

Do Skin Marker Pens Transmit Infection between Patients?

GARGESHWARI RAGHAVEDRA, MANDY LYALL, ROOPA SREENIVASA, NEIL MCLEAN, MAGDI YOUSSEF & TAMSIN OSWALD

Keywords: *Infection control; Surgery, equipment*

We have conducted a laboratory study to see whether there is a potential for cross infection from skin marker pens between surgical patients. A turbid suspension of Meticillin Resistant Staphylococcus Aureus (MRSA) with $6-7 \times 10^8$ colony forming units (CFU) ml⁻¹ was inoculated onto marker pen tips simultaneously; the caps were replaced and the pens incubated at room temperature awaiting inoculation. Columbia blood agar (CBA) plates and brain heart infusion (BHI) broths were inoculated at 0, 5, 10, 20, 30 and 60 minutes and the results read by a qualified biomedical scientist using standard techniques.

No growth was found at 5 minutes in the permanent marker and by 20 min in the surgical markers in CBA. There was no growth at 5 minutes in both the permanent and the surgical marker pens in BHI+CBA.

Under strict laboratory conditions, one of the standard marker pens used in our clinical practice is bactericidal within five minutes of use and hence, there is an almost negligible risk of bacterial transmission to another patient. Also, direct plating onto CBA plates produced higher yields of viable bacteria than by pre-inoculation in BHI prior to plating on CBA.

Introduction

Healthcare Associated Infections (HCAI) may develop in up to 9% of patients and can result in significant morbidity and mortality¹. Management of HCAI is a major burden on the NHS resources with communal equipment such as stethoscopes, auroscopes, blood pressure cuffs and marker pens, being potential modes of transmission of pathogens²⁻⁴. Both the Royal College of Surgeons⁵ and The National Patient Safety Agency⁶, recommend pre-operative marking of the site and side of operation, for the safety of patients and to alert the theatre staff. However they offer no guidance on the type of pen to be used or whether the pen should be disposable or non-disposable.

Ballal and coworkers showed⁷ that dry white-board marker (DWM) pens are unsafe for use in surgical marking as they retain viable bacteria for a significant time, with 100% of pens showing positive growth at 10 minutes. They also suggested a safe interval of 10 minutes when using the same permanent marker pen on multiple patients, as none of the used permanent marker pens had viable bacteria after 10 minutes of use. Tadiparthi et al⁸ demonstrated that permanent marker pens have a bactericidal action against MRSA that starts within seconds, and are therefore likely to be safe to use with a gap of at least two minutes between patients. However they recommended using disposable marker pens in MRSA positive and immunocompromised patients, to prevent cross infection. Many of the other studies on the role of skin marker pens

are potentially flawed. For example Wilson⁹ did not state the concentration of MRSA used and Thomas¹⁰ did not specify the organism grown. To our knowledge there is no published literature on how many of these marker pens carry infection after a single use.

In a preliminary ward based study carried out in our institution, we found that when 5 control samples of surgical markers and permanent markers pens were sent to the laboratory after a single use, there was no growth of bacteria. In view of the transit time taken between the ward and the microbiology laboratory and the potential for bactericidal destruction giving a false negative result, we decided to investigate the potential for cross infection in a laboratory based study by inoculating the tips of marker pens with MRSA, and then plating and culturing samples to review subsequent bacterial growth.

The aim was to determine firstly, the maximum transfer time between the inoculation of the pen and its plating for culture in the laboratory and secondly to assess the optimal culture medium for the common skin pathogen MRSA.

Authors' Addresses

GARGESHWARI RAGHAVEDRA Clinical Research Fellow
 MANDY LYALL Biomedical Scientist*
 ROOPA SREENIVASA Specialist Registrar**
 NEIL MCLEAN Consultant Plastic Surgeon
 MAGDI YOUSSEF Consultant Breast Surgeon
 TAMSIN OSWALD Consultant Microbiologist
 Department of Surgery, Wansbeck General Hospital, Woodhorn Lane, Ashington, Northumberland.
 * North Tyneside General Hospital ** Sunderland Royal Hospital

Materials and methods

Two brands of marker pens commonly used in our clinical practice were chosen for the study. The first was the Leonard Lang® disposable single use surgical marker pen and the other the Niceday® permanent marker with a bullet point of 1–3mm. Unused pens were employed. A turbid suspension of *S. aureus* NCTC 12493 (a methicillin resistant *Staphylococcus aureus* [MRSA] strain) was made up in saline to a McFarlane standard of 3 approximating to a concentration of $6-7 \times 10^8$ colony forming units (CFU) ml⁻¹ of solution. The tips of the marker pens were then contaminated with 100µl of this suspension, the tops were replaced and the pens were then incubated at room temperature awaiting plating and culture.

The standard culture plates used were Columbia Blood Agar (CBA) and Brain Heart Infusion (BHI) broth was used for enrichment culture (E&O Laboratories Ltd). The latter was used as it is known to enhance bacterial growth of common skin pathogens. A 10µl loop (Starstedt®) was used to streak the colonies onto the culture plates.

CBA plates and BHI broths were inoculated at 0, 5, 10, 20, 30 and 60 minutes after contamination. A single pen was used for each time point and each inoculation medium to prevent dilution effects. Each time point was repeated 5 times giving a total of 120 pens in the study. To ensure quality control, one drop of the solution was used to inoculate control CBA plates and BHI broths at the beginning and the end of the experiment to ensure that the organisms were viable and to quantify the number of bacteria present.

CBA agar plates were incubated overnight at 37°C in 5% CO₂, while the BHI broths were incubated overnight at 37°C, from which 10µl of the broth was inoculated onto a CBA the following day, spread for single colonies and incubated in the same way. The results were read by a qualified biomedical scientist and marked using a standard laboratory method with – showing no growth, + indicating growth in the initial inoculum streak, ++ indicating

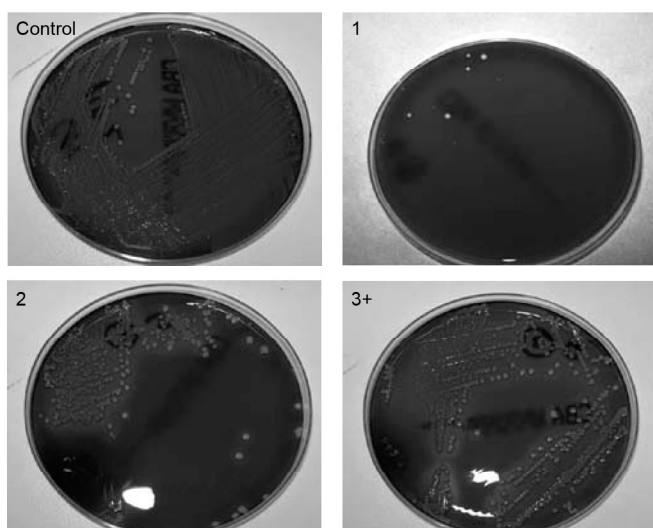


Figure 1: Grading of bacterial growth on culture plates.

growth in the second and third inoculum streaks, and +++ showing growth in the fourth inoculum streak (Figure 1). The results were also compared with the growth in the control CBA plate

Results

Table 1 shows the results of the cultures, both with the Leonard Lang® Disposable marker pens and the Niceday® Permanent marker pens. No evidence of growth was demonstrated with the Niceday® pens after 5 minutes, while the Leonard Lang® pens showed a reducing growth that was finally absent after 20 minutes.

Discussion

Healthcare Associated Infections (HCAI) are an important cause of morbidity and mortality in the National Health Service (NHS) and are not only a significant drain on NHS resources but are also sensationalised in the media. The combined annual cost of managing HCAI was over £120 million for all 170 NHS trusts in United Kingdom for the year 2007/1. This funding is being diverted from frontline services, thus it is important to know if communal equipment such as marker pens, act as fomites (an object or substance capable of carrying infectious organisms). Many of the previous studies on skin marker pens have been flawed for a number of reasons. In some there has been a time delay in the transfer of the skin marker pen to the laboratory⁴, which as we demonstrated in our pilot study, may have a significant effect in reducing the number of viable bacteria on the pen tip. In others, neither the culture medium used in the laboratory nor the organism grown has been specified⁴, the same pen tip has been used for multiple plating episodes and the pen tip rather than the more accurate 10ul loop has been used for the streaking of the colonies⁷, leading to the potential for inaccurate results. The average bacterial colonisation of *Staphylococcus aureus* in the scalp, axilla and groin is 10^5 CFU cm⁻²¹². The concentration of our test suspension used in this study, was $6-7 \times 10^8$ CFU ml⁻¹, which was 7,000 times more concentrated than the average skin count. Allowing for the fact that we contaminated the pens with 100µl of this suspension, we used a concentration of bacteria 700 times more potent than the normal skin colonisation and showed that there was no bacterial growth at either 5 minutes on the permanent marker pen, or at 20 minutes on the surgical marker pen on the CBA plates. There was no growth at 5 minutes in both types of marker pen in BHI+CBA. The BHI did not have the potential increasing for the growth as had been expected and this may be as a result of some of the pen reservoir fluid contaminating the BHI broth during inoculation and thus leading to a subsequent reduction in bacterial activity. These results also confirm that any time delay, no matter how short, between pen use and transport to the microbiology laboratory, significantly affects the outcome. The bacterial growth is also affected by the type of culture medium used. Direct inoculation on a CBA plate resulted in better growth than initial inoculation in to BHI.

Table 1 Bacterial growth on the marker pens over time periods .

		Leonard Lang® Disposable Surgical Marker		Niceday® Permanent Marker	
		CBA	BHI + CBA	CBA	BHI + CBA
	Controls	+++	+++	+++	+++
Time	0 min				
Pens	1	+++	+	+++	+++
	2	+++	+	+++	
	3	+++	-	+++	+
	4	+++	-	+++	-
	5	+++	+	+++	++
Time	5 min				+
Pens	1	++	-	-	++
	2	++	-	-	
	3	-	-	-	-
	4	-	-	-	-
	5	+	-	-	-
Time	10 min				
Pens	1	-	-	-	-
	2	-	-	-	-
	3	+	-	-	-
	4	-	-	-	-
	5	+	-	-	-
Time	20 min	No growth			
Time	30 min	No growth			
Time	60 min	No growth			

This current study was done under very strict laboratory conditions and we found the pens to be potentially bactericidal. This property of the pen could be as a result of the high alcohol content in the reservoir, due to properties of the dye itself or there could be other agents in the reservoir fluid that makes the pens bactericidal. To date, the manufacturer of the Niceday® permanent marker pen have informed us only, that the reservoir contains 60–70% of alcohol. We have requested more information on the other potential constituents of the fluid, but to date, have not received a reply. The Leonard Lang® disposable pen contains isopropanol (less than 50% by weight) and gentian violet (less than 10% by weight) both of which are known to be bactericidal. We believe that the higher concentration of alcohol in the permanent marker pen may be one of the main reasons that it was found to be the more bactericidal of the two pen types. We also noted that the size pen tip of the permanent marker pen was bigger, allowing for more

reservoir fluid to be present at the tip, thus potentially contributing towards the increased bactericidal activity.

Use of a permanent marker pen for skin marking may be potentially open to criticism given the employment of an item that is neither specifically designed nor marketed for this activity. Skin tattooing has been known to occur if permanent markers are used on broken or cut skin for the purpose of amateur tattooing. If used on intact skin, permanent marker pen ink tends to wash away with alcohol very easily and there is no reported incidence of permanent skin tattooing. Similarly, there is no evidence that the present day permanent markers can cause any form of harm to the skin.

In conclusion therefore, the current study has shown that under very strict laboratory conditions, one of the standard marker pens used in our clinical practice, the Niceday®

permanent marker, is bactericidal within five minutes of use and hence the risk of bacterial transmission from patient to patient is insignificant. An investigation into the details of the individual constituents of the reservoir ink is ongoing, to determine which of these is responsible for the bactericidal action and we await further information on the contents of the pen's reservoir fluid from the manufacturer.

References

1. National Audit Office. *The prevention, management and control of healthcare associated infections in Hospitals in England*. (Available from http://www.nao.org.uk/publications/o809/reducing_healthcare_associated.aspx)
2. Beni S, Barzilai A. Stethoscopes and otoscopes – a potential vector of infection? *Family Practice* 1997;**14**:446–9.
3. Datz C, Jungwirth A, Dusch H. What's on doctors' ball point pens? *Lancet* 1997;**350**:1824–4.
4. Wilson M. *Microbial inhabitants of humans: their ecology and role in health and disease*. Cambridge: Cambridge University Press, 2005, 82–7.
5. Royal College of Surgeons of England. Surgical site marking. (Available from: http://www.rcseng.ac.uk/rcseng/content/publications/docs/patient_briefing.html . Royal college of surgeons of England, London.
6. WHO Surgical Safety Checklist, Alert: NPSA/2009/PSA002/U1, 27 January 2009. (Available from: www.npsa.nhs.uk/)
7. Ballal MS, Shah N, Ballal M, O'Donoghue M, Pegg DJ. The risk of cross-infection when marking surgical patients prior to surgery-review of two types of marking pens. *Annals of the Royal College of Surgeons of England* 2007;**89**:226–8.
8. Tadiparthi S, Shokrollahi K, Juma A, Croall J. Using marker pens on patients: a potential source of cross infection with MRSA. *Annals of the Royal College of Surgeons of England* 2007;**89**:661–4.
9. Wilson J, Tate D. Can pre-operative skin marking transfer Methicillin-Resistant Staphylococcus Aureus between patients? A laboratory experiment. *Journal of Bone and Joint Surgery, (British)* 2006;**88**:541–2.
10. Thomas RJ, Goodbourne C, Goldie B. The transmission of MRSA via orthopaedic marking pens – fact or fiction? *Annals of the Royal College of Surgeons of England* 2004;**86**:51–2.
11. Kane TPC, Greig M, Grover ML. Can the tips of marker pens act as a source of cross-infection? *Annals of the Royal College of Surgeons of England* 2003;**85**:71–3.
12. Banerjee D, Fraise A, Chana K. Writing pens are an unlikely vector of cross infection with Methicillin resistant staphylococcus aureus (MRSA). *Journal of Hospital Infections* 1999;**43**:73–5.

The Journal of One-day Surgery Guidelines for authors

The Journal of One-day Surgery considers all articles of relevance to day and short-stay surgery. Articles may be in the form of original research, audits, case reports or series, practice development and letters to the editor. Review articles cannot usually be accepted due to lack of space. Research projects must clearly state that ethics committee approval was sought and that patients gave their consent to be included. Patients must not be identifiable unless their written consent has been obtained.

Articles should be submitted double spaced with wide margins and an electronic copy (disc or email) must also be supplied. Articles should be accompanied by a letter requesting publication, which should be signed by all authors. Any source of funding should be declared and authors should also disclose any possible conflict of interest which might be relevant to their article.

The first page should list all authors, their job titles, the hospital or unit(s) where the work is from and should give a current contract address for the corresponding author. The author should provide three or four keywords describing their article, which should be as informative as possible. Where appropriate, manuscripts should be divided into the following sections: Introduction, Methods, Results, Discussion and References. A short abstract or summary should also be provided. Each section should start on a new page. Tables and figures (if included) should follow, with each on a separate page. Each table and figure should be accompanied by a legend which should be sufficiently informative as to allow it to be interpreted without reference to the main text.

References should be cited numerically in the order they appear in the text. References should list all authors names. Journal titles should be given in full. Please provide both the first and last page numbers.

All submissions are subject to peer review. Proofs will not normally be sent to authors and reprints are not available.

All items should be sent to The Editor:

Dr Mark Skues, Department of Anaesthesia, Countess of Chester Hospital NHS Trust, Liverpool Road, Chester CH2 1UL. **Email:** Mark@Skuesie.wanadoo.co.uk