Critical Alarms Lab

Shaping the future of alarms and soundscapes in complex environments

VANBERLO

Erasmus MC
Universitair Medisch Centrum Rotterdam

TU Delft

Silent Intensive Care

Critical Alarms Lab

Audible alarms in intensive care units are of vital importance. They often mean the difference between life and death. Besides alarms, there are other sound sources in intensive care, e.g., whirring mechanical ventilators or nurses consulting with each other. The cacophony of sounds leads to alarm fatigue in nurses, disturbed sleep patterns in patients and even patient delirium.

This booklet contains three selected projects that exemplify our vision for a silent intensive care. All projects are based on our observations at and collaborations with the staff of Erasmus Medical Centre Rotterdam. The projects manifest the ethos of Critical Alarms Lab.

The Critical Alarms Lab at TU Delft is an international team of students and researchers that work together with clinicians and manufacturers in order to create a calmer atmosphere in the intensive care unit, allowing medical staff to work properly and patients to recuperate well.

We design without borders but with sensitivity to user context so that our lab inspires everyone in our network from students and researchers to hospitals, manufacturers, and policy makers.

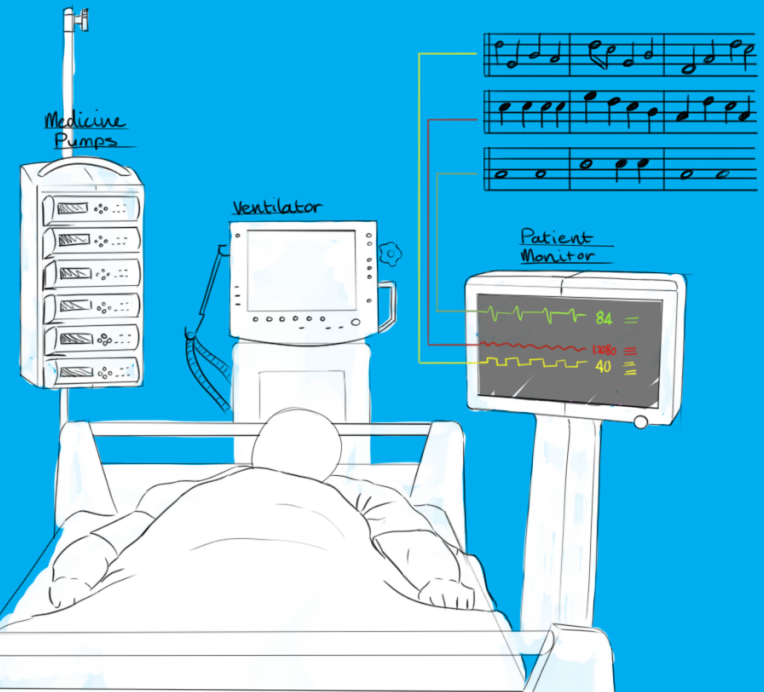
CareTunes

Powered by Design United

MSc Graduation project by
Koen Bogers

Koen Bogers

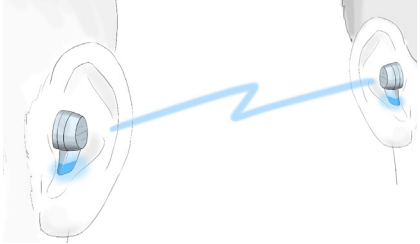
CareTunes challenges the existing norms for alarms and calls for daring and fresh design solutions that are beyond classical views on what alarms should be like. CareTunes is a wake-up call that critical alarms can be beautiful.



Care Tunes is a pleasurable substitute for the excessive amount of alarms and other disturbing noises in the intensive care unit. By wearing an earpiece that transforms patient data inro a musical piece, nurses can constantly be aware of their patients' vital signs without having to listen to the cacophony of alarm sounds. The patient's heartrate is audible through the drums, the oxygen saturation is played on the guitar and bloodpressure is revealed by piano music. When boundaries of the vital signs are reached, the music will be dissonant. Something the nurse cannot fail to notice.

Care Tunes is developed through an iterative design process in collaboration with US partners (Sen Sound and Vanderbilt University MC) and highly based on actual sound experiences of nurses working at Erasmus MC. Nurses revealed that alarms carry quite a low level of information and that they have different personal preferences when setting boundaries for their alarms. If alarms are set to narrow limits for reaffirmation, more alarms go off quickly, creating cacophony.

When sitting at the nursing desk, the nurse can monitor the patient visually by looking through the window of the patient box or at the CareTunes dashboard. In this situation, a nurse may want to opt for as few musical updates as possible.



With Care Tunes, nurses keep track of their patient's vitals by listening to a piece of music belonging to that specific patient. Nurses can tune into each others patients for support or when working together.

Care Tunes can also be set to play the musical updates more frequently. Therefore, the nurse can stay in control of the situation while being away from the desk.

When patients are visited by family, CareTunes can play music in continuous mode. Visitors will be reassured that their beloved one is stable without feeling unnecessarily alarmed.

Visual support and controls

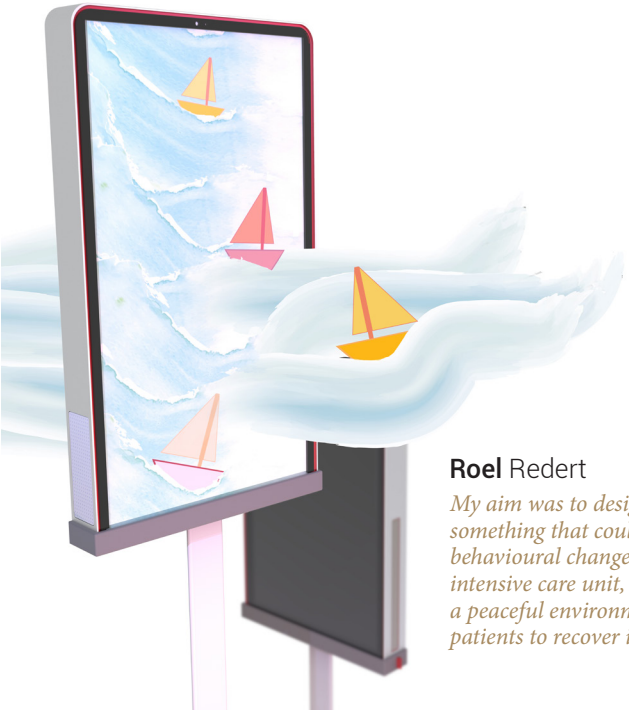
CareTunes has a learning curve. Nurses may initially need visual support to help them understand how the different sounds are related to changes in the monitored parameters (e.g., heart rate). The CareTunes dashboard helps them with monitoring. Nurses can also control the alarm limits, frequency of the updates and choose to which patients they want to listen to through the dashboard.

Doplor

Powered by Quietyme

MSc Graduation project by
Roel Redert

Patients at the intensive care often lack sleeping time due to all the ambient noise - not only from the devices but also from medical staff. Doplor shows all the people present in the intensive care unit when the sounds become disturbing. To do so, all sounds are registered by a sensor and translated into an interactive painting on the wall. The painting will symbolically show growing waves and deeper darker colours when sounds reach disturbing levels.



Roel Redert

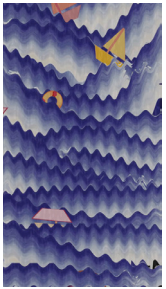
My aim was to design something that could lead to a behavioural change within the intensive care unit, to restore a peaceful environment for patients to recover in.

Doplor decides whether the sound environment is good or bad and if the nurses should act upon it.

When no action is needed, Doplor can show the nurse everything is okay ("it's silent in the room") or don't worry ("the sound level is high, but it's acceptable because of the emergency").

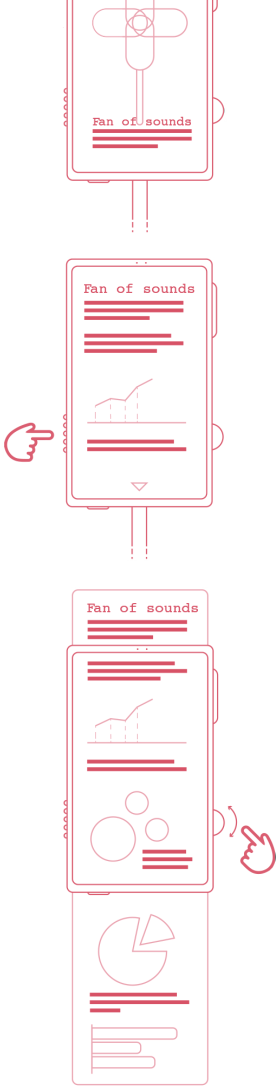
When the sound level was fine recently, but noise comes rapidly, nurses should "worry a bit".

When nurses just keep on talking for example, Doplor changes into dark colours and fast movements. So, nurses should "worry a lot! Action for quietness is desired".



By making medical staff aware of the sounds and behavioural patterns that cause noise, the sound levels should decrease gradually. Patients will naturally be allowed to get in a deeper stage of sleep.

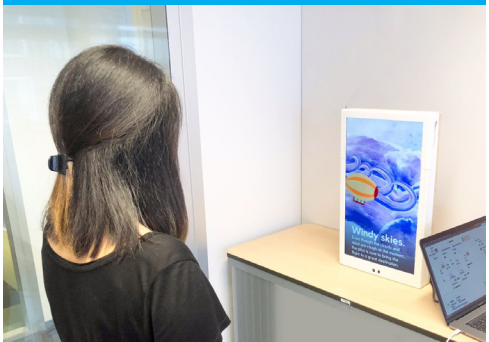
The name Doplor is coined after the Doppler effect in which the loud siren of the ambulance muffles away. The same effect of muffling excessive noise is envisioned with using Doplor.



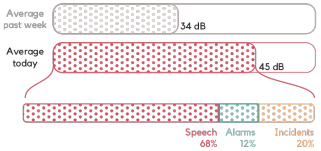
Interactions with Doplor

The main interaction with Doplor is first seeing what is going on: what does the painting want to show me? When further interaction is wanted, nurses can walk up to it. A proximity sensor notices someone coming closer. The title of the artwork is shown, followed by a **short description** of what the visualisation actually means.

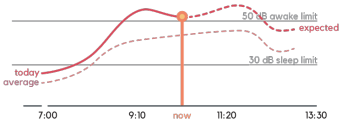
When nurses want to know what the main causes of the auditory disturbances are, they can get a **graph of the sound levels** of the past 8 hours by pressing the button at the left side of Doplor. It is also possible to actually understand what has caused all the sounds, by scrolling the right wheel at the right side and go through an **infographic** as if it were a large piece of paper.



How has the sound been?



Today has been a louder day than normally is measured. Don't worry, this can happen. Good that you are now here though, so that we can take a look together what has caused noise today, and how we can make sure that this does not happen again in the future.



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At least five times a conversation took place close to Doplor.

The average length of these conversations was 6 minutes.

6:03 minutes

During the past 8 hours only 1 alarm rang longer than half a minute. This is a great accomplishment!

<0:10 minutes

The average length that an alarm rang, was shorter than 10 seconds.

Lastly, only one incident took place. Even though most incidents are easy to prevent, this still is an okay result.

The incident that took place had a loudness of 68 dB, this is really loud in a critical care situation.

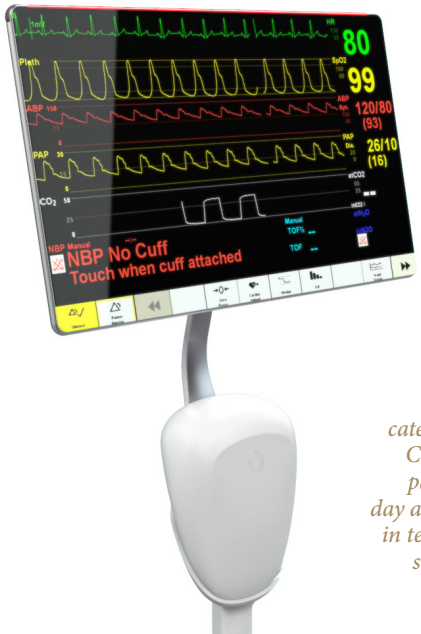
68 decibels

This sound level is comparable with the sound that a vacuum cleaner makes.

UltiMo

MSc Project by
Pinch Studio

Monitoring devices are designed to be a crucial work tool for medical staff at the intensive care unit. Patients and their families are involuntarily exposed to this visual and auditory information while they lack knowledge to interpret or act upon it. This leads to stressful situations for families and disturbing experiences for the patients, especially when clinicians are not present in the room. Therefore, there is a need for a patient monitor that adopts the information on the display to the needs of the ones present in the room.



Nitin Gurram,
David Schuit,
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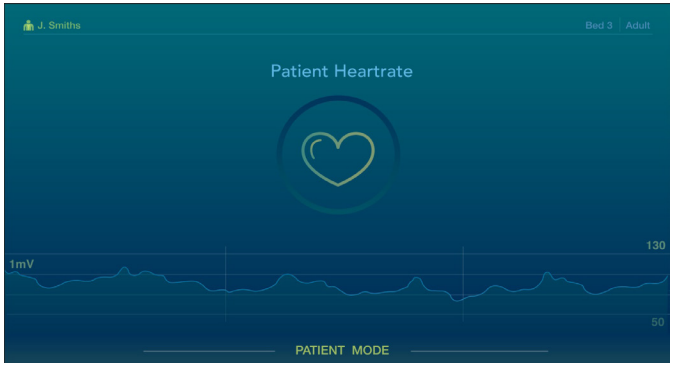
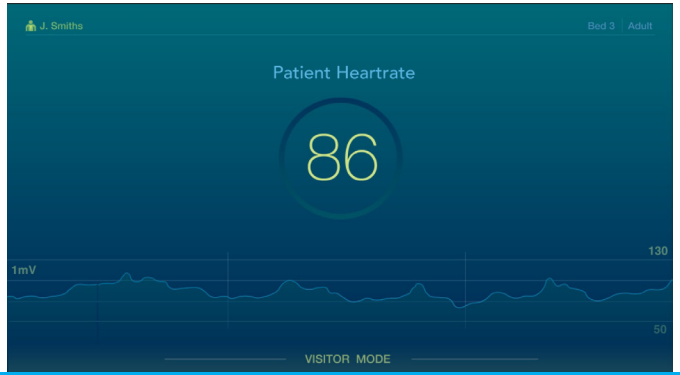
Marek Torbus

Pinch Studio

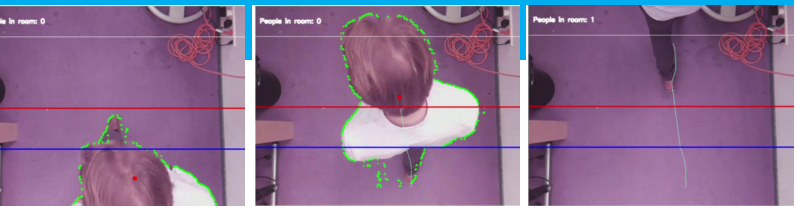
Our biggest challenge was to cater to the different user needs. Clinicians and visitors enter a patient room multiple times a day and both have different needs in terms of what is shown on the screen of the patient monitor.

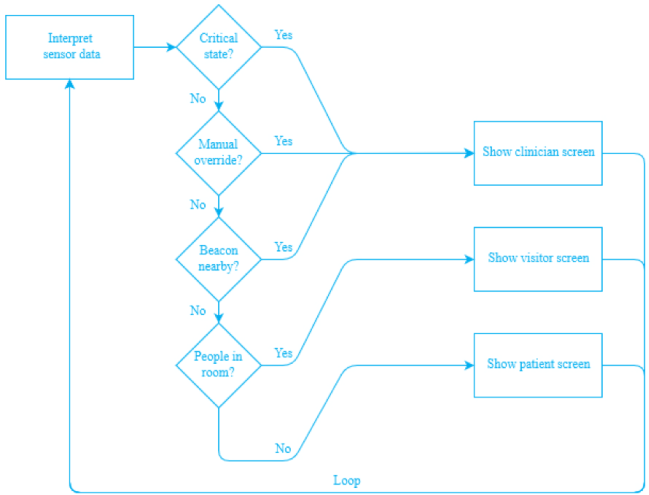




Patient monitor UltiMo is an intelligent monitor that seamlessly adapts itself by knowing who is present in the room. Is the **patient alone**? Then, UltiMo puts itself in the silent mode, without the beeps, warnings and diagrams that are difficult to interpret. When **family is present**, UltiMo gives basic information about the patient's heartrate. Information that can cause stress for visitors or the patient is **only shown to the clinicians**. Through a bluetooth beacon on the staff identity card, all vital functions and accompanying sounds will be activated on the screen.

The main function of the monitor is to inform the nurses about their patients' vitals. Thus, a hierarchy is built in when different types of people are in the patient room. Whenever a clinician walks into the room, even though other people are in there, the monitor overrides other people and shows the clinician's screen.





Designing the monitor started with the brain of the system: the PC. The PC processes the data received from the sensor panel and camera and scans the beacons on the staff identity card. Based on the logic, it controls the monitor to switch between the display modes. Mounted to the monitor through a basket-like structure, clinicians can take the PC with them when the patient is shifted from one place to another.

The designed monitor is envisioned to fit in a silent intensive care unit where the patient experiences a peaceful recovery. The novelty of the design suggests that the monitor senses the people present in the patient room and reacts accordingly. The new design has a calm and friendly look that conveys the sensitive nature of the system.

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