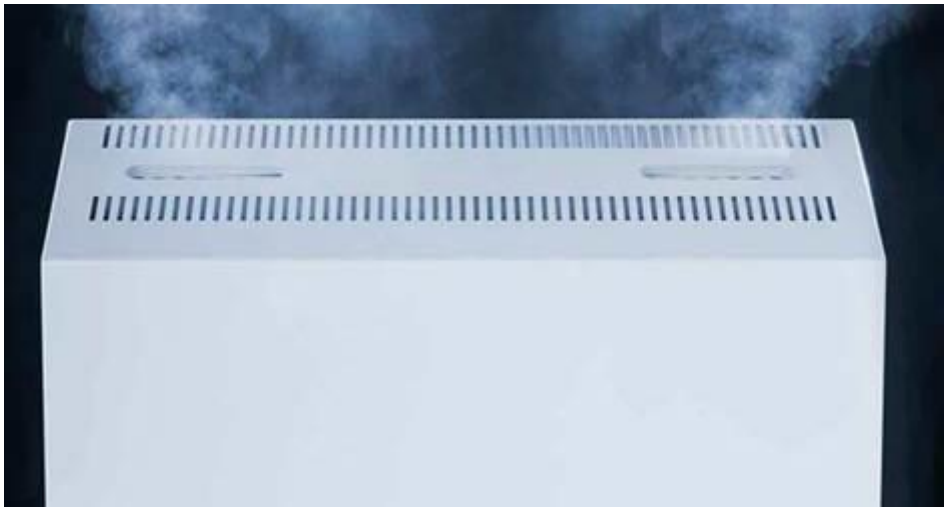
What do these machines look like?

Her some examples. There are literally hundreds of different machines on the market.



How do these machines generate the fog?
Generally there are three different methods.

1. The aqueous H_2O_2-solution is pressed through a nozzle which rips the liquid into little drops. These drops are very small, so they do not fall down immediately but stay in the air for a while.

2. The liquid is transformed into drops with ultrasound. This produces drops which are even smaller.

3. Inside of the machine the liquid is being dropped on a hot surface, becomes steam and this steam is blown out of the machine. When the steam leaves the machine it comes into contact with the cold air, it condensates and the result (once again): little drops.

All three methods have in common that they produce little drops that contain H_2O_2. If a drop comes into contact with a surface, this might inactivate a germ.

How are these machines applied in daily use?

The standard application: Place the machine inside the room to be disinfected. Press “start”. Usually it is programmed that there is a time delay of 30 or 60 seconds before it starts, so you can leave the room and lock the door. The nebulizing action is carried out by the machine for some minutes. After having produced the amount of fog as programmed, you have to wait (depending on the volume of the room) some time, so the drops have enough time to drift and to reach as many places as possible. The longer you wait the more surfaces will get in touch with some drops. After for example 45 or 60 minutes you open the door, wait some minutes, so the concentration of H_2O_2 goes down and access to the room becomes possible again.

Where is the method used?

These machines are applied in many surroundings. It is very common that laboratories use this method in order to disinfect the chamber of isolators or manlocks, see the following picture which shows a H_2O_2 nebulizer, directly connected to the chamber of a lock.

Another application would be the disinfection of ambulance vehicles after having transported a patient who had been potentially infectious. Here in Germany, most rescue stations use stand-alone machines (like the photos in the beginning), but in some ambulance cars, this "fog producing unit" is even already installed in the vehicle, see the video: https://www.youtube.com/watch?v=v1y4c1IFrt8

There are many other applications. In some hospitals patient rooms and operation rooms are disinfected. Medical supply stores offer materials for handicapped persons for rent and they disinfect wheel chairs, respirators etc. before giving them to another client. The method is also being used outside of healthcare, for example in Hotels for spa or swimming facilities, for fitness studios etc.

Does it work?

Yes, it does, but only within some limits. Concerning H_2O_2 sterilization processes you are already familiar with many problems, like for example the decomposition of H_2O_2 into H_2O_2 and O_2 when having contact with some materials (like celluloses) before it can kill any germ, the impact of the carrier material on the resistance of an organism, the impossibility to determine the D-value of a biological indicator etc. All these problems (and probably even more) are also valid when it comes to disinfection with H_2O_2 nebulizers.

The disinfection of an isolator or a manlock in a laboratory is probably a reliable method because the walls and all other surfaces of the isolator or the lock are specially designed to be cleaned and disinfected easily.

But when you have a look on the next application (picture taken from https://www.klinik-rothenburg.de/hygienemanagement.html) then it becomes clear that it is very unlikely that

the disinfection of bed linen, of the bed construction, of curtains, mattress, wall paper etc. will succeed.

The producers claim that disinfection with H_2O_2 cannot replace manual disinfection. So they try to get out of any responsibility by saying that the nebulizer is only an additional method but can never stand alone. The clients – unfortunately – do not listen very carefully. Just take the example of https://www.klinik-rothenburg.de/hygienemanagement.html from the picture above. You can read in the text on their homepage that they really believe that everything becomes disinfected in this patient room and that this nebulizer machine is a real miracle. So there is a lot of misunderstanding, of ignorance, of credulity and naivety.

How to monitor this process

The most common biological indicator being used in these processes are sets of three spore disks made of steel, delivered with 10^4, 10^5 and 10^6 CFU of *G. Stearothermophilus*. These triple-set indicators are placed inside of the room to be disinfected. Sometimes all three BI are inactivated, sometimes the version 10^6 CFU fails, sometimes 10^5 CFU fails also and sometimes all three will grow. This result can give some information about the dispersion of the H_2O_2 fog. A BI on the floor will probably be completely inactivated (because the drops fall down sooner or later) and the same BI, hung on the wall or stuck on the ceiling will probably grow (because the drops can stay in the air for some time but the quantity of drops that reach the ceiling is of course less numerous).

ATTENTION – no. 1: This result says something about the places where there had been more H_2O_2 or less H_2O_2. But it does not tell anything about the success of the disinfection, because it is unknown if *G. Stearothermophilus* is harder to be inactivated than pathogenic germs. We do not know, if *G. Stearothermophilus* is really the "worst case". Many germs protect

themselves against H_2O_2 with the help of catalase, an enzyme that destroys H_2O_2. Therefore some vegetative germs might even be harder to be inactivated than spores.

Maybe our new CI-prototypes for H_2O_2 will turn out to be suitable for this application too. I would recommend to place all six indicators at a position that is easy to reach for the drops that fall down. If the CI reaches the final colour at this “easy” position, you can start trying different (“harder”) positions by hanging it on the wall, sticking it under the ceiling etc., in order to make visible, where the amount of H_2O_2 (number of drops) is higher, lower or near zero.

ATTENTION – no. 2: Never start any discussion about the method, its efficiency and its reliability. Many publications exist, but so far there is no publication of reference that conclusively proves the effectiveness. So stay apart when discussions about PRO and CON start.

We cannot give any evaluation of the disinfection process, but thanks to our new CI’s we might be able to help when it comes to figuring out which would be the “easy” positions inside of a room to be disinfected and which positions would be hard to reach for the H_2O_2 drops.