ABSTRACT

Facility management (FM) is present in healthcare. According to the International Facility Management Association (IFMA) guidelines, an organisation is obliged to take precautions to enable continuous business operation and reduce hazards. As FM organizations or facilities services are sometimes responsible for water systems, and hence in the reduction of hazards in this area, the FM’s role is vital for maintaining hygiene. Being healthcare providers, dental surgeries are subject to strict hygienic criteria. During treatment patients are consigned to the care of dentists. The instruments of a dental chair unit (DCU) operate with drinking water from a source. In the process of an implemented hygienic concept in the dental surgeries the care instruments get disinfected systematically. But the water system of the building itself allows limited access, and its hygienic status is not always documented well. As can be seen by this example, hygiene concepts potentially contain blind spots. As a result, not only patients but also medical staff might be exposed to hygienic hazards, which are meant to be reduced to a minimum. Contaminated water lines may cause certain diseases (e.g. Legionnaire’s Disease). Inevitably, the personnel responsible have to manage the facilities appropriately to reduce the risks of a contamination. Literature on Legionella suggests an urgent need to address the issue of Legionella in dental surgeries. This paper will highlight the issue of Legionella in dental surgeries and aims to detect potential hazards from the built environments’ hygiene with a focus on water lines. It will further draw attention to additional criteria relevant for FM and duty holders. During the case study, data was collected on Legionella contamination in dental surgeries' waterlines. Building and water lines of the DCUs were tested as well, in compliance with the Swiss drinking water ordinance. Appreciating the fact, that there was no pathogen Legionella pneumophila detected in all samples of the DCUs, the questions arises on the incident of a potential contamination of the facilities (building) water line system itself as well as on the duties of the stakeholders involved.

Keywords Healthcare, Facility Management, Legionella, Contamination, Dental Surgery

1 INTRODUCTION

1.1 Occurrence of Legionella

The genus Legionella is a pathogenic group of gram-negative bacteria, which includes the species Legionella pneumophila, causing Legionellosis. Legionella contaminated water systems in facilities are a serious problem and an issue which needs to be addressed. Besides the threat of economic losses or damage to image, a risk to the public is undeniable. Potentially affected are people being exposed to open water systems or the apertures of water systems (i.e. all varieties of water outlets). Hazards arise from contaminated small-size water droplets, termed aerosols, in...
which *Legionella* exist. Especially in facilities management (FM) contexts, where managers (i.e. operators or any duty holders) can be responsible for building associated facilities such as water systems, awareness of the potential contamination risks needs to be addressed. Understanding the context is the first step towards precisely defining actions against hazards such as *Legionella*. Prominent cases of contaminated water systems or water-bearing facilities, which document the hazardous potential of contamination with *Legionella*, can be found worldwide. The surveillance report from the European Centre for Disease Prevention and Control (ECDC) states, that 5,852 cases of Legonnaires’ disease were reported by EU member states, Iceland and Norway. Of the 29 countries involved, six countries accounted for 84% of all notified cases. Interestingly these countries have a high level of awareness and run reporting systems on *Legionella*. 69% of the reported cases were community-acquired, 20% were travel associated and 8% were linked to healthcare facilities (ECDC, 2014). Healthcare facilities are usually visited by immunocompromised people or people who need a medical operation. Thus they constitute a risk group whose environment should meet stipulated requirements of hygiene. The ECDC’s report states two main reasons why Legonnaires’ disease is thought to be underreported: (a) insufficient diagnosis by clinicians, and (b) failure to notify health authorities, although the disease can be registered in all European Union (EU) and European Economic Area (EEA) countries. Switzerland is not mentioned in the ECDC report.

1.2 *Legionella* in the context of FM

Water systems, including all related facilities, are in the range of duties FM organizations or facilities services (e.g. property operators) sometimes are responsible for. The IFMA guidelines define the competencies of FM. In 2013 the chapters “Emergency Preparedness and Business Continuity” and “Environmental Stewardship and Sustainability” were added to these guidelines. Thus the management competencies of FM now include hazard prevention requirements. Hazards might, for example, arise from microbiological contamination with species of *Legionella* (*Legionella* spp.). The facultative pathogen *Legionella pneumophila* (Heesemann J., 2012), a species of *Legionella*, accounts for 85-98% of confirmed cases, depending on the testing method used (ECDC, 2014). In community and in healthcare organisations, the potential consequences of a case of *Legionella* are particularly profound. In healthcare not only the health of patients and staff might be affected (working people such as doctors, care personnel, cleaning personnel, and service personnel), but also the performance of and confidence in the organisation.

The former draft of ASHRAE-Standard 188P entitled “Legionellosis: Risk Management for Building Water Systems” puts forward criteria to help facility managers understand building water systems with respect to avoiding amplification and dissemination of *Legionella*. With respect to the design and operation of the building water systems, the upcoming standard will provide practical guidance to control exposure. It will include design, maintenance and operational procedures throughout the life-cycle of the building (Martin D., 2012; Scott J., 2014). One tragic example of a *Legionella* outbreak, which is associated with a particular FM service provider, is a case in Germany in 2009. The city of Ulm recorded over 65 cases and several deaths (von Baum H. *et al.*, 2010). The outbreak was caused by *Legionella* infected aerosols from a cooling tower of a thermal block-type power station. Several years of litigation ensued before prosecution stopped the investigation procedure (Mayer C., 2013).

To counteract potential threats caused by *Legionella* contamination, organisations should consider a mandatory scope statement as part of their risk management. However, the legal framework or potential threats are not always identified sufficiently. Duty holders may fail to
determine appropriate strategies to counteract *Legionella* (Gollnisch A. *et al.*, 2003). Considering parameters specific to the organisation is an essential part of risk assessment. An infected water system is a defect of a building and reduces the value of a facility. Professionals with operator’s duties must bear that in mind. Probably derived from demands like these the UK HSE guidance ‘Legionnaires’ disease: Technical guidance’ was compiled (HSE, 2014).

### 1.3 Drinking water and *Legionella* in Switzerland

A report from the Swiss Federal Office of Public Health (FOPH, 2008) concluded that the incidence of Legionnaires’ disease in Switzerland is relatively high compared with other countries in Europe). FOPH’s ongoing statistics on the number of cases registered, document an increasing number of deaths caused by Legionnaires’ disease. The numbers represent all cases reported to the FOPH. During the past 52 weeks the number of cases has increased to 296 (FOPH, 2015). Statistics are listed consecutively due to the fact that in Switzerland Legionnaires’ disease has been a reportable disease since 1988. In a module-based document the Swiss authority reports on different perspectives on *Legionella* and prevention strategies. Special cases are seen in hospitals and care units (FOPH, 2009). The Swiss regulations on drinking water – including Foodstuffs and Consumer Goods Regulations, Hygiene Regulations and Regulations on Drinking Water, Spring Water and Natural Mineral Water – make no mention of *Legionella*. Nevertheless pathogens are tolerated up to a limit to 300 microbes per ml (millilitre).

### 1.4 *Legionella* aerosols in healthcare facilities

Legionnaires’ disease is transmitted by air through inhalation of contaminated aerosols or aspiration of contaminated water (Heesemann J., 2012). Aerosols occur both inside and outside buildings, and are often associated with the water systems of cooling towers, heat exchange systems, showers, swimming pools, thermal spas or similar (Laganà P. *et al.*, 2014). Facilities of this kind promote the creation and distribution of aerosols. A large proportion of people present in a healthcare facility are there because they suffer from poor health and are thus vulnerable to infection. As a result of this, indoor environments should be subjected to high standards of hygiene and prevention control (Haupt T.E. *et al.*, 2012). In many cases a relatively high level of hygiene is achieved for the proximity (working environment). However, ‘non-obvious’ risks, such as water-bearing facilities, might be neglected. Even in healthcare, a field of high-level hygienic risk control, this phenomenon is present (Fragou K. *et al.*, 2012; Spagnolo A.M. *et al.*, 2013). In dentistry we find situations where (a) aerosols might be emitted by the water-associated instruments of dental chair units (DCUs), (b) aerosols potentially contain *Legionella* arising from the dental unit waterlines (DWULs), and (c) patients and working personnel are exposed to aerosols.

## 2 CONTEXTUAL FRAME AND AIM OF THE STUDY

The Commission of Hospital Hygiene and Infection Prevention (KRINKO) compiled guidelines for the prevention of nosocomial infections and for operational-organisational and constructional-functional hygiene measures in hospitals and other medical facilities. The guidelines are published by the Robert Koch-Institute (RKI) with respect to the latest epidemiology results, and are considered best practice in many places (Simon A. and Christiansen B., 2012). As outlined in the introduction section, risk management and control strategies for hygienic risks of processes in healthcare require and involve FM activities. In that context this research affects facilities of buildings and water lines in the context of *Legionella*. The purpose of the present work is to outline needs of duty holders and relevant activities in healthcare associated facilities (here: dentistry).
This study is currently at the stage of preforming and analyzing a case study to obtain evidence on water lines in dental surgeries in the canton of Zurich. Previously a literature review was carried out to get an impression of the potential level of a contamination by Legionella in dental surgeries. Findings from the literature review as well as an up-to-date evaluation of the case study will be presented in this paper. In addition to the usual water lines in the buildings, attention is paid to the DCUs, which are supplied by water of drinking water quality (Barben J. et al., 2009). Depending on the technical level of the facility the water is processed before final usage. The ‘raw material’ is the water coming from the source of the local water provider to the building’s operator. As soon as the water gets into the facility it is the building operator’s duty to ascertain the quality level of the water according to regulatory.

In Switzerland, the FOPH has published guidelines for testing of Legionella for several types of facilities. The limits for concentration of Legionella pneumophila in the water line system obtained from these guidelines are used for orientation. With respect to Legionnaires’ disease, the FOPH does not give particular modules for dental surgeries. In module 13, “Special case hospitals and care homes”, limits for Legionella in the water lines of hospitals are laid down. Dental surgeries, as part of healthcare, will be evaluated according to the limits described in module 13. It is an aim of this research to assess the risk arising from potentially contaminated water in dental surgeries.

Further aims are:

- Outlining the relevance of the issue of Legionella in FM
- Bringing attention to and showing the need for ongoing research on Legionella in the context of FM and water lines.
- Encouraging a framework for appropriate hygiene monitoring as part of the risk management in FM for prevention and steering measures, including the crucial players.
- Generating data during a field study in the canton of Zurich to evaluate the presence and relevance of the Legionella issue in dental surgeries (facilities in healthcare).
- Gaining an impression of the technical level and age of DCUs in dental surgeries in the canton of Zurich.

3 RISK ASSESSMENT AND HYGIENE MANAGEMENT IN DENTAL SURGERIES

This paper deals with the issue of Legionella contamination risk in healthcare facilities, which can be part of an FM activities’ portfolio. A special hotspot of facilities’ risk in healthcare is seen in dental surgeries, where Legionella might be released during dental treatment. A pilot study identified the transmission of pathogens to patients during dental treatments (Exner M. et al., 1981). Studies in Liverpool and London have also shown the significance of bacterial contamination with Legionella in dental surgeries (Martin M.V., 1987; Oppenheim B.A. et al., 1987). The guidelines for infection prevention in dentistry, issued by the KRINKO at the RKI, list the following factors as being most relevant to risk potential with regard to Legionnaires’ disease risk in dental surgeries (KRINKO, 2006):

- Age of DCU
- Presence of a hygiene concept regarding prevention of Legionella (cleaning/disinfection)
- Hazard analysis in case of a positively tested case
- Continuous monitoring of defined check points (CPs) within an existing hygiene concept
- Source of contamination (technical system or main waterlines of the building installation)
- Raising awareness of a potential contamination scenario (training)

An analysis of a survey carried out in 2009 (Hübner N.O. et al., 2012) identified deficiencies in the hygiene management of dental surgeries. However, Hübner et al. also stated that hygiene
management and hygiene equipment in dental surgeries have improved considerably compared to a previous survey in 2002/2003. The 2006 KRINKO guidelines for dental practices were assigned to this effect. The study focused mainly on DCUs and to a lesser extent considered facility water lines, which are also relevant to facilities duty holders.

A prevalence of between 10% and 50% for _Legionella pneumophila_ in DCUs has been reported in the literature (Lück P.C. _et al._, 1992; Oppenheim B.A. _et al._, 1987; Reinthaler F.F. _et al._, 1988). In Switzerland, one study from Berne showed that only 10% of DCUs complied with existing criteria required for drinking water. It documented that for _Legionella_ the tolerated margin of 1,000 microbes per litre was frequently exceeded (Tonetti-Eberle B. _et al._, 2001). In a study, conducted by Barben _et al._ in 2009 (Barben J. _et al._, 2009) in St. Gallen, Switzerland, the water quality in 76 DCUs was tested. Microbial contamination was detected by evaluating the prevalence of _Pseudomonas aeruginosa, Legionella_ and heterotrophic bacteria as ‘markers of pollution in water’. Among others, water samples for quality testing were taken from the 3-in-1 air water syringe. _Legionella_ were found in 20% of the DCUs tested, indicating the 3-in-1 air water syringe being one of the sampling locations with bacterial count. The study also showed a significantly higher risk of contamination associated with older DCUs. Furthermore, the study showed that the water quality of 60% of the DCUs tested neither complied with Swiss drinking water standards nor with the recommendations of the American Centres for Disease Control and Prevention (CDC).

To investigate incidences that were discussed above, but considered from a different perspective, we conducted our own case study research with a specific link to facilities duty holders in the canton of Zurich.

4  **CASE STUDY DENTAL SURGERIES IN THE CANTON OF ZURICH**

4.1  **Design and Methodology**

During the case study quantitative data was collected on _Legionella_ contamination. The case study research was design mixed method. The qualitative part was realized by a survey which was divided into three categories (technical, structural and organizational). It contained in-depth questions about the facility, the facilities’ waterlines, the technical specifications of the DCUs, and on the characteristics of an existing hygiene concept. The case study involved five dental surgeries, randomly selected in the canton of Zurich. Within this sample the presence of _Legionella_ was tested by taking water samples from different waterlines. Both the buildings’ and the DCUs’ waterlines were tested. The sample covered 11 waterlines from the building, each including warm and cold tap water. The points of water sampling included taps at the sink in the laboratory, taps at the sink in the break room and hand basins in the customers’ toilet. Furthermore, the testing scenario covered 14 DCUs. Here the points of water sampling included the 3-in-1 air water syringe and the taps to fill the tooth mug. The water samples were taken according to DIN EN ISO 19458. According to this norm the sampling procedures can be assigned to ‘aim c for orientation’. This category was selected as worst-case-testing scenario for the waterlines as it tests the waterline system on the present conditions in use. Divergent to the norm, it must be mentioned for the sampling procedure for facility waterlines, that there was no sampling at either the water circulation return or the outlet of the hot-water boiler. Furthermore, we applied a 1 minute interval water rinse to receive water from regions deeper in the water line system. All water samples were subjected to microbiological tests according to Swiss norm SN EN ISO 11731-2:2008-05.
4.2 Findings

- There was no evidence of the presence of *Legionella pneumophila* or *Legionella spp.* in waterlines in the DCUs. Hence there was no observed impact of the age of the DCUs on the *Legionella* contamination result.
- There was evidence for the presence of *Legionella pneumophila* and *Legionella spp.* in waterlines in the facility where the dental surgeries are located.
- In 4 out of the 11 hot water lines of the building there were samples which tested positive to *Legionella pneumophila* and *Legionella spp.* In 3 of them the values exceeded the threshold of 1,000 microbes per litre (FOPH, 2009), indicating a potential contamination of the hot water line.
- In the field of hygiene, as part of quality management, dental surgeries maintain a documentation including risk prevention strategies.
- In 7 out of 10 cases the water temperature measured at the opening of the hot water taps was not greater than 55°C, and so not in accordance with the recommendations of the FOPH. The temperature ranged from 46.9°C to 53.9°C. The fact that the temperature falls below this value is a commonly known and discussed subject amongst technicians and plumbers regarding drinking water hot water lines. This issue is also in line with known discussion on biofilms in waterlines.
- In cases, the dentists did not have in-depth knowledge about their facilities’ water lines, the treatment of the water of their DCUs and the microbiological quality of the water lines in the building in which the surgery located.

5 CONCLUSION

To maintain continuously high hygienic safety and to minimize the risks of contamination by *Legionella*, appropriate hygiene monitoring (qualitative and quantitative) is essential for risk management, which includes prevention measures. It involves national legislation, guidelines, limiting values, and consulting subject-specific professionals to consider generally recognised codes of practice. Preliminary results of this case study suggest that less risk results from water in DCUs, from which aerosols might be released into the indoor environment. Cases of *Legionella* associated with dental treatment are documented in the literature. But *Legionella* infection risks occur in different types of healthcare facilities, not limited to dental surgeries. Risks of *Legionella* contamination potentially occurs in public buildings as well as in private institutions. The question remains, as postulated by ECDC, whether all cases of Legionnaires’ disease are notified to health authorities and whether dental surgeries represent a potentially more hazardous environment compared with other healthcare facilities. National legislation differs from country to country, but the risk of *Legionella* is common to all. To reduce the risk of damage to health, the World Health Organisation’s guidelines for drinking water quality recommend that health care facilities adopt a water safety plan (WHO, 2011) to practice it as a substantial part of their risk management. The use and provision of microbiologically clean water also complies with the generally accepted principles of preventing infection.

In means of our case study, not only assessing potential hazards (e.g. age of DCU, implemented hygiene concept including CPs and hygiene monitoring) is crucial for *Legionella* prevention as it was outlined by KRINKO 2006. Also the raising awareness for potential sources of contamination, the source of contamination itself, the water lines (of the DCUs and of the facility) as well as the knowledge about the latter should be considered by duty holders.

We found evidence for the presence of *Legionella pneumophila* and *Legionella spp.* in waterlines in the facility in which the dental surgeries are located. It leaves open the question ‘Where are
the water lines in dental surgeries assigned to”? For facility water lines (sanitation in private household) in Switzerland there are different thresholds regarding the assessment of a potential contamination compared to those determined for hospitals and other health care facilities, according to the report of FOPH (FOPH, 2009). Appreciating the fact that there was no single pathogen *Legionella pneumophila* detected in all samples of the DCUs, the questions arises about the potential for contamination of the facilities (building) water line system itself.

FM needs to keep an eye on the topic of *Legionella* and water systems of facilities. In FM contexts *Legionella* is a serious and present issue and needs more investigation. Systemic approaches and legal authorities must be considered for identifying the sources, to launch protection strategies and to fulfil long-term responsibilities towards people and the preservation of facilities.

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REFERENCES


