Using marker pens on patients: a potential source of cross infection with MRSA

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ABSTRACT

INTRODUCTION Marker pens are widely used in surgery but pre-operative marking of patients may be a cause of bacterial cross-infection.

PATIENTS AND METHODS Two experiments were performed to assess whether marking pens can be cause of cross-infection: (i) 26 indelible marker pens were collected from surgical wards for analysis; and (ii) 'fresh' as well as 'dry' (artificially dried by removing cap and exposing tip for 2 h) new permanent marker pens, and whiteboard marker pens were inoculated by dipping the tips into various concentrations of methicillin-resistant *Staphylococcus aureus* (MRSA). Each pen was inoculated onto 2 blood agar plates at 0 (immediately after inoculation) to 30 min at various intervals, 4 h and 24 h. The plates were incubated for 18 h at 35°C in an incubator.

RESULTS Of 26 pens collected from the wards, 2 cultured Micrococci spp. (skin commensals). The constituents of new 'fresh' pen tips rapidly kill MRSA – in all cases by 4 h, but usually within minutes. At high inoculum concentrations, MRSA is not killed immediately. Dry marker pens harbour MRSA for at least 30 min and probably longer.

CONCLUSIONS Marker pens can act as fomites for nosocomial infection. The ethanol-based ink in permanent marker pens has a bactericidal action against MRSA that starts within seconds, and they are likely to be safe to use with a gap of at least 2 min between patients. Usually, harmless skin commensals are not pathogenic except in immunocompromised patients. Old or dried-out marker pens can harbour pathogens and should be discarded before attempted use on patients. We recommend disposable markers for the immunocompromised and patients with a known positive MRSA status.

KEYWORDS

Marker pens – MRSA – Surgical marking – Correct site surgery – Nosocomial infection – Pre-operative marking

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Use of indelible marker pens is common place in surgical practice. Their use has been advocated in the *Correct Site Surgery* document issued by the UK NHS national patient safety agency in 2005.¹ Marker pens may be a source of nosocomial infection as they are used without knowledge of, or regard to, patients' infection or colonisation status. Furthermore, as well as use for indicating operative site or surgical incision sites, marker pens are used directly on or around infected areas, for example, to mark out areas of cellulitis.

Hospital equipment such as stethoscopes, writing pens, tourniquets, and otoscopes have been shown to act as fomites, and thus potential sources of cross-infection in a number of studies.^{2–4} However, few reports have been published on permanent marker pens.^{8–10}

The aim of this study was to assess the potential for cross-infection by *Staphylococcus aureus* (MRSA) from the use of permanent marker pens between different patients.

Patients and Methods

Twenty-six permanent marker pens (of brands Penflex, Pentel, Guilbert, Niceday, and Edding) were collected, 21 from the surgical wards and 5 from surgical doctors within our hospital. The pen tips were sampled by both 'writing' with the tip on an agar surface for one set of culture plates and rolling the side of the tip across the agar for the other set. Aerobic culture of the blood agar plates was undertaken at 37°C in a CO₂ incubator and examined for growth at 24 h and 72 h.

Three different concentrations of *S. aureus* NCTC 12493, a methicillin-resistant strain (MRSA) commonly used in clinical laboratories, was used to perform the remaining parts of the experiment, at concentrations of 10^3 , 10^4 and 10^5 colony forming units (CFUs)/ml. These concentrations were chosen based on different *S. aureus* concentrations on intact living skin: 10^2 – 10^5 CFUs/cm² on areas such as the forearm and leg, to 10^5 CFUs/cm² on the soles of the feet, axillae, forehead, and scalp.⁵ Four permanent marker pens (Pentel N50) were inoculated by dipping into one of the MRSA concentrations for approximately 1 s. One pen was used as the control and, therefore, not inoculated. Each pen was used to inoculate two blood agar plates using the methods previously described at 0 h (immediately after inoculation), 4 h, and 24 h and the plates incubated for 18 h at 35°C in a CO₂ incubator.

The 10^5 CFUs/ml concentration of the same MRSA strain was used to inoculate 8 new permanent marker pens (Pentel W10), 8 new whiteboard (non-permanent) marker pens and 1 'dry' permanent marker pen (cap removed and tip exposed for 2 h). Each pen was inoculated onto blood agar plates at set times: 0 (immediately after inoculation), 1, 2, 3, 4, 5, 10, and 30 min. Different 'fresh' and whiteboard marker pens were used each time to avoid the dilutional effect of repeated sampling. The inoculated plates were incubated for 18 h and 48 h at 35°C in a CO₂ incubator. The single 'dry' marker pen was sampled at all the set times.

Results

Of the 26 pens collected from our hospital, no growth was found after 24 h. After 72 h, two of the pens cultured were positive for *Micrococci* spp. The remaining pens did not show any bacterial growth after 72 h of incubation.

Two of the permanent pens inoculated with various MRSA concentrations, cultured positive at 0 min with higher concentrations of MRSA (10^4 and 10^5 CFUs/ml). However, the constituents of the pen tips rapidly killed the MRSA, in all cases by 4 h (Table 1).

Analysis of the various pen types over a shorter time-scale showed that the dry pen grew MRSA at all stages (0–30 min) whereas the whiteboard marker was positive at 0 min and 1 min only. In contrast, MRSA was not cultured at any time from the 'new' permanent marker pens (Table 2).

Discussion

Nosocomial infections occur at a rate of 5–10 per 100 admissions and are associated with significant morbidity, mortality and healthcare costs.⁶ It is a significant source of anxiety for patients, and has an unquantifiable effect on public perceptions of the healthcare system through regular features in the media. It has been estimated that one-third

Table 1 Growth from 'fresh' permanent marker tips at different concentrations of MRSA at 0, 4, and 24 h

'Fresh' permanent marker pen	Time from inoculation with MRSA		
	0 h	4 h	24 h
Control (no MRSA)	No growth No growth	No growth No growth	No growth No growth
Pen 1 (~ 10^3 CFUs/ml)	No growth No growth	No growth No growth	No growth No growth
Pen 2 (~ 10^4 CFUs/ml)	No growth 2 colonies	No growth No growth	No growth No growth
Pen 3 (~ 10^5 CFUs/ml)	11 colonies 60 colonies	No growth No growth	No growth No growth

of all nosocomial infections may be preventable.² Organisms causing particular concern include MRSA, vancomycin-resistant enterococci (VRE) and multi-resistant pseudomonas.⁶

A variety of hospital equipment has been identified as a vector for potentially harmful organisms (fomites). These include stethoscopes, writing pens, thermometers, tourniquets, and auroscopes.^{2–4} MRSA has been isolated from stethoscopes, otoscopes, and writing pens and VRE has also been isolated from writing pens.^{2,7}

To our knowledge, only three studies have investigated marker pens as a source of nosocomial infection. Wilson and Tate¹⁰ performed a laboratory experiment comparing two brands of permanent marker pens. Thirty-one Viomedex (VIO Health-care Ltd, Uckfield, UK) and 30 Penflex pens (Penflex, Cape Town, South Africa) were contaminated with MRSA (concentration not stated) and incubated for 0–60 min, 24 h and 5 weeks. No MRSA was grown from the Penflex pens after 15 min whereas Viomedex pens grew MRSA for 1 week after contamination. They attributed this difference to the different solvents used in the pens. Kane *et al.*⁸ analysed 16 marker pens (Guilbert PM75) from orthopaedic wards and showed no bacterial growth after 48 h of incubation. Furthermore, they showed no growth from marker pens used on healthy volunteers. They concluded that the ethanol-based ink used in marker pens has antibacterial activity and is effective in preventing cross infection. Thomas *et al.*⁹ did culture organisms (not specified), but not MRSA, from 8 used pens collected from orthopaedic wards. Marker pens were inoculated with 'different' concentrations of MRSA, and were sampled at 0–10 min only. They

Table 2 Growth of MRSA from the three types of pen tips at 0–5, 10, 30 min

Minutes after inoculation	'Fresh' permanent marker pen	Whiteboard marker pen	'Dry' permanent marker pen
0	No growth	> 500 colonies	> 500 colonies
1	No growth	3 colonies	150 colonies
2	No growth	No growth	26 colonies
3	No growth	No growth	16 colonies
4	No growth	No growth	15 colonies
5	No growth	No growth	1 colony
10	No growth	No growth	2 colonies
30	No growth	No growth	1 colony

concluded that a 10-min interval should elapse between marking of patients and that pens more than 3 months' old should be discarded as they increase the risk of transmitting of pathogens.

The culture of micrococcus in 2 of the 26 pens in our study confirms that clinically used marker pens can harbour bacteria. Micrococci are Gram-positive, aerobic bacteria which are common commensals of human skin.⁵ However, skin is also a source of less innocuous organisms including *S. aureus* and MRSA, which can cause significant morbidity and, occasionally, mortality. Infection of skin with *S. aureus* has been suggested to occur when the inoculum exceeds 10^6 , unless a foreign body (*e.g.* suture or implant) is present.⁸

At high concentrations of MRSA (10^5 CFUs/ml), both 'fresh', and 'dry' permanent and fresh whiteboard marker pens can all potentially transmit pathogens. The whiteboard marker sustained the organisms for 2 min, whereas the dry permanent marker sustained MRSA even at 30 min. Ethanol-based ink used in permanent marker pens is known to have antibacterial activity that can help prevent cross-infection.⁹ The age, degree of usage and tip exposure to the environment can all reduce the ethanol content of the pen tips. This is demonstrated by the increased growth of MRSA from the 'dry' markers compared to the 'fresh' pens. Whiteboard markers are not ethanol based and so have less bactericidal action.

Surveillance studies have shown that up to 7.3% of patients admitted to hospital may carry MRSA, with the percentage being higher in the elderly, those recently hospitalised, and those transferred from other institutions.^{10,11} Marker pens are used for a variety of purposes on patients without, or regardless of, the knowledge as to what potential organisms are colonising their skin.⁹ If present in a suit-

ably high concentration in the marked area, skin flora as well as more harmful pathogens such as MRSA can be transmitted, but this is very unlikely with fresh marker pens with a small time interval between usage. However, disposable marker pens would seem to be a sensible precaution when used on patients with known colonisation with MRSA or with suspected or on-going infections. Old 'dry' permanent markers are hazardous, with significant potential for cross infection. Immunocompromised patients are at particular risk of infection with skin commensals, MRSA, and other pathogens. Therefore, disposable markers are recommended for all patients, especially the immunocompromised (*e.g.* transplant, leukaemia, and AIDS patients and in 'clean' hospital areas, such as bone marrow and chemotherapy units).

White board markers are sometimes used inadvertently or if permanent markers are unavailable. Although ineffectual in their task, they pose less of a risk of bacterial cross-infection than 'dry' markers.

The viability of other organisms, including many other bacteria, viruses and fungi, on the tips of permanent markers remains unknown. However, it is likely that these organisms will have a viability profile similar to that found within the equivalent concentration of ethanol as contained in permanent marker pens.

Conclusions

Marker pens can act as fomites for nosocomial infection. Permanent marker pens have a bactericidal action against MRSA that starts within seconds, and they are likely to be safe to use with a gap of at least two minutes between patients. However, we recommend disposable markers for immunocompromised or MRSA patients to prevent cross-

infection. Old or dried-out marker pens can harbour pathogens and should be discarded before attempted use on patients.

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