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ORIGINAL STUDY

Comparison of glove donning techniques for the likelihood of gown contamination. An infection control study

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The creation of an optimal environment, whenever major joints are opened or metal is implanted into bone, is important to reduce infection following orthopaedic surgery. Following normal hand washing protocols, it is possible that pathogenic bacteria can remain on the skin. These bacteria may inadvertently be transferred to the surgical gown during the glove donning procedure and therefore contamination of the surgical wound could follow. We aimed to determine whether there is a difference between three differing glove donning techniques, open, closed and scrub staff assisted, in terms of accidental gown contamination, as the optimum method is unknown. Three differing glove donning techniques were assessed using ultra-violet (UV) lotion, applied to the hands after the scrub, to demonstrate patches of contamination on the surgical gowns. Two studies were carried out. An initial pilot study with theatre personnel and the main study by a single surgeon rehearsed in the various techniques. The region and size of contamination patches were documented. In the pilot study 12 out of 13 individuals were seen to have patches of UV fluorescent gown contamination following an observed scrub. In the main study, both the open and closed technique had a 100% gown contamination rate. This was concentrated around the cuff region. There were no contamination patches in the scrub staff assisted technique. Glove donning, using the scrub staff assisted technique can minimise the possibility of gown contamination. This is important in surgical procedures where the results of infection can be devastating.

Keywords : infection ; gloves ; orthopaedics.

INTRODUCTION

Deep infection remains an uncommon but potentially devastating complication of total joint arthroplasty (*7*). The introduction of vertical laminar airflow (*2,9*), prophylactic antibiotics and occlusive clothing (*16*) have resulted in infection rates of less than one per cent. Recent investigations have shown that in an ultra clean environment the contribution to wound contamination from the air can be disregarded when measuring bacterial load in a wound, with bacteria possibly arriving from other sources (*4*), either endogenously from the patients themselves, or exogenously from un-sterile instruments, drapes, gowns or gloves (*3*). Hand antisepsis reduces infection and is probably the single most

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important step taken by surgeons to prevent disease. However, bacteria may still persist (*12,14*). The degree of hand disinfection is also reliant on time spent and the accuracy of the technique. It is therefore reasonable to assume that in day to day clinical practice absolute hand sterilization does not occur with every scrub. The current 'Gold Standard' for glove donning is thought to be the closed glove technique. Studies have also suggested that double gloving reduced the chances of cross infection at the surgical site (*8*), however, accidental gown contamination especially at the cuff region will be unaffected by double gloving.

During observation of members of staff in theatre, it appeared there were multiple occasions when the gown could have been accidentally contaminated during the glove donning period. The gown could therefore be a potential source of cross infection as much as the gloves.

In order to evaluate this potential of contamination we undertook a study to identify whether simulated bacterial transfer occurs during various methods of glove application. Our aim was to identify whether glove-donning techniques play a role in contamination of the gown.

MATERIALS AND METHOD

Materials

Gown

An initial survey of various types of disposable gown was employed to ascertain their background UV luminescence. Gowns were examined under UV light in a darkened environment. Also UV luminescent cream was applied to the *inside* of the gowns and examined under UV light. This was to ensure any UV luminescence seen was due to contamination of the gown on the outside as apposed to UV cream on the inside merely radiating through the fibres of the gown. We found that the Barrier® Fluid Protection Plus Surgical Gown had no background UV luminescence or visible luminescence from UV cream applied to the inside. We thereforeemployed this gown type for the purpose of this study.

Gloves

In the pilot study we asked the members of staff to use their standard glove type which were from several different manufacturers. In the study proper we used Ansell Derma Prene® Ultra latex free gloves. These gloves exhibited no background UV luminescence and furthermore, the UV cream on the inside did not fluoresce through under UV light.

UV disclosing material

'GlitterBug®'(Brevis) UV disclosing lotion was the chosen method of demonstrating contamination of gowns and gloves.

UV lamp

The Blak-Ray® Long wave UV lamp (UVL) was used to illuminate the UV disclosing lotion.

Method

Pilot Study

The pilot study was carried out within the normal theatre scrub room. Members of staff within the department that are normally required to scrub were recruited into the study. Demographic data was collected on a Proforma, including job description, specialty and seniority. In order to maintain normal habitual donning technique, staff members were not informed of the nature of the study. In order to try to further ensure there was no alteration in normal scrub habits, the dispensing bottle label was covered to further blind the exact nature of the UV fluorescent cream to the staff member. Members of staff were instructed to lightly apply the cream to the tips of each of the fingers of both hands. The gown and gloves were then opened onto the normal preparation area by an assistant who had not had any contact with the UV cream. The staff member was then instructed to don the gown and gloves in their normal fashion. The gown and glove donning technique was recorded on the proforma. The gown was tied at the rear in the normal fashion. The UV lamp was then used with lights dimmed to observe areas of UV luminescence. The number, size and distribution of UV luminescent patches were recorded in a Proforma. The area of distribution was allocated to a *zone* of the gown to accurately record the patches of contamination (fig 1).

Methodology of comparison study between three different glove-donning techniques

In order to demonstrate whether repeated contamination of gowns during glove donning occurs, the

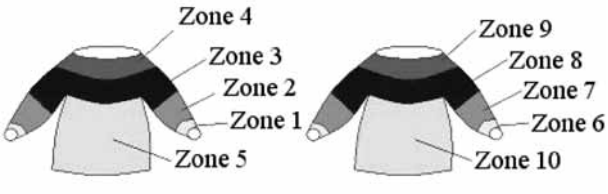

Fig. 1. — The different zones of the grown (anterior and posterior).

'Open' donning technique, 'Closed' donning technique and the 'scrub staff assisted' technique were compared (Figures 2,3,4).

The study was carried out in experimental conditions in a clean environment where the lights could be dimmed to easily observe UV luminescence with the UV lamp.

We observed the donning of gown and gloves using each of the techniques twenty times each.

UV luminescent cream was lightly applied to the tips of each of the fingers on both of the subject's hands. A gown and a pair of gloves were opened by an assistant who had not had any contact with the UV disclosing lotion, (the UV lamp was used to check the hands of the assistant prior to each procedure to ensure no cross contamination). The gown and gloves were then donned following the standard prescribed method. The subject had the recommended glove donning technique available to cross reference the technique at all times.

The UV lamp was used to check the number, size and site of any patches of decontaminations on the gown and gloves. The same individual repeated the procedure twenty times for each differing glove donning technique. This was to ensure complete standardisation of the donning technique.

The mean area of contamination in each zone of the gown was calculated (+/- Standard Deviation). The mean of the area contaminated in each zone was compared between the three different glove-donning techniques.

RESULTS

Pilot Study

We observed 13 individuals donning their normal gown and gloves of choice. Among these individuals there was a wide spread of experience, specialty and roles within theatre (table I).

Of the 13 individuals 9 used the closed glove donning technique and the remainder used the open glove technique. Twelve of the 13 individuals were seen to have patches of UV fluorescent contamination on the gown. The location of the patches of contamination was variable in each individual (table II).

Results of comparison between 3 different glove donning techniques

Open Glove donning technique

During 20 repeated observed donning procedures there was seen to be contamination of the gown in all 20 cases. The cuff areas of the gown (Zone 1 and Zone 6) on both left and right sides were contaminated in all of cases. In the non-dominant hand, zone 2 was contaminated in every case, with the non-dominant area zone 2 being contaminated in 5 cases (table III). On two occasions the collar of the gown was contaminated whilst picking the gown up out of its packet.

Closed Glove donning technique

During 20 repeated observed donning procedures there was seen to be contamination of the gown in 20 of the cases. The cuff areas on the dorsum of the gown (Zone 6) on both left and right side, were seen to be contaminated in 20 of cases. The volar surface of the cuffs on the gown (Zone 1), were contaminated in 17 of cases on the left side and 16 on the right side (table III).

Scrub Assisted donning technique

In all 20 cases no evidence of contamination of any of the zones on the gown was demonstrated (table III).

DISCUSSION

The introduction of ultra-clean surgical environments in orthopaedics has reduced the contribution of airborne pathogens to wound contamination. Despite the introduction of antibiotics and an

Fig. 2. — Open glove donning technique

Fig. 3. — Closed glove donning technique

increased understanding of bacterial contamination sources, infection following joint replacement surgery continues to be a problem. The rate of deep wound infection is reported as less than one percent following joint replacement, which represents a significant number of affected individuals considering that a total of 77,233 hip and knee arthroplasty procedures were performed in the NHS in 2005 (*10*). In addition, the cost of revision surgery, which is on average 30% greater than that of a primary procedure (*1*), can pose a substantial economic burden on the state. Postoperative infections therefore expose the NHS to considerable but potentially avoidable financial demands.

Efforts to reduce bacterial contamination, despite the use of ultra clean air, must include searching for other potential sources of contamination. Transfer of micro-organisms by contact may be significant and as surgical standards of hand disinfection may fail to eliminate all bacteria, establishing a best practice policy of scrub technique is essential (*13*).

This study demonstrates that not all glove and gown donning techniques are equal and that depending on the technique used, there is potential for indirect transmission of pathogens from the skin of theatre staff to a surgical wound. It is assumed that sterile operative conditions require no

Fig. 4. — Scrub staff assisted glove donning technique

Table I. — Table to show the differing grade and specialty of staff taking part in the Pilot Study

GRADE	SPECIALTY	GLOVE DONNING TECHNIQUE
F GRADE NURSE	ORTHO	CLOSED
D GRADE NURSE	ORTHO	CLOSED
F GRADE NURSE	ENT	OPEN
D GRADE NURSE	ENT	CLOSED
D GRADE NURSE	ENT	CLOSED
H GRADE NURSE	ENT	CLOSED
CONSULTANT	GEN SURG	OPEN
SHO	ORTHO	OPEN
SPR	ANAEST	CLOSED
SHO	ANAEST	OPEN
SHO	GEN SURG	CLOSED
SPR	GEN SURG	CLOSED
SPR	ORTHO	CLOSED

SHO : Senior House Officer ; SPR : Specialist Registrar ; ENT : Ear, Nose and Throat

contact between naked skin and the operative field. In the pilot study, almost all of staff members fell short of this standard when donning gloves unassisted. This implies that deficient technique is responsible.

In the study proper, de-sterilisation of the surgical gown is seen to occur over a larger area when comparing an open technique with a closed one. This further provides evidence that the open technique is the least acceptable method of glove

Table II. — Table demonstrating the mean area of gown contamination in each zone of the gown observed in the Pilot Study

Gown Zone	1 Left	1 Right	2 Left	2 Right	3 Left	3 Right	4	5	6 Left	6 Right	7 Left	7 Right	8 Left	Z8 Right	9	10
Mean area of contamination / mm^2	12	9	4.5	1.2	2	0	1.84	0	10.5	11	0.6	1.3	2.5	0	0	0

Table III. — Mean area of contamination occurring in each zone of gown with each technique

Technique	Zone of Gown															
	1 Left	1 Right	2 Left	2 Right	3 Left	3 Right	4	5	6 Left	6 Right	7 Left	7 Right	8 Left	Z8 Right	9	10
Open	8.45	6.26	3.5	0.13	0	0	0.05	0	8.7	6.88	2.8	0	0	0	0	0
Closed	6.305	5.31	0	0	0	0	0	0	3.5	2.8	0	0	0	0	0	0
Scrub Staff Assisted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

donning in terms of accidental gown contamination. What is clearly demonstrated however is that assisted techniques do not lead to de-sterilisation.

In both the closed and open glove technique the majority of contamination appears to occur in a limited area around the cuff of the gown and the glove, areas that are in close proximity to and often direct contact with surgical instruments and vulnerable tissues. Some observational conclusions can be made as to the method of contamination during the gown donning procedure. It appears that the sleeves on the surgical gown are seldom long enough to cover the entire hand during glove donning. The bare fingers therefore touch the inside of the glove cuff, which in turn is exposed to the outside of the gown cuff. When the sleeves are drawn up the arm the contaminated area now lies outside the glove cuff. It is therefore theoretically possible to perform a closed glove donning technique with no contamination of the gown, although challenging at best. If the scrub staff assisted technique was to be employed then the first member of staff would have to either perform a perfect closed technique or following the gowning of the other members of staff re-gown using the staff assisted method. Duxbery *et al* used UV fluorescent powder to compare open versus closed glove donning in intraoperative glove changes. Interestingly, they found the open technique produced less contamination than the closed technique in this instance (*5*). Also of interest they state in their article that if contamination occurred during the initial scrub procedure the staff were asked to rescrub. Implicit in this statement is that accidental contamination occurs at this initial stage. Fraser *et al* stated that the closed technique for intraoperative technique is preferred (*6*). This conclusion was also reached by Newsom *et al* (*11*). It is interesting that the current gold standard of 'Closed glove donning' appears to be theoretical rather than scientifically proven with no study proving evidence of one technique over the other. To our knowledge there are no studies that compare the three techniques we have examined in this study.

In conclusion, best practice glove and gown donning technique involves the scrub staff assisted method.

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