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INFECTION CONTROL
SOLUTIONS

Where to install filters and which type of filters for the prevention of waterborne infections in health-care settings and public receiving buildings.

HOW TO PROTECT PATIENTS AND GENERAL POPULATION.

There is now a largely diffused information in the public related to the **risk of waterborne contamination** and **infection** since some **mediatic outbreaks** of **gastroenteritidis**, **legionellosis** and **health-care associated infections**. The request of a safe environment, both in hospital settings and public receiving buildings is clearly expressed by the users who don't hesitate to go in front of a court in case of such an acquired infection where the issue could be fatal. Thus professional guidelines are now helping the personnel in the control of the this risk but, in absence of their application, the court would not hesitate to consider the institution as guilty.

For an adequate control it is first **necessary to perform a risk analysis** taking into account the potentially present hazards, the **possible routes of contamination** (oral, respiratory, cutaneous, etc…) and the **immunological status of the exposed population**. In developed countries, distributing in the network a water in accordance with the potability criteria, the risk of outbreak of gastroenteritis is very limited, excepting from viral origin in some occasions. Thus it is not necessary to filter the tap water before drinking. On the other hand this **filtration is more than recommended** in many developing countries. It is also necessary to remember, even an adequate treatment has been applied, **a « potable » water in not sterile** and may **contain harmful microorganisms for immunocompromised persons via a respiratory exposure** (e.g *Legionella pneumophila*) or via **cutaneous exposure** (e.g. *Pseudomonas aeruginosa*). **These bacteria are resistant to some disinfection treatments.**

This leads the team in charge of environmental control to **review all possible exposures** to **water or aerosols** and the **critical points** for their distribution, taking into account the susceptibility of the **exposed people**, for organizing the best « **Water Safety Plan** » in accordance with the strategy defined by WHO.

The risk is different in hospital settings where many opportunistic bacteria could be encountered and public receiving buildings where the major risk is linked to *Legionella pneumophila*. The main adversaries in hospital are **Gram negative bacteria** (G-bacilli).

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Inside the G- bacilli, the gender *Pseudomonas* has been submitted to numerous changes and it is now necessary to refer to different sub-classes of *Proteobacteria* :

- *Brevundimonas sp*,
- *Burkholderia sp, Ralstonia sp*…
- *Pseudomonas sp, Xanthomonas sp, Stenotrophomonas sp*…

These bacteria are growing in aerobiosis with a respiratory metabolism and a large variety of possibilities to use carbonated substrates and numerous hydrolytic enzymes. As a consequence, they are able to grow in a lot of different environments, particularly using plastic materials and hydrocarbons. They are now at least 150 species inside the gender *Pseudomonas* which may be found in a vast majority of ecosystems with a **remarkable ability to survive** and multiply **even hostile conditions**, in particular in **water with scarce nutriments**. The main species of interest in hospitals is *Pseudomonas aeruginosa*, bacterium with a hydric tropism, able to grow inside biofilms and **resistant to numerous biocides and antibiotics**. This allows *Pseudomonas* to **colonize water distribution** networks, **fittings**, **siphons** and **every humid environment** (surfaces, linen, medical devices, etc…).

The species *P. stutzeri* may be sometime involved in human pathology and ***Burkholderia complex cepacia*** and ***Stenotrophomonas maltophilia*** are more and more involved during **infections in Intensive Care Units (ICUs) and immunocompromised patients, especially in the Neonatal ICUs (NICUs)**. Each species is easily able to build biofilms and to grow inside these biofilms: they may also be hosted by free living amoebae which **are very resistant to disinfectants**.

Legionella pneumophila is also a G- bacteria, hydrophilic, able to grow in biofilms, **resistant to some disinfectants**, especially when hosted in free living amoebae.

Other **Gram-bacilli** are taking more and **more importance in the waterborne infections** in **ICUs because of their ability to be antibiotic resistant** by different mechanisms. They also like the humid environments where they may survive during long periods. The siphons are often contaminated with these AB resistant G-bacteria like *Klebsiella*, *Enterobacter*, *Serratia*, *Acinetobacter*, etc. also possibly resistant to disinfectants and able to survive inside amoebea.

The results of the routine analyses at the taps of hospital water distribution networks indicate a **low percentage of positive samples** containing these adversaries. This illustrate that distributed water, even a disinfection treatment is applied, continuously or discontinuously, may disseminate this kind of bacteria inducing the need of specific preventive measures.

This underlines **the importance of a perfect water** quality during the **patient's grooming in ICUs and NICUs or for rinsing medical devices**, even more when the patient is immunocompromised or immunosuppressed.

Since decades filters are used for improving the microbiological quality of water and there is a consensus between the manufacturers for producing filters with a porosity of around 0.22 micrometers for being a physical barrier for bacteria. They are two possibilities for placing the filter in the water distribution network:

- The traditional one, before the tap, in a carter inserted in the pipe, needing to remove this carter for the interventions necessary for maintenance,
- The most recent one, after the tap or directly on the shower head, with a new category of filters called « **Point Of Use Filters** » (POUFs) where the technical progresses allowed to insert all the

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filtration system in a small carter to clip directly on the tap or the showering line, easily removable when necessary.

In public receiving building, the control of the legionellosis risk is necessary both in the ventilation system which may disseminate contaminated aerosol via cooling towers or humidifiers and in the hot water distribution system. It is possible to control the level of *Legionella* in the distribution network when the temperature is maintained higher than the level necessary for its inactivation (55°C). When this is not achieved, it is useful to protect the most sensitive users like immunocompromised persons (around 1% of the general population in developed countries) with the aid of POUFs, both for showers and taps.

Inside healthcare settings, the situation is more complex because of the diversity of patients and water uses.

For example in **level III High-Risk Nurseries** (HRNs) or **Neonatal Intensive Care Units (NICUs)**, the **new-borns** have a **limited immune system** linked to their age of gestation and to a few amount of antibodies transferred by mother. In **adults ICUs the immunosuppress** is possibly inducted by a **pharmaceutical treatment** (ex. cortisone or antirejection drug) or linked to **their age** or to the **evolution of the sickness** (ex. cancer, cystic fibrosis, burns…).

The evolution will be more severe if the **strain is antibiotic-resistant**, inducing a limitation of the therapeutical possibilities and also if the patient is immunocompromised. This allows the **expression of the virulence factors of these bacteria**, particularly the extracellular proteolytic enzymes. The clinical symptoms will be diverse and different according to the infected site; a fatal issue is frequent.

Thus it is necessary to insure a **high level of microbial water quality** for all cares : this is not sterile water because too expensive but **bacteriologically controlled water** (BCW) produced by **local filtration** according to the criteria of absence of *Pseudomonas aeruginosa* considered as an indicator of quality. It is clear *Legionella pneumophila* is also absent after such a filtration.

The indications of these two kinds of filters are different:

- The **capsule carters** before the tap are indicated for large uses of filtrated water, for example for the production of water in hospital for filling a bath necessary for the treatment of severe burns or bathing immunocompromised newborns or children. **Due to the « dead » volume between the filter and the tap, a microbial proliferation may occur in the interval during successive uses**. This may be due to the well known retro-contamination of the tap linked to contaminated aerosols or droplet-nuclei generated by human activity, especially from the sink drain. Thus they are more indicated when the risk is limited to legionellosis because the probability for *Legionella* to retro-contaminate the tap is more than limited.
- The **Point-of-Use Filters** (POUFs) are indicated for the **local production of BCW** used both for cares dedicated to **immunocompromised patients** and **rinsing of critical medical devices in ICUs** and many technical wards **with a requirement of bacteria-free water**. The retro-contamination of their external surface may occur but both correct use and adequate maintenance allow to limit the contamination of the surface with water inside the carter and the volume is very limited.

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The performances of these filters were described in the paper of Ortolano et al. in 2005.

Numerous epidemiological **studies have been dedicated to the health care associated infections** (HCAIs) due to *Pseudomonas aeruginosa* and other Gram- bacteria in ICUs and **reanimation wards**. The epidemiological situation is very variable according to the hospitals and their control measures, but it is possible to assume that, globally speaking, **half of these infections in ICUs are endogeneous**, linked to an original carriage by the patient. **The second half of these infections is due to cross-contamination linked with a transmission to the patient of a human or environmental strain;** in this case the w**ater inside the ICU is often the reservoir of this strain** (Bertrand et al. 2001). This has been clearly demonstrated since the 2000's, for example by Trautmann et al 2001 (17 patients followed, 29 % infected with a strain found in the tap).

A lot of papers reported such HAIs cases linked to a contamination of newborns by *Pseudomonas aeruginosa* or other Gram- bacteria. **The most famous recent outbreak involving** *Pseudomonas aeruginosa* **occured in Northern Ireland neonatal ICUs in 2011**. The following investigations described by Walker et al. in 2014 reported the same strain of *Pseudomonas aeruginosa* **present in biofilms from different taps**.

Thus it appeared necessary to **secure the taps in this kind of wards for avoiding waterborne infections**. **Point of Use Filters (PoUFs) are fully indicated for this prevention**. Trautmann et al. were the first to publish in 2005 and to demonstrate the efficacy of PoUFs in an adult ICU. In his study the **use of filters allowed to obtain a germ-free water** at all points of use and a progressive diminution of the number of colonizations/infections from 5 to 10 at the beginning to 0 or 1 each month at the end of the study. Some researchers pinpointed the lack of statistical power, thus this group, after a longer observation's period, published in 2008 new results clearly evidencing the efficacy of the PoUFs.

The same demonstration was published in a **haematological ward** by Vianelli et al in 2006 **after setting filters at all point of use** (taps and showers).

Since this initial period, more and more **ICUs and NICUs are using in Europe PoUFs** for the **reduction of the bacterial content of water used for cares** and for being in accordance with the quality criteria requested, for example, in the **French water guidelines** (Guide de l'Eau 2005) for the water called «Bacteriologically Controlled Water» (BCW) or in the **UK guidelines of 2012** asking for surveillance of *Pseudomonas aeruginosa* as an **indicator of quality in NICUs and ICUs water.** They are a lot of papers illustrating the excellent results obtained with POUFs, both in term of absence of opportunistic bacteria after the **filter which is a physical barrier** and in term of clinical results with a **drastic reduction of the colonizations** and **infections**, like the article of Kerr and Snelling in 2009 dedicated to *Pseudomonas aeruginosa* and infection prevention in ICUs and NICUs.

IT seems now no more possible for ethical reasons, taking into account the published results and the official guidelines to treat such patients without **using POUFs which is often considered as a standard of care.**

The **increased surveillance** and **water quality control** in wards **hosting neonates** and **patients at risk** inside the health care settings is absolutely essential and the **terminal filtration of water inside NICUs and ICUs** where are hospitalized the most fragile patients with a low immunity, is an **indisputable progress** of the last decades. The surveillance of *P. aeruginosa*, considered as an indicator and the most representative microrganism of the waterborne infectious risk is required at the points of use and POUFs allows to validate the level of <1UFC/100mL in BCW and to insure an excellent protection during hospitalization. **This is now a standard of care in many countries**.

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FILT'*RAY* 2G Filters are recommended for **Preventing Healthcare Associated Infections** (HAis) from **Waterborne pathogens** by constituting an immediate physical barrier against all water contaminants.

Prevent the **discharge of planktonic legionella & pseudomonas** and others **waterborne pathogens** from tap, shower outlets and inline filters and should be used to reduce human risk in healthcare and nursing facilities. They can be used as a temporary measure throughout a building, and should be used **proactively in areas with high-risk patients** (Bone marrow/solid organ transplant units, Burn units, Oncology units, NICUs/ICUs, as well in the OR for surgical scrub sinks).

Called Bubl'Air Wash™ Technology , self-cleaning mechanism of 0.2 µm membrane microfiltration which introduces turbulent flow during filtration to keep particulates from becoming fully trapped on the membrane and permits longer life use has been and higher reduce monthly cost for user.

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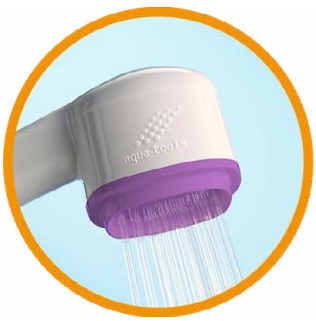
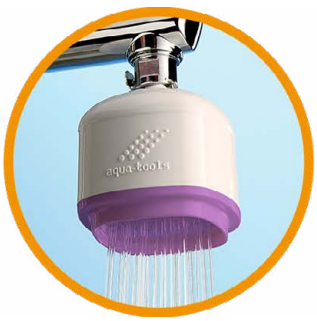
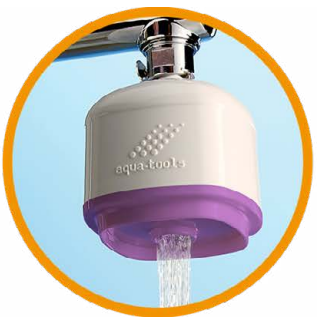
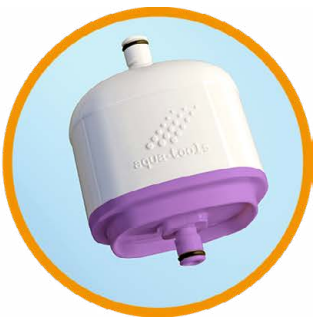

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