A new hospital infection control strategy

Remote monitoring of a building's drainage and sewer system...

The Dyteqta System is a preventative monitoring system that ensures that there is an adequate seal between the population of a building and the virus/pathogen laden contents of the building drainage and sewer system.

The building drainage system is possibly the only engineered fluid carrying system that interconnects all parts of a building. In a healthcare building this means that there is a system that links wards, laboratories, mortuaries, isolation rooms, operating theatres, public waiting spaces, offices and plant rooms. This extensive pipe network is sealed from the building population, in the main, by a small volume of water in a water trap seal or U-bend. The flows found in building drainage systems are a combination of solid and liquid waste: faecal solids, urine, toilet paper in the main. However other products are commonly discharged into the system; for example, feminine sanitary protection pads, tampons, used condoms and items containing blood are not uncommon items to be found in a building drainage system. Water is used to transport waste from the building and the sewer to a processing plant. As such the building drainage system can be viewed as a rich reservoir of viruses and bacteria.

It might seem obvious that the design of a building drainage system involves sizing the pipe network to facilitate the efficient discharge of the water/solids mixture described above. It is less obvious that the main design consideration is the flow of air and the attendant air pressure regime in the system. The mechanism for airflow in a building drainage system is principally the force at the water/air interface and since the water flow is unsteady in nature, due to the random discharge of appliances, then the airflow and the air pressure are also unsteady. The study of building drainage performance therefore necessitates the study of air pressure transients (surges) in the system.

The protection afforded by the water trap seal is substantial. However it has a number of weaknesses that make it vulnerable. The air pressure transients described above can be of sufficient magnitude and duration to either suck the water out of the water trap seal (negative air pressure transients) or blow the water out of the appliance (positive air pressure transients). Either of these scenarios will result in an empty water trap seal. The water in the trap seal of an unused appliance can also evaporate over time leading to an empty trap. It should be noted that all of the above weaknesses are possible even in a system designed to meet all building regulations and standards and subject to a proper maintenance regime.

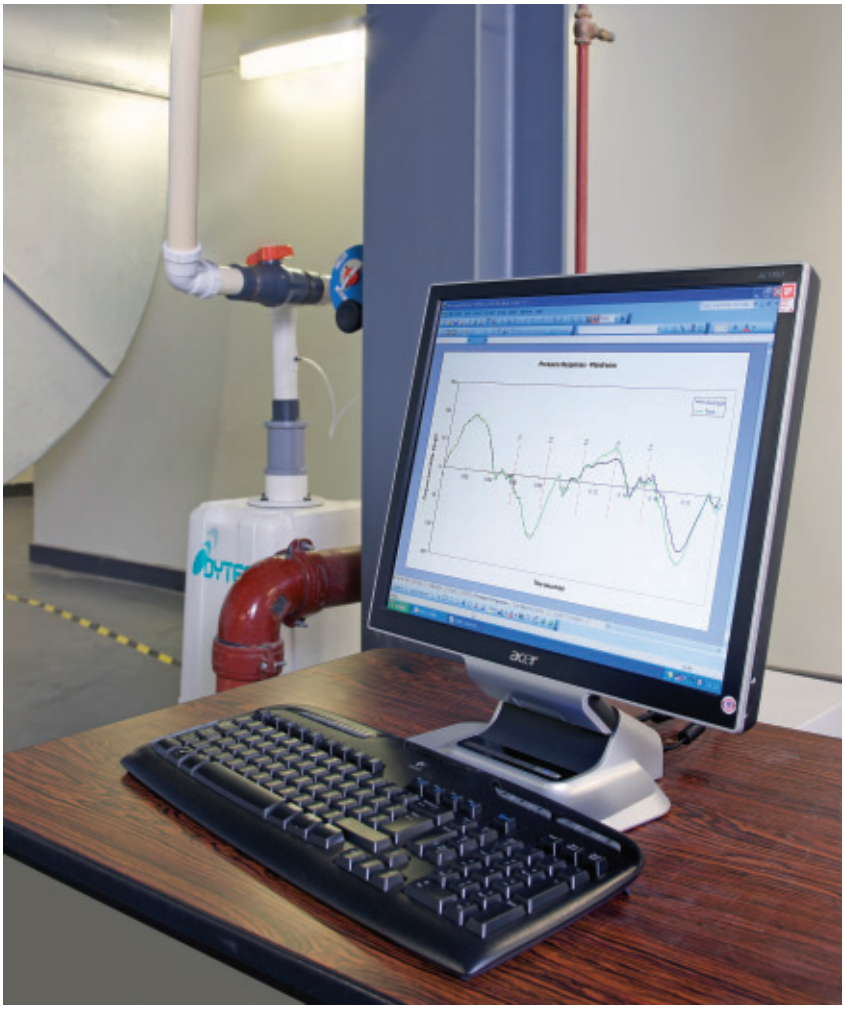
The consequences of an empty water trap seal are that the required seal between the habitable space containing the population of the building and the source of potential infection has been lost. The empty water trap seal also acts as a vent for the system so air can flow into and out of the drainage system thus allowing the possibility of pathogen infected aerosols entering the habitable space. It should be noted that because of the interconnection of the drainage system, infected aerosols can originate in any part of the building, not just in the vicinity of the empty trap.

Extensive work has been carried out to prove that pathogenic microorganisms can be transmitted in airborne aerosols (Hutchison (1956), Darlow and Bale (1959) and Gebra et al. (1975)). Viruses such as adenoviruses, astrovirus, enteroviruses, hepatovirus, norovirus, reoviruses and rotavirus and bacteria such as *Escherichia coli (E. coli), Legionella pneumophila, Salmonella* and *Shigella* passed in the excreta of infected individuals have been found not only to exist within the building drainage system but are also amenable to airborne transmission within aerosolised water particles (Feachem et al. 1983).

The mode of cross infection depends on the route of the infective pathogens once aerosolised. They may either be deposited on surfaces, leading to self-inoculation through hand-to-mouth contact (Hendley et al., 1973), or remain airborne (Couch et al., 1966) and thus spread the disease further afield through ingestion or inhalation by uninfected victims. Airborne transmission, through the transfer of infectious droplets and aerosols, remains the most important mechanism of uncontrollable dissemination of disease and studies have shown that aerosolised pathogens can travel up to 1.5km from source (Parker et al., 1977; Cronholm, 1980).

The Dyteqta System is a sonar-like system for monitoring the state of the seal between the building drainage and sewer system and the healthcare building population and so prevents cross contamination from one part of a hospital to any other.

The equipment introduces a low amplitude, sinusoidally varying, air pressure wave into the building drainage and vent system via a controlled excitation unit installed at the highest point in the buildings drainage network, usually in a plant room. The air pressure wave propagates throughout the system, reflecting from system bound-



aries such as water trap seals, open terminations and other system components. These reflections are recorded by a pressure transducer and data acquisition system located at the control unit. These reflections provide a 'signature' for the state of the system and can be compared to a known good signature that is recorded at commissioning. Signatures are recorded and analysed on a control computer that can be accessed remotely on a scheduled basis. The system therefore reports on the seal between the building drainage system and the hospital population, providing valuable information that could be used to inform hospital infection control strategies. It could also play a significant role in the forensic analysis of historical outbreaks in areas of persistent risk within a building. A change in this signature indicates a change in the state of the system's boundaries; an empty water trap will return a reflection different from that of a full one. The exact location of the anomaly is then automatically calculated and reported to facilities management personnel via email, SMS or existing building management system. A facilities manager can also interrogate the system utilising the intuitive remote web based interface.

The technique incorporated in the Dyteqta System was invented by academics at Heriot-Watt University in direct response to the WHO report into the outbreak of the SARS epidemic in South East Asia in 2003 (Hung et al., 2006, WHO 2003 – Appendix B). It was found that empty water trap seals were a contributor to the rapid spread of the virus in one particular housing block (Amoy Gardens) where there was a higher than expected concentration of cases. There were 321 in total and a significant number of fatalities; 42 people died of the virus in this one housing block alone.

The system is unique in that no such system exists anywhere else in the world. The techniques employed are those most closely associated with sonar tracking systems. Considerable academic research has been carried out to ensure that the technique is repeatable and non-destructive (Kelly et al., 2008, Beattie, 2007). The frequency of the applied air pressure wave has been carefully chosen so as not to cause any disturbance in the water trap seals to be tested. Research has also simplified installation (see Gormley and Hartley, 2009 in Appendix A-1) to ensure the maximum number of appliances can be monitored from a single control unit.

The system is automatic and there is an option to operate and interrogate the system remotely from off-site allowing facilities management greater flexibility. It has never before been possible to collate information on the performance of a building drainage system remotely.

The Dyteqta System is a preventative measure designed to ensure that fewer pathogens and viruses can escape from the significant virus and infected pathogen reservoir of the building drainage and sewer system.

The Dyteqta System really is healthcare for your building.

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