that the patient wakes up and experiences as little pain as possible. In the process, the point of light sinks to zero on the x-axis. In other words, the concentration of soporifics has been reduced, while the analgesics are still preventing the patient from feeling pain.

Remaining within the isoboles

The next step was to mark out the danger areas on the graph. These indicate the maximum and minimum concentrations of anesthetic agents and must be avoided during anesthesia. They show, for example, where the patient might regain consciousness although surgery is still in progress, or where the anesthetic becomes so deep that it would protract the wakeup phase beyond a reasonable length of time.

Based on the example of a moving map, the developers of the SmartPilot introduced a number of boundary lines (so-called isoboles) into the graph. The upper isobole marks a statistically determined state in which 90 percent of all patients show no reaction, whether in the form of perspiration, increased blood pressure, or an increased pulse, to the irritation caused by a laryngoscopy. As a rule, it therefore makes little sense to increase the concentration of anesthetic agents at this point. The lower isobole marks a state in which only half of all average patients do not react when spoken to or shaken. Assuming that the patient is to remain unconscious, it might therefore be prudent at this juncture to increase the concentrations of anesthetic agents.

What works fine in theory has now been confirmed by initial practical tests with the SmartPilot. Experts were particularly impressed with the operability and the quality of visualization of the solution, which Dräger will integrate into its Infinity Explorer software platform. "The display is highly intuitive to use and doesn't overtax the anesthesiologist in any way during an operation," says PD Dr. Martin Luginbühl, senior physician in the Department of Anesthesiology at Bern University Hospital, Switzerland.

"Ideally suited"

The display features not only a graph showing the real-time state of anesthesia but also a variety of other data presented in easily comprehensible form. This includes the current concentration of each administered drug, represented in a different color. In addition, the anesthesiologist can mark different points in time on the display during the course of the operation. These might include, for example, the moment of incision, and thus enable not only the recording of the patient's "flight" through the anesthesia but also monitoring and allowing for any differences between the patient on the operating table and the model data based on a statistically relevant sample of patients. "SmartPilot View is particularly useful for helping young anesthesiologists control the course of anesthesia and the dosage of drugs," says Martin Luginbühl. "It's therefore ideally suited for training purposes."

Professor Jürgen Schüttler, Director of the Department of Anesthesiology at Erlangen University Hospital and President of the German Society of Anesthesiology and Intensive Care Medicine, agrees. At the same time, he also underlines the solution's importance in supporting processes beyond the operating room. "First of all, it improves the overall course of recovery when the patient is not sent into an unnecessarily deep narcosis," he explains. "And secondly, it reduces the wakeup time and therefore relieves the burden on personnel in the recovery room." Moreover, there is also a possibility that the SmartPilot might find a use in the intensive care unit. "If it can be adapted to the parameters of a medically induced coma," says Prof. Dr. Jürgen Schüttler, "then it could bring huge benefits in this area of hospital activities as well." **Frank Grünberg**

Full overview

The display shows the data the anesthesiologist needs in three clearly structured columns. On the left is a 2D graph marked with isoboles, below the event markers. The middle column shows important vital parameters of the patient and data related to medication and the concentration of active agents. On the right is various information, including a prognosis of how concentrations of anesthetic agents and effective ingredients will develop over time. A glance at the display provides the anesthesiologist with information on a host of parameters and their development.