# Practice and attitudes regarding double gloving among staff surgeons and surgical trainees

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**Background:** Despite supporting evidence, many staff surgeons and surgical trainees do not routinely double glove. We performed a study to assess rates of and attitudes toward double gloving and the use of eye protection in the operating room.

**Methods:** We conducted an electronic survey among all staff surgeons and surgical trainees at 2 tertiary care centres in Alberta between September and November 2015. We analyzed the data using log-binomial regression for binary outcomes to account for multiple independent variables and interactions. For 2-group comparisons, we used a 2-group test of proportions.

**Results:** The response rate was 34.3% (361/1051); 205/698 staff surgeons (29.4%) and 156/353 surgical trainees (44.2%) responded. Trainees were more likely than staff surgeons to ever double glove in the operating room ($p$ = 0.01) and to do so routinely ($p$ = 0.01). Staff surgeons were more likely than trainees to never double glove ($p$ = 0.01). A total of 300/353 respondents (85.0%) reported using eye protection routinely in the operating room. Needle-stick injury was common (184 staff surgeons [92.5%], 115 trainees [74.7%]). Reduced tactile feedback, decreased manual dexterity and discomfort/poor fit were perceived barriers to double gloving.

**Conclusion:** Rates of double gloving leave room for improvement. Surgical trainees were more likely than staff surgeons to double glove. Barriers remain to routine double gloving among staff surgeons and trainees. Increased education on the benefits of double gloving and early introduction of this practice may increase uptake.

**Contexte :** Malgré les preuves à l'appui, plusieurs chirurgiens en poste et chirurgiens en formation n'utilisent pas d'emblée le double gantage. Nous avons procédé à une étude pour évaluer le taux d'utilisation du double gantage, les opinions à son endroit et l'utilisation de la protection oculaire au bloc opératoire.

**Méthodes :** Nous avons envoyé un sondage électronique à tous les chirurgiens en poste et chirurgiens en formation de 2 centres de soins tertiaires de l'Alberta entre septembre et novembre 2015. Nous avons analysé les données à l'aide d'un modèle de régression logarithmique binomiale pour les résultats binaires afin de tenir compte des variables indépendantes et des interactions. Pour les comparaisons à 2 groupes, nous avons utilisé le test de comparaison de 2 proportions.

**Résultats :** Le taux de réponse a été de 34,3 % (361/1051); 205 chirurgiens en poste sur 698 (29,4 %) et 156 chirurgiens en formation sur 353 (44,2 %) ont répondu. Au bloc opératoire, les stagiaires étaient plus susceptibles de doubler leurs gants que les chirurgiens en poste ($p$ = 0,01) et de le faire d'emblée ($p$ = 0,01); et les chirurgiens en poste étaient plus susceptibles de ne jamais doubler leurs gants que les stagiaires ($p$ = 0,01). En tout 300 répondeurs sur 353 (85,0 %) ont dit utiliser d'emblée une protection oculaire au bloc opératoire. Les piqûres d'aiguille accidentelles ont été fréquentes (184 chez les chirurgiens en poste [92,5 %], 115 chez les stagiaires [74,7 %]). Une réduction de la sensibilité tactile et de la dextérité manuelle et l'inconfort ou le piètre ajustement ont été les obstacles perçus au double gantage.

**Conclusion :** Les taux de double gantage laissent à désirer. Les chirurgiens en formation sont plus susceptibles d'adopter le double gantage que les chirurgiens en poste. Des obstacles continuent de nuire à l'utilisation du double gantage d'emblée, tant chez les chirurgiens en poste que chez les chirurgiens en formation. Une meilleure sensibilisation aux avantages du double gantage et l'introduction de cette pratique dès le début de la formation pourrait faciliter son adoption.

Staff surgeons and surgical trainees are routinely exposed to blood and other bodily fluids and are at risk for percutaneous injury and contamination. Despite evidence supporting double gloving in the operating room, the literature suggests that many staff surgeons and surgical trainees do not routinely double glove.[1] Previous studies showed slow adoption of double gloving by staff surgeons and surgical trainees in Canada. A 2003 survey in the Capital Health Region and University of Alberta, Edmonton, showed that most staff surgeons and surgical trainees did not routinely double glove.[2] A 2011 study from Ontario also showed low rates of compliance with this safety practice.[1] Similar studies in other jurisdictions revealed low rates of double gloving.[3–5]

The low level of double gloving is inconsistent with evidence supporting this practice. A range of studies, including randomized trials, have shown that perforations develop in surgical gloves during a wide range of procedures and that double gloving reduces exposure to blood and other bodily fluids.[6–11] These data were analyzed in a Cochrane meta-analysis by Mischke and Verbeek,[12] who examined 12 studies showing a statistically significant benefit of double gloving to reduce perforations of a surgeon's innermost glove. The American College of Surgeons supports double gloving as a routine safety practice in its Statement on Sharps Safety.[13] Despite protests to the contrary, it has been shown that double gloving does not reduce manual dexterity or tactile sensation.[14]

The purpose of this study was to examine the practice of double gloving among staff surgeons and surgical trainees in Alberta. In addition, we wished to assess the use of eye protection in the operating room. Differences in the uptake of these safety behaviours may suggest further opportunities for education or study.

## Methods

This was an observational study among staff surgeons and surgical trainees affiliated with the University of Calgary or the University of Alberta. We designed a survey to assess rates of and attitudes toward double gloving and the use of eye protection in the operating room. The primary outcome was the proportion of staff surgeons and surgical trainees who double glove and whether they do so routinely, selectively or rarely. Secondary outcomes included attitudes toward double gloving and rates of eye protection use. Research ethics boards at both universities approved the study protocol.

We constructed survey tools (Appendix 1, available at canjsurg.ca/013616-a1) in an electronic format using SurveyMonkey (SurveyMonkey Inc.). Data captured included the institution of affiliation, staff surgeon or surgical trainee status, surgical specialty, age group, years of practice or training, sex, whether and how often the respondent double gloved, double-gloving technique used, motivations for double gloving (or not), factors influencing the choice to double glove, history of needle-stick injury, use of eye protection in the operating room and type of eye protection used. The survey was distributed electronically to all staff surgeons and surgical trainees at the University of Alberta and University of Calgary by program directors/administrators and department/section heads. The survey was conducted between Sept. 28 and Nov. 8, 2015. Reminders were sent 2 and 4 weeks after the initial invitation to participate.[15]

### *Statistical analysis*

We analyzed the data using log-binomial regression for binary outcomes to take account of multiple independent variables and their interactions. We used log-binomial regression rather than the more typical logistic regression to obtain results in terms of relative risk (RR) rather than odds ratios for easier interpretability. In the case of 2-group comparisons, we used a simple 2-group test of proportions. Significance was set a priori at $p = 0.05$. We analyzed free-text responses by grouping responses by themes.

## Results

Of the 698 staff surgeons invited to participate, 205 (29.4%) responded, and of the 353 surgical trainees invited, 156 (44.2%) responded. The overall response rate was 34.3% (361/1051). University of Calgary respondents accounted for 243 survey responses (67.3%) (Table 1). There was broad representation of surgical specialties across respondents (Table 2). The characteristics of the study population are given in Table 3.

### *Double gloving*

Of the 361 respondents, 282 (78.1%) reported ever double gloving in the operating room; the values for staff surgeons and surgical trainees were 149 (72.3%) and 133 (85.2%), respectively (Table 3). Of the 282 respondents who reported ever double gloving, 188 (66.7%) (52.1% of all survey respondents) reported doing so routinely. The corresponding values for staff surgeons were 93/149 (62.4%) (45.4% of all staff surgeons) and for surgical trainees, 95/133 (71.4%) (60.9% of all surgical trainees).

**Table 1. Response rate by university affiliation**

| | No. (%) of respondents | | |
|---|---|---|---|
| Institution | Staff surgeons | Surgical trainees | Total |
| University of Alberta | 57/343 (16.6) | 61/179 (34.1) | 118/522 (22.6) |
| University of Calgary | 148/355 (41.7) | 95/174 (54.6) | 243/529 (45.9) |
| Total | 205/698 (29.4) | 156/353 (44.2) | 361/1051 (34.3) |

Of the 282 respondents who reported ever double gloving, 76 (45 staff surgeons and 31 surgical trainees) (27.0%; 21.0% of all respondents) did so selectively depending on the case. Forty respondents specifically mentioned a patient at high risk and/or known or suspected to carry a blood-borne illness (e.g., HIV infection or hepatitis) as the motivation for double gloving. Other reasons included open surgery, expectation of exposure to bodily fluids, cases involving implants/prostheses and procedures perceived to hold a high risk for glove compromise. Seventeen respondents (6.0%) who reported ever double gloving (4.7% of all respondents) indicated that they rarely double gloved. One respondent who reported double gloving did not indicate routine, rare or selective use of this practice.

The prevalence of double gloving varied across specialties (Table 4). The subspecialties with the highest rates of routine double gloving were orthopedic surgery (92%), general surgery and subspecialties (66%) and neurosurgery (62%). Specialties with low or nonexistent rates of routine double gloving included obstetrics and gynecology (15%), otolaryngology (5%), cardiac surgery (0%) and ophthalmology (0%).

Just over two-thirds (91 [68.4%]) of the surgical trainees who reported double gloving began the practice in medical school, and the remaining 42 (31.6%) began during residency. Most staff surgeons started double gloving during training: 63 (42.8%) in residency and 10 (6.8%) in fellowship; the remainder starting double gloving in medical school (36 [24.5%]) or in practice (38 [25.8%]). The most common reason for double gloving was a belief that this practice was the best way to protect oneself, followed by instruction to do so from another surgical team member (Table 5). Despite this, needle-stick injury was common: 184/199 staff surgeons (92.5%) and 115/154 surgical trainees (74.7%) reported at least 1 needle-stick injury (overall rate 84.7%).

On multivariable analyses, after any possible institutional effect was accounted for, surgical trainees were more likely than staff surgeons to ever double glove (85.3% v.

**Table 3. Characteristics of respondents**

| Characteristic | No. (%) of respondents* | | |
|---|---|---|---|
| | Staff surgeons *n* = 205 | Surgical trainees *n* = 156 | All respondents *n* = 361 |
| **Sex** | | | |
| Male | 169 (82.4) | 88 (56.4) | 257 (71.2) |
| Female | 36 (17.6) | 68 (43.6) | 104 (28.8) |
| **Age, yr** | | | |
| < 25 | 0 (0.0) | 4 (2.6) | 4 (1.1) |
| 25–29 | 0 (0.0) | 85 (54.5) | 85 (23.5) |
| 30–34 | 12 (5.8) | 54 (34.6) | 66 (18.3) |
| 35–39 | 34 (16.6) | 10 (6.4) | 44 (12.2) |
| 40–44 | 39 (19.0) | 2 (12.8) | 41 (11.4) |
| 45–49 | 34 (16.6) | 0 (0.0) | 34 (9.4) |
| 50–54 | 30 (14.6) | 0 (0.0) | 30 (8.3) |
| 55–59 | 31 (15.1) | 1 (0.6) | 32 (8.9) |
| 60–64 | 17 (8.3) | 0 (0.0) | 17 (4.7) |
| ≥ 65 | 8 (3.9) | 0 (0.0) | 8 (2.2) |
| **Years in practice, mean ± SD (range)** | 15.4 ± 9.8 (1–40) | — | — |
| **Years of training, mean ± SD (range)** | — | 3.1 ± 1.9 (1–8) | — |
| **Double glove** | | | |
| Never | 56 (27.3) | 23 (14.7) | 79 (21.9) |
| Yes | 149 (72.7)† | 133 (85.2) | 282 (78.1) |
| Always/routinely | 93 (45.4) | 95 (60.9) | 188 (52.1) |
| Selectively | 45 (22.0) | 31 (19.9) | 76 (21.0) |
| Rarely | 10 (4.9) | 7 (4.5) | 17 (4.7) |

Note: SD = standard deviation

*Except where noted otherwise.

†One respondent reported double gloving but did not indicate routine, rare or selective use of this practice.

**Table 2. Response rate by specialty**

| Specialty | No. (%) of respondents | | |
|---|---|---|---|
| | Staff surgeons | Surgical trainees | Total |
| Cardiac surgery | 9/19 (47) | 4/17 (24) | 13/36 (36) |
| Dental and oral surgery | 15/43 (35) | 0/2 (0) | 15/45 (30) |
| General surgery and subspecialties | 56/114 (49) | 48/94 (51) | 104/208 (50) |
| Neurosurgery | 14/29 (48) | 7/24 (29) | 21/53 (40) |
| Obstetrics and gynecology | 3/142 (2) | 30/70 (43) | 33/212 (16) |
| Ophthalmology | 6/89 (7) | 3/21 (14) | 9/110 (8) |
| Orthopedic surgery | 46/110 (42) | 28/60 (47) | 74/170 (44) |
| Otolaryngology | 13/45 (29) | 8/18 (44) | 21/63 (33) |
| Plastic surgery | 12/46 (26) | 18/25 (72) | 30/71 (42) |
| Thoracic surgery | 8/9 (89) | 0/1 (0) | 8/10 (80) |
| Transplantation surgery | 2/7 (29) | 1/2 (50) | 3/9 (33) |
| Urology | 12/35 (34) | 8/17 (47) | 20/52 (38) |
| Vascular surgery | 9/10 (90) | 1/2 (50) | 10/12 (83) |
| Total | 205/698 (29) | 156/353 (44) | 361/1051 (34) |

**Table 4. Routine double gloving by specialty**

| Specialty | No. (%) of respondents | | |
|---|---|---|---|
| | Staff surgeons *n* = 205 | Surgical trainees *n* = 156 | Total *n* = 361 |
| Cardiac surgery | 0/9 (0) | 0/4 (0) | 0/13 (0) |
| Dental and oral surgery | 2/15 (13) | 0/0 (0) | 2/15 (13) |
| General surgery and subspecialties | 29/56 (52) | 40/48 (83) | 69/104 (66) |
| Neurosurgery | 7/14 (50) | 6/7 (86) | 13/21 (62) |
| Obstetrics and gynecology | 0/3 (0) | 5/30 (17) | 5/33 (15) |
| Ophthalmology | 0/6 (0) | 0/3 (0) | 0/9 (0) |
| Orthopedic surgery | 40/46 (87) | 28/28 (100) | 68/74 (92) |
| Otolaryngology | 0/13 (0) | 1/8 (12) | 1/21 (5) |
| Plastic surgery | 5/12 (42) | 10/18 (56) | 15/30 (50) |
| Thoracic surgery | 2/8 (25) | 0/0 (0) | 2/8 (25) |
| Transplantation surgery | 1/2 (50) | 1/1 (100) | 2/3 (67) |
| Urology | 2/12 (17) | 4/8 (50) | 6/20 (30) |
| Vascular surgery | 5/9 (56) | 0/1 (0) | 5/10 (50) |

**Table 5. Motivation for double gloving**

| Reason | No. (%) of respondents |
|---|---|
| **Surgical trainees (*n* = 133)** | |
| My staff/preceptors routinely double glove | 9 (6.8) |
| My senior residents and fellow routinely double glove | 4 (3.0) |
| The nursing staff in the operating room routinely double glove | 1 (0.8) |
| I was explicitly told by another member of the surgical team such as a nurse, resident or staff surgeon | 38 (28.6) |
| I felt it was the best way to protect my patients | 4 (3.0) |
| I felt it was the best way to protect myself | 73 (54.9) |
| I experienced a previous percutaneous injury/exposure | 2 (1.5) |
| I feel pressured to double glove | 2 (1.5) |
| **Staff surgeons: double gloving beginning in training (*n* = 109)** | |
| My staff double gloved and I followed their practice | 20 (18.3) |
| My senior resident double gloved and I followed his/her practice | 1 (0.9) |
| I was explicitly told to double glove by a senior member of the surgical team such as a nurse, resident or staff surgeon | 29 (26.6) |
| I felt pressure from my staff or senior colleagues to double glove | 2 (1.8) |
| I felt it was the best way to protect my patients | 10 (9.2) |
| I felt it was the best way to protect myself | 45 (41.3) |
| I received a previous percutaneous injury/exposure | 2 (1.8) |
| **Staff surgeons: double gloving beginning in practice (*n* = 38)** | |
| I felt it was the best way to protect my patients | 5 (13.2) |
| I felt it was the best way to protect myself | 22 (57.9) |
| I received a previous percutaneous injury/exposure | 2 (5.3) |
| I want to set a good example | 2 (5.3) |
| Other | 7 (18.4) |

72.7%, RR 1.15, 95% confidence interval [CI] 1.03–1.26) and were more likely to do so routinely (60.9% v. 44.9%, RR 1.29, 95% CI 1.06–1.58). Staff surgeons were more likely than surgical trainees to never double glove (27.3% v. 14.7%, RR 1.74, 95% CI 1.14–2.75).

There was no significant difference in the probability of routine double gloving between men and women (RR 1.24, 95% CI 1.00–1.59) after staff or trainee status was accounted for. Two-group comparison of proportions tests showed that staff surgeons at the University of Alberta were more likely to double glove routinely than were those at the University of Calgary (57.9% v. 40.5%, $p = 0.04$). There were no between-institution differences in overall or routine double gloving by surgical trainees ($p = 0.1$ and $p = 0.4$, respectively).

Of the 78 respondents who reported not double gloving, 75 (53 staff surgeons and 22 surgical trainees) outlined factors that prevent them from double gloving. Reduced tactile feedback (45 staff surgeons [85%], 19 surgical trainees [86%]), decreased manual dexterity (43 [81%] and 18 [82%], respectively) and decreased comfort/poor fit (43 [81%] and 18 [82%], respectively) were identified as important or very important factors preventing double gloving. Respondents indicated they would be more likely or much more likely to double glove if there was a high expectation of glove compromise (32 staff surgeons [60%], 19 trainees [86%]). Surgical trainees were more likely or much more likely to double glove if a patient was suspected or known to be infectious (21 trainees [95%] v. 23 staff surgeons [43%]) or if the procedure involved bony fragments (14 [64%] v. 22 [42%]). Both staff surgeons and surgical trainees were less likely or much less likely to double glove for a delicate procedure (41 [77%] and 20 [91%], respectively).

**Table 6. Use of eye protection**

| Wear eye protection in the operating room | No. (%) of respondents: Staff surgeons *n* = 199 | Surgical trainees *n* = 154 | Total *n* = 353 |
|---|---|---|---|
| No | 27 (13.6) | 11 (7.1) | 38 (10.8) |
| Yes | 172 (86.4) | 143 (92.8) | 315 (89.2) |
| Always/routinely | 164 (82.4) | 136 (88.3) | 300 (85.0) |
| Rarely | 2 (1.0) | 0 (0.0) | 2 (0.6) |
| In selected cases | 6 (3.0) | 7 (4.5) | 13 (3.7) |

**Table 7. Type of eye protection used**

| Type of eye protection | No. (%) of respondents: Staff surgeons *n* = 172 | Surgical trainees *n* = 143 | Total *n* = 315 |
|---|---|---|---|
| Safety glasses | 21 (12.2) | 44 (30.8) | 65 (20.6) |
| Prescription glasses | 85 (49.4) | 35 (24.5) | 120 (38.1) |
| Safety glasses overtop of prescription glasses | 4 (2.3) | 1 (0.7) | 5 (1.6) |
| Surgical mask with integrated eye shield | 22 (12.8) | 48 (33.6) | 70 (22.2) |
| Surgical loupes | 40 (23.2) | 15 (10.5) | 55 (17.5) |

### *Eye protection*

The use of eye protection in the operating room was common, with 172/199 staff surgeons (86.4%) and 143/154 surgical trainees (92.8%) reporting this practice; 85.0% of respondents overall reported doing so always/routinely (Table 6). The types of eye protection and the frequency with which they were used are outlined in Table 7. Staff surgeons reported using prescription glasses more often than any other type of eye protection. A log-binomial regression model testing for any difference in the proportion of staff surgeons or surgical trainees using routine eye protection after institutional effect was accounted for showed no difference (RR 1.08, 95% CI 0.98–1.18). After staff or trainee status was accounted for, there was also no difference in the proportion of respondents who reported using eye protection routinely at the 2 institutions (RR 0.95, 95% CI 0.86–1.05) or in the proportion of male and female respondents who reported using eye protection routinely.

## Discussion

A total of 78% of our respondents reported double gloving in the operating room, two-thirds of whom did so routinely. The proportion of all respondents who reported that they

double glove routinely, 52%, is similar to that observed in previous studies,[1,2] whereas the proportion who reported ever double gloving, 78%, is higher.[1,2] In a large study ($n$ = 509) conducted in Toronto and published over 20 years ago, Wright and colleagues[5] reported lower rates of routine double gloving (23.3%) and use of protective eyewear (66.4%) than those observed in the current study. The higher rates of double gloving in our study likely reflect increased concern for the personal safety of the surgical team and improved adherence to safety behaviours and best safety practices. Our survey responses suggest that surgical team members encourage safety behaviours such as double gloving, but the data also indicate that today's surgical staff and trainees are more sensitive to the risks of exposure to blood or other bodily fluids or percutaneous injury. Indeed, the most common reason cited by respondents as their motivation for double gloving was self-protection.

In our study, surgical trainees were significantly more likely than staff surgeons to ever double glove and to do so routinely. This is a finding not reported in more recent studies[1,2,4] but reported by Wright and colleagues.[5] Staff surgeons were significantly more likely than surgical trainees to never double glove. This may again reflect current trainees' heightened awareness of personal safety and protective equipment due to improved understanding of communicable disease transmission, teaching regarding personal protective equipment during medical school or role modelling by other surgical team members. Most respondents who reported double gloving indicated that they believed that this practice was the best way to protect themselves. More surgical trainees than staff surgeons began double gloving in medical school (68% v. 24%). Certain specialists rarely double glove, but trainees who begin this practice early may continue it throughout their career and ultimately influence their own trainees.

Wright and colleagues[5] reported double gloving in 89% of procedures by orthopedic staff surgeons and surgical trainees, similar to the rate in the current study (92%). Clearly, this is the standard of practice within orthopedic surgery. A number of specialties reported to have low rates of double gloving had much higher rates in the current study: Wright and colleagues[5] reported rates less than 30% for general surgery, neurosurgery and plastic surgery, whereas in the current study the corresponding rates were 66%, 62% and 50%. These higher rates may reflect heightened awareness of the benefits of double gloving in preventing exposure to blood and other bodily fluids, or may be the result of improved role modelling by staff surgeons in these specialty areas. At least 50% of general surgery and neurosurgery staff respondents in the current study reported that they double glove routinely. The high rate of routine double gloving in orthopedic surgery may have evolved from experience with sharp bone fragments or power tools, or may reflect sensitivity to the risk of contamination or infection when using prostheses. Higher rates of double gloving within neurosurgery may similarly be due to heightened respect for sterility of prostheses and attempts to reduce contamination.

Cardiac and ophthalmologic surgery involve delicate sutures and fine anatomic structures, which may explain the 0% rate of double gloving within these specialties in the current study. Plastic surgery and vascular surgery, which often involve similarly delicate procedures, had rates of routine double gloving of 50%. We thus believe that perceptions of reduced dexterity or tactile feedback when double gloving are products of practice and conditioning, or a lack thereof. Surgeons and trainees who routinely double glove, even for delicate procedures, show that adequate performance is possible when wearing 2 pairs of gloves. The data from this study similarly reflect this.

Barriers to double gloving in the operating room persist. Both staff surgeons and surgical trainees cited reduced tactile feedback, decreased manual dexterity and decreased comfort/poor fit as important or very important factors that prevent them from double gloving. This is contrary to evidence showing no deficit in tactile feedback or manual dexterity when double gloving.[12,14,16] One way to alter this perception might be simulation training involving 2 pairs of gloves to allow trainees to build familiarity and experience as well as to afford the opportunity to experiment with different glove size combinations for comfort in a low-stakes environment. These barriers are similar to those described by St Germaine and colleagues.[2] Wright and colleagues[5] also reported discomfort and interference with surgery as barriers to double gloving. In the current study, both staff surgeons and trainees indicated they were more likely to double glove if there was a high expectation of glove compromise; however, the operating theatre is a dynamic environment, and glove compromise may occur unexpectedly. Although certain circumstances can be identified as holding elevated risk for glove compromise, given the evidence that double gloving reduces perforations and exposure to blood and/or other bodily fluids, the safest course of action is to double glove at all times.

The rate of routine use of eye protection in the operating room in the current study was high, at 85%. This is similar to the figure reported by St Germaine and colleagues,[2] although they did not qualify routine versus nonroutine use of eye protection. Both staff surgeons and surgical trainees had much higher rates of routine use of eye protection than of double gloving, even though most had had needle-stick injuries. It is curious that rate of eye protection use was so much higher than that of double gloving, as both are simple safety behaviours. We did not expect this difference, and the motivations behind the use of eye protection were not explored in our survey tool. Differences in the use of eye protection and double gloving may reflect different discomforts or hindrances associated with each behaviour. There may be a perceived difference in the risk of exposure to blood or other bodily fluids involving the conjunctiva compared to the skin on the hands. This difference has been reported; however, percutaneous exposure to

infected blood and other bodily fluids holds a higher risk for infection than mucocutaneous exposure.[17–19] The risk of infection from percutaneous exposure ranges from 1 in 3 for blood positive for hepatitis B e antigen, to 1 in 30 for blood positive for hepatitis C virus, to roughly 1 in 300 for HIV-positive blood.[17–19] The risk of infection from mucocutaneous exposure to infected blood and other bodily fluids is felt to be lower, less than 1 in 1000.[17–19] Thus, it seems contrary that the use of eye protection is more common than double gloving when the higher-risk exposure events are more likely to occur involving a surgeon's hands.

The practical need for some sort of eyewear to successfully complete a procedure might explain the higher rate of eye protection use. In the current study, staff surgeons who reported using eye protection most commonly wore prescription glasses (49%) or surgical loupes (23%), which suggests that, in 72% of cases, eye protection had a functional purpose and was necessary for successful performance of surgery. Surgical trainees more commonly wore eye protection specifically designed for safety, with 34% choosing a surgical mask with an integrated eye shield and 31% wearing safety glasses. Only 24% reported wearing prescription glasses, and 10%, surgical loupes. It appears that surgical trainees are more conscientious when it comes to eye protection, as a much smaller proportion reported using eyewear for vision correction or assistance.

A comparison of our respondents to the overall population of surgeons in Canada[20] (Table 8) reveals distributions that are broadly similar, although our results should not be used to draw strong conclusions about all surgeons in Canada. Important differences between the proportions of our respondents and the overall proportion of surgeons in Canada exist. Our study had an overrepresentation of general and orthopedic surgeons, and an underrepresentation of ophthalmologists and obstetrician/gynecologists. The data may be more representative for specialties such as cardiac surgery, otolaryngology, vascular surgery and urology given the small differences in proportions.

**Table 8. Generalizability of study sample to Canadian surgical population**

| Specialty | No. (%) invited to participate *n* = 1051 | No. (%) of respondents *n* = 361 | No. (%) of surgeons per specialty[20] *n* = 10 179 |
|---|---|---|---|
| Cardiac surgery | 36 (3.4) | 13 (3.6) | 359 (3.5) |
| Dental and oral surgery | 45 (4.3) | 15 (4.2) | — |
| General surgery and subspecialties | 208 (19.8) | 104 (28.8) | 2017 (19.8) |
| Neurosurgery | 53 (5.0) | 21 (5.8) | 332 (3.3) |
| Obstetrics and gynecology | 212 (20.2) | 33 (9.1) | 2260 (22.2) |
| Ophthalmology | 110 (10.5) | 9 (2.5) | 1273 (12.5) |
| Orthopedic surgery | 170 (16.2) | 74 (20.5) | 1648 (16.2) |
| Otolaryngology | 63 (6.0) | 21 (5.8) | 770 (7.6) |
| Plastic surgery | 71 (6.8) | 30 (8.3) | 603 (5.9) |
| Thoracic surgery | 10 (1.0) | 8 (2.2) | — |
| Transplantation surgery | 9 (0.8) | 3 (0.8) | — |
| Urology | 52 (4.9) | 20 (5.5) | 711 (7.0) |
| Vascular surgery | 12 (1.1) | 10 (2.8) | 206 (2.0) |

It is important to recognize that double gloving and personal protective equipment are one safety strategy and should be part of an overall program of safety within any surgical suite. Organizational safety programs play a major role and may be more important than individual safety practices. A hierarchy for reducing percutaneous exposure includes eliminating sharps completely when able and using safety-engineered devices when sharps are absolutely necessary.[21] Evidence supports the use of blunt-tipped suture needles to reduce glove perforation and needle-stick injury, and the use of safety-engineered scalpels, needles and syringes is best practice.[21–24] When sharps are required, standard procedures for passing and handling these items are important. Many injuries occur during hand-to-hand passing or handling of sharps.[21] Placing sharps in a neutral zone rather than passing hand to hand, and using instruments or packaging to handle sharps rather than handling them directly are important safety measures. It is important is to build a culture of safety within the operating room, recognizing that safety is important for both the patient and the surgical team.

### *Strengths and limitations*

A strength of this work is broad representation across specialties. This study has several limitations. The voluntary nature of the electronic survey tool can introduce selection bias; thus, the respondents may not constitute a representative sample of the target population. The response rate, 34.3% was lower than that in other studies. Wright and colleagues[5] reported an impressive response rate of 93.3%. However, their survey was on paper, was conducted by mail, was limited to a single academic institution within a single urban centre and was conducted over 6 months rather than the 6 weeks over which the current study was collected.[5] St Germaine and colleagues[2] had a response rate of 63.4%, but their study was less than half the size of the current one. Second, there is the potential for nonresponse bias. Nonrespondents may have chosen not to participate because they do not double glove and did not wish to share this information. This would have resulted in overestimation of those who double glove in our sample. Similarly, a strong belief in the practice of double gloving may have led to a self-selection bias that would have caused overestimation of the prevalence of double gloving in our sample. In addition, self-reports of safety behaviours may be subject to recall bias and may not accurately reflect actual practice. As well, the Hawthorne effect may influence responses: respondents may overreport the use of safety behaviours in the context of a study. Respondents from the University of Calgary outnumbered those from the University of Alberta nearly 2 to 1. The academic affiliation of the principal author may explain

this, although invitations to participate were distributed through program administrators or directors and surgical division leaders. Finally, this study involved staff surgeons and surgical trainees affiliated with Canadian postgraduate surgical education programs, and the results may not be generalizable to staff surgeons and surgical trainees in non-academic environments or in other countries.

## Conclusion

Our findings show that double gloving is underused by staff surgeons and surgical trainees. Despite evidence supporting double gloving, only 52% of all respondents reported routinely adhering to this practice. Two-thirds of staff surgeons and surgical trainees who reported double gloving did so routinely. Surgical trainees were more likely than staff surgeons to double glove and were more likely to do so routinely. It is hoped that this signals that routine double gloving is becoming more prevalent over time. Perceived barriers to double gloving included reduced tactile feedback, decreased manual dexterity and discomfort/poor fit. Increased education on the benefits of double gloving may expand the routine use of this practice. Early introduction of double gloving in training is important, as it helps trainees develop comfort and familiarity when performing surgical procedures. Such training may address perceptions of reduced tactile feedback, decreased manual dexterity and discomfort. Early adoption of and comfort with wearing 2 pairs of gloves while performing surgical procedures may lead to durable behaviour patterns in practice.

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