

A short history of infection control in dentistry

Helen Nield, Head of Library and Knowledge Services at the British Dental Association (BDA), provides a snapshot history of infection prevention and control in dentistry.

'First do no harm'

The beginnings of modern infection prevention can be dated to 1847 when the Hungarian physician and scientist Ignaz Semmelweis realised that the reason so many mothers were dying of puerperal fever in his hospital was because doctors were going straight from performing autopsies to delivering babies. When he instructed that hands be washed between the two procedures the death rate dropped dramatically.

For the first time it had been demonstrated that infection could be caused inadvertently by healthcare professionals and that there was a way to prevent this.

Something in the air

At this time it was generally believed that wound infection was caused by a miasma of bad air. However, on 7 April 1864 in front of an audience that included the author Alexandre Dumas, a French biologist called Louis Pasteur proved that microorganisms existed within the air. Glasgow-based surgeon Joseph Lister (Fig. 1) immediately saw the significance of this.

In a series of articles in *The Lancet*¹ and the *BMJ*² in 1867 he described how these 'microbes' could be prevented from causing infection by the cleansing and covering of a wound with a carbolic acid (phenol) soaked rag and carbolic acid, linseed oil and carbonate of lime putty mixture. He reported that nine months since the introduction of this treatment into his surgical wards at the Glasgow Royal Infirmary 'not a single instance

of pyaemia, hospital gangrene or erysipelas has occurred in them'.²

Although not universally accepted for many years, the idea of antiseptics was taken up and reported on in 1876 by a London dentist, Ashley Barrett. In a paper read before the Odontological Society of Great Britain he described how he used the practice in root canal therapy by cleaning and then filling the pulp cavity and 'interior of the fangs' with 'wool dipped in carbolic acid' followed by the placement of a permanent metal filling over the top, 'thus preventing further putrefaction'. He further went on to describe how he treated 'chronic periodontitis' (a term he used to describe chronically infected pulps and dental abscesses) by a course of carbolic acid used to 'mop out the interior of [a] tooth', following the release of 'products of decomposition' from the walls of the pulp cavity. Thus he demonstrated the prevention of putrefaction of the dental pulp after devitalisation by arsenic and showed the arrest of putrefaction of the dental pulp when once established and so 'directly curing periodontitis'.³

A glove story

Lister, following Semmelweis, also advocated the disinfection of the hands of operators. This took an obvious toll on the skin. After American surgeon William Halsted's scrub nurse Caroline contracted severe dermatitis as a result he decided in the winter of 1889-90 that 'As she was an unusually efficient woman' he would request the Goodyear Rubber Company to make 'as an experiment two pair of thin rubber gloves with gauntlets'.⁴ These were so successful that not only did he later marry her but the wearing of gloves by theatre assistants became increasingly commonplace. Surgeons did not start wearing them until Dr Joseph Bloodgood published a report in 1899 showing that after he had tried it there was a subsequent near 100% drop in the infection rate following hernia operations performed by him over a year.⁴ Despite this, sterilisation of hands is in evidence in dentistry but not gloves as can be seen from the minutes of the National Dental Hospital in London in 1900 where dressers are told to dip their hands in 'perchloride of mercury' before putting their fingers into mouths⁵ (Box 1).



Fig. 1 Joseph Lister in a surgical ward at King's College Hospital, 1890. BDA Museum Collection

Syphilis and dental instruments

Lister had also argued for the disinfection of surgical instruments, but this was not widely practised. In 1891, the American dentist Willoughby Dayton Miller published *The disinfection of dental and surgical instruments*⁶ after a growing concern that syphilis was being spread as a result of dental care. Some of his recommendations were that 'Napkins' and rubber dams should be boiled although he wasn't a fan of the

reuse of the latter. Instruments could not be sterilised by dry heat because of the length of time it took and after much experimentation with chemicals he concluded that the best means of sterilisation for them also was boiling water (Fig. 2). In this article he also asserted that 'whatever method of disinfecting we may use, the instruments should first be cleaned mechanically'⁶ and thus was one of the earliest to recognise that reducing the 'bioburden' on the instruments

greatly facilitated the effectiveness of the sterilisation procedure.⁷

The autoclave had been invented by microbiologist Charles Chamberland and Louis Pasteur in 1879 as a means of sterilisation by steam but was not widely used until following a 1952 World Health Organisation panel (brought together to address the public health problem of hepatitis) also recommended that chemical disinfectants should not be used for invasive surgical instruments. The cost of autoclaves fell throughout the 1950s and so became increasingly affordable for the general dentist.

What's in an aerosol?

The knowledge that aerosols affect people and their surroundings is not new. Lister used a machine that sprayed aerosols of carbolic acid to create an antiseptic operating environment. As far back as 1884, Robert Koch showed the adverse effect of oral aerosols by proving that tuberculosis could be transferred by aerial droplets from the oral cavity and respiratory tract.⁸ Later, in 1891, the 'toxic properties of saliva' were referred to by W. D. Miller (Fig. 3) in a series of articles in *Dental Cosmos* about the mouth as a focus of infection.⁹

The consequences of this for dentists were not appreciated until in 1931 a report by the Registrar General of Great Britain showed that 'airborne infection and incidence of tuberculosis was higher for dentists than for people engaged in other occupations'.¹⁰ Despite this nothing was done to protect the dental team until the introduction of ultrasonic scalers and the high-speed turbine engine in the late 1950s finally stimulated proper research into dental aerosols which led to a number of recommendations including:

- 'Water-on' air rotor method
- Rubber dam use
- Good ventilation
- Reduction of residual water accumulation
- Preoperative mouth rinse
- Masks and glasses
- High velocity suction next to the handpiece
- Disinfection of burs
- Wiping down of all knobs, handles, armrests etc between appointments
- Spraying of the operating area at the end of the day.⁸

The 1980s – a watershed

The 1980s saw the emergence of HIV/AIDS and this along with the increasing prevalence of hepatitis B and C led to the introduction of sharps management procedures and the more widespread adoption of barrier

Box 1 Taken from the National Dental Hospital and School Minutes 1900. As reproduced in: Donaldson J A. National Dental Hospital 1859-1914. p 74. BDJ Publishing, 1992⁵

In order to thoroughly carry out aseptic measures in the extracting rooms we recommend the following purchases.

1. Aseptic moveable instrument table
2. Two porcelain dishes
3. Two Macintosh aprons
4. Two big jars with taps to be placed on a shelf for solutions of perchloride of mercury and carbolic acid
5. Two basins for dressers hands
6. White blouses for anaesthetists, house surgeons and dressers
7. One pair of Read's upper and lower forceps and one pair of full lower molar forceps

We recommend the following instructions to be printed for display in the extraction room of the hospital

1. All dressers to wear a blouse
2. Hands to be washed and nails scrubbed continually during the morning
3. Before placing fingers in the mouth, dressers are to dip their hands in basins containing 1:1000 solution of perchloride of mercury.
4. The junior dressers to clean each instrument, including mouth props after each extraction in the following manner; all instruments to be first washed with running water, then placed in a steriliser for 3-4 minutes and afterwards dipped in 1:4 solution of carbolic acid.
5. We also suggest an instrument maker be employed to send a man once a week to see that the instruments are kept in a proper condition and that the Hall Porter's assistant attaches fresh strings to the mouth props every morning.



Fig. 2 Hot water steriliser heated by oil burners, c. 1890s. BDA Museum Collection

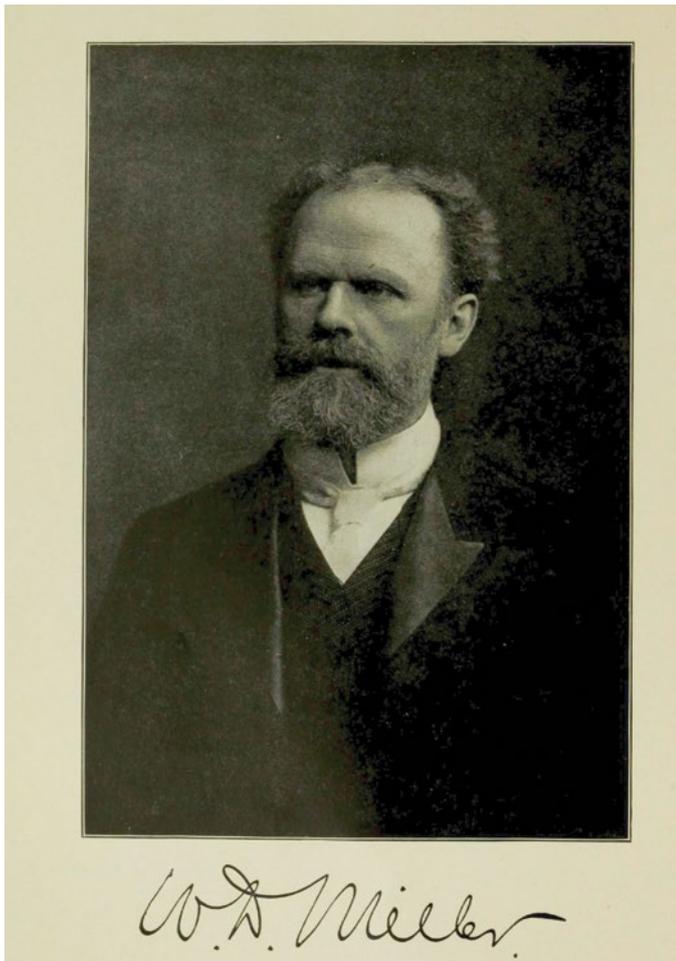


Fig. 3 W. D. Miller pictured in Dental Cosmos, 1907



Fig. 4 MTD HARVEY® Chemiclave 5000 chemical vapour autoclave. BDA Museum Collection

protection and use of autoclaves (Fig. 4) rather than boiling water for instrument sterilisation. Another problem, that of biofilms in water in practices, was highlighted by M. V. Martin in 1987 in an article which showed that microorganisms ‘could be transferred to patients as a result of dental treatment’ via the Dental Unit Water Supply (DUWS).¹¹ This led to the introduction of anti-retraction valves and various measures to improve the quality of DUW levels such as the use of bottled water and regular flushing and disinfection of units.¹²

Where are the guidelines?

Up to this point there had been very few guidelines for dentists with dental practices very much left up to their own devices. British Dental Association (BDA) members did at least have advice sheet A12 on ‘The Control of Cross Infection in Dentistry’ from 1991 which became the most requested advice sheet because there was nothing else like it. The fear of prions would change all that.

In the late 1990s human cases of vCJD

were diagnosed, caused by the consumption of beef infected with the prion-mediated disease, BSE. Although there have been very few cases diagnosed since the year 2000 the fact that it can be transmitted orally and was found to be present in dental pulp in animal studies led directly to the first major UK guidelines on infection control in dentistry: *Decontamination in primary dental practices (HTM 01-05)*. These were published first in 2009 by the English Department of Health, modified in 2013¹³ and influenced later documents produced in the other UK countries. Their main impact, other than to provide the dental team with a set of infection prevention rules to follow, was in the mandatory single patient use of endodontic reamers and files to mitigate against prion transmission. There was a great emphasis on single-use instruments for other procedures and the washing and rinsing of instruments prior to sterilisation – not that the latter was a new idea! The guidelines covered a whole range of standard infection prevention protocols such as:

- Instrument cleaning and decontamination

of instruments, equipment and surfaces

- Sterilisation
- Hygiene
- Personal protective equipment (PPE)
- Standards of equipment and water systems.

COVID-19

Personal protective equipment is not a new phenomenon. We have grown up seeing images of the beaked plague doctors of the past (Fig. 5). A Colorado doctor recently published his thoughts on this medieval figure with its grotesque beak with head covering, covered eye holes, waxed robe and cane before and after his first approach to a patient dressed in similar garb of hazmat suit, gloves, goggles, and respirator mask (Fig. 6). At the guilt he felt at barricading himself away from his patient but at the same time the necessity for it and subsequent appreciation by the patient despite the distancing protective garb.¹⁴

This history of infection prevention has led us up to where the profession sits now – in the midst of a pandemic but with the tools it needs to prevent infection to and from



Fig. 5 A physician wearing a seventeenth century plague preventive costume. Watercolour. Credit: Wellcome Collection. Attribution 4.0 International (CC BY 4.0)



Fig. 6 Noor Al-Helou, a foundation dentist in full PPE ready to treat a patient today. Image published in *BDJ Team*: <https://www.nature.com/articles/s41407-020-0371-4> (17 July 2020)

the patient using what W. D. Miller called 'the rock upon which the edifice of modern surgery is founded',⁵ asepsis and antisepsis.

In exploring the history of infection prevention it can be seen that all its tenets were discovered or rediscovered in the nineteenth century and yet it took over a century for these findings to become everyday procedure. It is that procedure built on an accumulation of evidence that will protect both patients and the dental team now and in times to come.

References

1. Lister J. On a new method of treating compound fracture, abscess, etc.: with observations on the conditions of suppuration. *The Lancet* 1867; **89**: 326-329, 357-359, 387-389, 507-509; **90**: 95-96.
2. Lister J. On the antiseptic principle in the practice of surgery. *Br Med J* 1867; **2**: 246-248.
3. Barrett A W. Decomposition of the dental pulp the cause of periodontitis. *Transactions of the Odontological Society of Great Britain* 1876; **VIII**: 46-52.
4. Latham S R. Caroline Hampton Halsted: the first to use rubber gloves in the operating room. *Proc (Bayl Univ Med Cent)* 2010; **23**: 389-392.
5. National Dental Hospital and School Minutes 1900. In: Donaldson J A. *National Dental Hospital 1859-1914*. p 74. *BDJ Publishing*, 1992.
6. Miller W D. The disinfection of dental and surgical instruments. *Dental Cosmos* 1891; **33**: 514-526.
7. Fulford M R, Stankiewicz N R. *BDJ Clinician's Guide. Infection control in primary dental care*. Springer, 2020.
8. Lu D P, Zambito R F. Aerosols and cross infection in dental practice--a historic view. *Gen Dent* 1981; **29**: 136-142.
9. Miller W D. The human mouth as a focus of infection. *Dental Cosmos* 1890-1; **33**: 689-713, 789-804.
10. Registrar General, Great Britain. *Death from respiratory tuberculosis*. HM Printing Office, 1931.
11. Martin M V. The significance of the bacterial contamination of dental unit water systems. *Br Dent J* 1987; **163**: 152-154.
12. Pankhurst C L, Coulter W A. *Basic guide to infection prevention and control in dentistry, 2nd edition*. Wiley-Blackwell, 2017.
13. Department of Health. *HTM 01-05: Decontamination in primary care dental practices*. Department of Health, 2009 and 2013. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/170689/HTM_01-05_2013.pdf (accessed 6 August 2020).
14. Earnest M. Perspective – on becoming a plague doctor. *NEJM* 20 May 2020. Available at: <https://www.nejm.org/doi/full/10.1056/NEJMp2011418> (accessed 6 August 2020).

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