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A COMPREHENSIVE SYSTEM FOR THE PREVENTION OF LEGIONELLOSIS IN A HOSPITAL

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BACKGROUND

Legionella is an ubiquitous bacterium in aquatic environments. In Europe, about 90% of the infections caused by this bacterium are due to *L. pneumophila* with type 1 serogroup.*Legionella* bacteria are present in rivers, lakes, wells, thermal springs, sometimes also present in aqueducts, as they are able to overcome normal potable treatments.Therefore, all water distribution plants are at risk. In plants that involve moderate water heating and spraying, it is more likely that bacteria develop. Man contracts the infection through aerosol, that is when inhaling small droplets (1-5 micron) of water contaminated by sufficient bacteria; when it comes into contact with the lungs of risk subjects, causes pulmonary infection.

Aim of our study is to demonstrate that a comprehensive prevention system is able to diminish risks of *Legionella pneumophila* spreading and infection in the "Pugliese" General Hospital, with 450 beds (5 floors), of AziendaOspedalieraPugliese-Ciaccio Catanzaro (AOPC-CZ),considering the difference between a complete prevention system (main station) and a partial one (secondary station), through the comparison of the results obtained by searching *Legionella pneumophila* in water samples taken on 21 significant points.

Prevention protocol of Legionellosis with risk mapping and risk management was the first intervention, then the installation of a plant of water treatment on the main line and supervision by maintenance staff. Monitoring of possible bacterial contamination has been performed through bacteriological analysis, according to the protocol "PrevenzioneLegionellosi", drafted by the AOPC-CZ in 2016 as required by IstitutoSuperiore di Sanità (ISS) guidelines.

MATERIALS/METHODS

Inside the hospital there are two water power plants, a main one that serves all departments and a secondary plant serving areas in which at the moment there aren't any risks for public health.

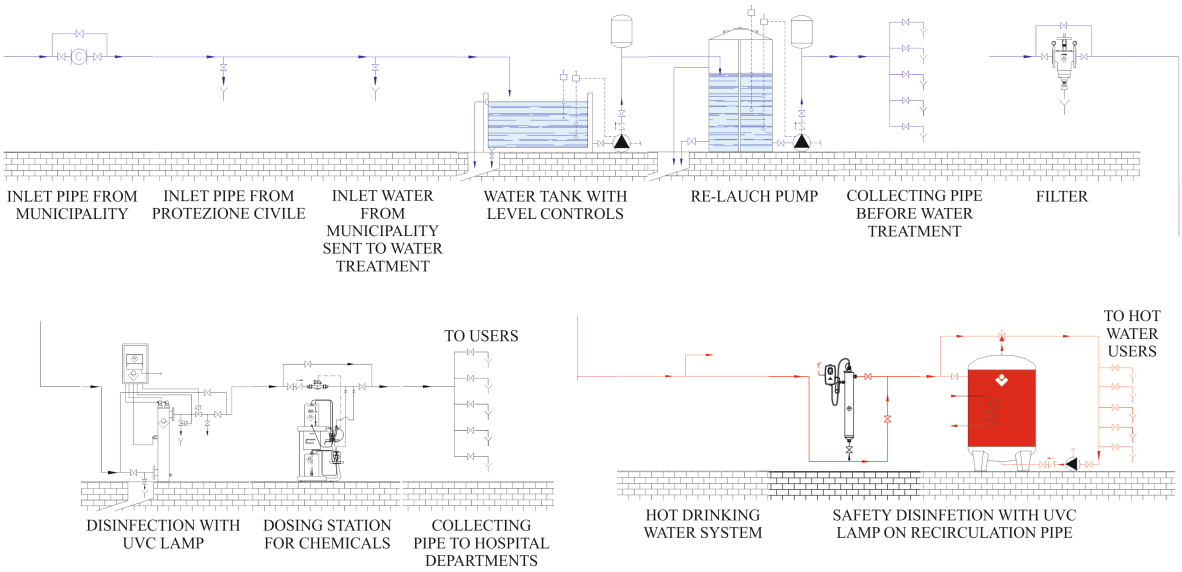
On the main power station where the entrance of cold water is situated, a water treatment plant has been installed, composed of a semi-automatic filtration (Cillit FA DN 125), an ultraviolet lamp provided with sensor UVC able to monitor the correct irradiation and then instantaneous disinfection (UV lamp with a UVC probe-CillitAquazon UVCS AC 800 W), a chemical disinfection and an anti-corrosion protection (CiĺlitDosamat duplex dosing CillitAllsil Super 25 H_2O_2, Ag+) and CillitCsp (based on phosphorus silicate).

The system goes into alarm in case of malfunction. To complete the system, a hot water ultraviolet lamp is also installed on sanitary hot water recirculation, even equipped with UVC sensor and alarm (CillitElios 6300 AC).

DESIGN AND PLANT CONSULTANCY STUDIO

Ing. Maurizio Gimigliano

WATER ROOM PUGLIESE HOSPITAL CATANZARO



Moreover, as an additional security measure, Filters Pall were installed at the endpoints of the hospital departments at risk.Finally, possible presence of *Legionella* had been monitored for 4 months.
One of the main and innovative choices has been the one to operate on all the water circulating in the hospital. The treatment is carried out from the cold water of the principal power station after the storage tank and the autoclave relay group. The secondary plant water, received directly from the city's aqueduct, does not undergo any treatment but, in emergency situations, has been subjected to thermal (t>/= 60°C) and chemical (disinfection of boilers and tanks with H_2O_2) shock.
The water has been sampled twice a month for four months along the distribution system in a series of specific control points (n. 21) and sent within one hour to the Unit of Microbiology and Virology for the *Legionella pneumophila* research.
The samples collected in sterile containers of 1 litre, have been filtered by the vacuum pump EZ-Stream pump (Millipore), with the Ramp Speed Flow (Crami Group srl) and the 0,22 micron membrane filters (Millipore).
The filters have been resuspended in 10 ml of water and 100 ul have been inoculated in culture media: Selective Medium MWY (Oxoid) for *Legionella*, BCYE Medium (Oxoid) completed with growth supplement (among which L-cisteine) and BCYC Medium (Oxoid) without the supplement L-cisteine.
For the presumptive identification has been used the *Legionella* Latex Test (Oxoid), while the confirmation has been performed by the Mass Spectrometer MALDI-TOF (Biomérieux).

RESULTS

The concentration of *Legionella* in the samples was always found below the threshold deemed to be safe (Table). After a few months of disinfection treatment, the concentration of *Legionella* was found substantially decreased throughthe whole water distribution system.

In reference to the area in which is already taking place a process with a systemic approach (prevention of plant, management, maintenance) it is noticed that some starting values (03.05.2017) were positive, even if in most cases they were lower than limits of compliance. In the next checks we can notice an almost complete disappearance of *Legionella*, except for an area destined to the day hospital in which for the effect of an episodic use of water, which naturally causes stagnation of the same, positive growth results occur, for which a resolution is being implemented (increased of H_2O_2 dosing and timer tap installation).

In the control area, in which there aren't risk situations, it has been opted for the partial application of the Protocol's Prevention of Legionellosis (according to the guidelines 2016 of the ISS) with management and maintenance. In this area positive values are detected (in some cases over the limits of conformity), which lead to extraordinary actions (chemical shock with the product used for the treatment of water coming from the main station, thermal shock).

Sample	Control Point	03/05/17	16/05/17	20/06/17	26/06/17	04/07/17	17/07/17	03/08/17	30/08/17
		Starting Condition	Implementation of Protocol						
Main station: prevention involving plant, management and maintenance									
1	Aqueduct	No growth	No growth	No growth	No growth	No growth	No growth	No growth	No growth
2	Exit of treatment plant	No growth	No growth	No growth	No growth	No growth	No growth	No growth	No growth
3	Tank	No growth	No growth	No growth	No growth	No growth	No growth	No growth	No growth
4	Boiler 1	1000 CFU/L	No growth	No growth	No growth	No growth	No growth	No growth	No growth
5	Boiler 2	600 CFU/L	No growth	No growth	No growth	No growth	No growth	No growth	No growth
6	Water recirculation	1000 CFU/L	No growth	No growth	No growth	No growth	No growth	No growth	No growth
7	Cold Water - Ward 1	No growth	No growth	No growth	No growth	No growth	No growth	No growth	No growth
8	Hot water - Ward 1	2000 CFU/L	100 CFU/L	400 CFU/L	600 CFU/L	400 CFU/L	400 CFU/L	No growth	900 CFU/L
9	Cold Water D.H. 1	100 CFU/L	No growth	No growth	No growth	No growth	No growth	No growth	No growth
10	Hot Water D.H. 1 **	100 CFU/L	No growth	100 CFU/L	200 CFU/L	200 CFU/L	1700 CFU/L *	2200 CFU/L *	800 CFU/L
11	Cold Water Ward 2	100 CFU/L	No growth	No growth	No growth	No growth	No growth	No growth	No growth
12	Hot water Ward 2	No growth	No growth	No growth	No growth	No growth	No growth	No growth	No growth
13	Cold Water Ward 3	//////////////	//////////////	//////////////	No growth	No growth	No growth	No growth	No growth
14	Hot water Ward 3	//////////////	//////////////	//////////////	No growth	No growth	No growth	No growth	No growth
Secondary station: control areas with no risks for public health at the moment									
15	Control area	Massive growth *	No growth	400 CFU/L	600CFU/L	No growth	No growth	No growth	No growth
16	Aqueduct of control area	//////////////	1000 CFU/L *	No growth	No growth	No growth	No growth	No growth	No growth
17	Boiler 1 Control Area	Massive growth *	Massive growth *	Massive growth *	Massive growth *	200 CFU/L	2000 CFU/L *	800 CFU/L	No growth
18	Boiler 2 Control Area	Massive growth *	9000 CFU/L*	Massive growth *	9000 CFU/L *	No growth	1800 CFU/L *	1300 CFU/L *	No growth
19	Cold Water Control Area	100 CFU/L	No growth	No growth	No growth	No growth	No growth	No growth	No growth
20	Hot water Control Area	No growth	No growth	No growth	No growth	No growth	No growth	No growth	No growth
21	Water recircul. Control Area	1000 CFU/L *	No growth	1000 CFU/L *	No growth	No growth	No growth	No growth	No growth

Table: Legionella spp research results

CFU = Colony Forming Unit

Green: No infectious risk

Orange: Legionella under the threshold foreseen by guidelines (1000 CFU/L)

Red: Legionella over the threshold foreseen by guidelines (1000 CFU/L)

* Maintenance intervention and thermal and disinfection shock

** Day Hospital characterized by limited use of water

CONCLUSION

The results show that the water supplied through the main station, in which the preventive process is complete (plant, management, maintenance), there is no *Legionella* and infectious risk, while on the

secondary line, without plant, the *Legionella* growth is always present and can be kept under control only by making additional disinfection interventions, such as thermal or chemical shock at the moment of confirmation of positivity.Such interventions are performed when water analysis, on risky points, show increasing*Legionella* concentrations and are, however, difficult to implement in community structures such as hospitals.

The risks related to this situation induce to monthly monitoring (much more frequently than expected in the LG ISS, once a year, except in case of accidental infection) in order to detect immediately a possible positive result, by taking corrective actions without which patients and staff would have very high risk of infection. The concentration of *Legionella* in the samples of water subjected to treatment (in the main circuit) was always found below the threshold considered at risk, proving that the combined approach using physical and chemical disinfection has achieved the result of reducing the likelihood of *Legionella* infection both by decreasing the preexisting microbial contamination and by impeding new contamination.

The systemic approach, therefore, is the only intervention that allows, regardless of the monthly controls, to achieve and maintain a safe level of security by which the “zero risk” target of *Legionella*becomes concrete and achievable.