

# Surgeons' and residents' double-gloving practices at 2 teaching hospitals in Ontario

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**Background:** Surgeons and residents are at increased risk of exposure to blood-borne pathogens owing to percutaneous injury (PI) and contamination. One method known to reduce risk is double-gloving (DG) during surgery.

**Methods:** All surgeons and residents affiliated with the University of Western Ontario (UWO) and McMaster University in 2005 were asked to participate in a Web-based survey. The survey asked respondents their specialty, the number of operations they participated in per week, their age and sex, the proportion of surgeries in which they double-gloved (DG in  $\geq 75\%$  surgeries was considered to be routine), and the average number of PIs they sustained per year and whether or not they reported them to an employee health service.

**Results:** In total, 155 of 331 (47%) eligible surgeons and residents responded; response rates for UWO and McMaster surgeons were 50% and 39%, respectively, and for UWO and McMaster residents, they were 52% and 47%, respectively. A total of 43% of surgeons and residents reported routine DG; 50% from McMaster and 36% from UWO. Using logistic regression to simultaneously adjust for participant characteristics, we confirmed that DG was more frequent at McMaster than at UWO, with an odds ratio of 3.32 (95% confidence interval 1.35–8.17). Surgeons and residents reported an average of 3.3 surgical PIs per year (2.2 among McMaster participants and 4.5 among UWO participants). Of the 77% who reported at least 1 injury/year, 67% stated that they had not reported it to an employee health service.

**Conclusion:** Percutaneous injuries occur frequently during surgery, yet routine DG, an effective means of reducing risk, was carried out by less than half of the surgeons and residents participating in this study. This highlights the need for a more concerted and broad-based approach to increase the use of a measure that is effective, inexpensive and easily carried out.

**Contexte :** Les chirurgiens et les médecins résidents risquent davantage d'être exposés à des agents pathogènes transmissibles par le sang à cause de lésions percutanées et contaminations. Une façon connue de réduire le risque consiste à porter des doubles gants au cours des interventions chirurgicales.

**Méthodes :** On a demandé à tous les chirurgiens et les médecins résidents affiliés à l'Université Western Ontario (UWO) et à l'Université McMaster de participer à un sondage web en 2005. Les répondants devaient indiquer leur spécialité, le nombre d'interventions auxquelles ils participaient chaque semaine, leur âge et leur sexe, le pourcentage d'interventions chirurgicales au cours desquelles ils avaient porté des doubles gants (le port de doubles gants dans  $\geq 75\%$  d'interventions chirurgicales était considéré comme utilisation de routine), le nombre moyen de lésions percutanées qu'ils avaient subies par année et s'ils les avaient signalées ou non à un service de santé des employés.

**Résultats :** Au total, 155 des 331 (47 %) chirurgiens et médecins résidents admissibles ont répondu. Les taux de réponse ont atteint 50 % et 39 % chez les chirurgiens de l'UWO et de McMaster respectivement et 52 % et 47 % chez les médecins résidents de l'UWO et de McMaster respectivement. Au total, 43 % des chirurgiens et des médecins résidents ont déclaré porter régulièrement des doubles gants, soit 50 % de McMaster et 36 % de l'UWO. En utilisant une régression logistique pour tenir compte simultanément des caractéristiques des participants, nous avons confirmé que le port de doubles gants était plus fréquent à McMaster qu'à l'UWO et que le risque relatif atteignait 3,32 (intervalle de confiance à 95 %, 1,35–8,17). Les chirurgiens et les médecins résidents ont signalé en moyenne 3,3 lésions percutanées subies au cours

des interventions chirurgicales par année (2,2 chez les participants de McMaster et 4,5 chez ceux de l'UWO). Parmi les 77 % qui ont signalé au moins 1 lésion par année, 67 % ont dit ne pas l'avoir déclarée au service de santé des employés.

**Conclusion :** Les lésions percutanées sont fréquentes au cours des interventions chirurgicales, mais moins de la moitié des chirurgiens et des médecins résidents participant à cette étude ont signalé porter habituellement des doubles gants, moyen efficace de réduire le risque. Les résultats démontrent qu'il faudrait avoir recours à une approche plus concertée et générale afin d'accroître l'utilisation d'une mesure efficace, peu coûteuse et facile à appliquer.

**T**o what extent do surgeons use strategies during surgery that have been demonstrated to be effective in preventing percutaneous injuries (PIs)? In this study, we assessed surgeons' and residents' use of double-gloving (DG; wearing 2 pairs of gloves), a work practice that has been shown to reduce PI risk during surgery.<sup>1</sup>

Health care workers are at risk of contracting blood-borne diseases from PIs with contaminated sharp items.<sup>2</sup> The risk of seroconverting is between 6% and 30% after a hepatitis B-contaminated PI, depending on the patient's HBeAg status,<sup>3</sup> between 1% and 3% for hepatitis C<sup>4</sup> and about 0.3% for HIV.<sup>5</sup>

The economic costs associated with PIs are substantial; for example, postexposure follow-up costs about \$600 without prophylactic drug treatment<sup>6</sup> and about \$3000<sup>7</sup> when the exposure is high-risk without transmission but with prophylactic treatment.

The operating room is the hospital environment with the greatest concentration of sharp items; the surgical team regularly comes into contact with undiluted blood.<sup>8</sup> Consequently, those performing surgical procedures are at increased risk of blood-borne infection. The source patient's infectivity, whether the item causing injury is hollow-bore and the depth of penetration have a substantial influence on the occupational risk incurred by personnel.<sup>9</sup> Factors influencing the likelihood of exposure include the type, length and emergency status of the surgery; the amount of blood loss; and the number of personnel present throughout the procedure.<sup>10,11</sup>

Surgeons and surgical residents are usually at higher risk for PIs than other operating room personnel.<sup>12-16</sup> Makary and colleagues<sup>17</sup> found that by their final year of training, 99% of surgical residents had had a needle-stick injury. Despite high PI rates, PI underreporting among surgeons remains the highest among hospital workers.<sup>18</sup> In a 2008 study,<sup>19</sup> it was reported that fewer than 1% of injuries that surgeons incurred were documented in occupational health records, and in a 2009 study,<sup>20</sup> it was found that only 9% of surgeons followed hospital PI reporting policy.

Although reporting and managing PIs appropriately are important, it is crucial to prevent as many PIs as possible from happening in the first place. To achieve this, several effective measures, including DG during surgery, have been proposed. Both the American College of Surgeons (ACS)<sup>21</sup> and the Association of Perioperative Registered

Nurses (AORN) in the United States<sup>22</sup> have issued statements supporting routine DG by surgeons during all types of surgical procedures.

Cochrane reviews, specifically a meta-analysis of 14 DG trials published between 1990 and 2004 that included 8885 surgeries, demonstrated that the addition of a second pair of gloves significantly reduced perforations to the innermost gloves (odds ratio [OR] 4.10, 95% confidence interval [CI] 3.30-5.09);<sup>1,23</sup> 10 of these trials were published before 2001.

Two previous Canadian investigations have assessed the extent of DG by surgeons. In 1992, 24% of University of Toronto surgeons and residents reported that they double-gloved in 75% or more procedures.<sup>24</sup> In 2001, 43% of University of Alberta surgeons and residents responded positively to "Do you double-glove in the operating room?"<sup>25</sup>

As these investigations showed uptake of this evidence-based work practice by only a minority of surgeons, we decided to further evaluate the degree to which Ontario surgeons use DG. The main objective of this study was to determine the proportion of surgeons and surgical residents who routinely double-gloved during surgery at 2 Ontario teaching hospitals affiliated with the University of Western Ontario (UWO) and McMaster University, and to explore whether uptake differed at the study sites. In addition, variation in DG based on age, sex, surgical specialty, status as resident or surgeon, and the frequency and reporting of PI, were assessed.

## METHODS

Approval for the study was received from the McMaster University and UWO ethics review committees.

We surveyed surgeons in active practice and surgical residents in training at UWO and McMaster University in November 2005. Surgeons' names and email addresses were obtained from the websites of the university surgical departments and those of surgical residents were obtained from the postgraduate education offices.

We used SurveyMonkey, an online data collection service, permitting us to track participants' response status and password-protect the data. The questionnaire, accessed through a website link, took up to 10 minutes to complete. Although participants were also offered a paper version, none requested this format. Before administering the

survey, we pilot-tested the questionnaire among 5 team members to assess face validity (the questions being asked were measuring what they were intended to), clarity and sequence of the items.

Surgeon members of the research team who are well known in their respective institutions (K.H. at UWO; A.T. at McMaster) sent initial emails containing the link to the questionnaire and a letter assuring confidentiality and secure data storage. Reminder emails followed every week for 3 subsequent weeks. Data collection stopped at the end of the fourth week.

Participants were asked “For approximately what percentage of surgeries do you wear double gloves: 0%, 25%, 50%, 75%, or 100%?” This item was the same as that used in the study by Wright and colleagues.<sup>24</sup> Sex, age, surgical specialty and status as resident or surgeon in active practice were also recorded.

In addition, they were asked

- “On average, how frequently each year are you injured by sharp items (e.g., scalpels, needles) during surgery?”
- “Approximately what percentage of sharp injuries do you report to employee health or the emergency department?”
- “On average, how many surgical procedures do you perform and/or participate in per week?”

### Statistical analysis

We developed a dichotomized variable that represented routine versus nonroutine DG: routine DG was defined as DG in about 75% or more of surgical procedures, and nonroutine DG was defined as DG in about 50% or less of procedures. We carried out a descriptive analysis of the study variables, then the association of DG, the outcome of primary interest, was examined with university affiliation, sex, age, surgical specialty and status as resident or surgeon, using cross-tabulation. This was followed by logistic regression to enable simultaneous adjustment of these factors. Regression coefficients were expected to be reliable given that there were 5 independent variables and that 67 participants routinely double-gloved, resulting in more than 10 “events” per independent variable.<sup>26</sup>

## RESULTS

Of 331 eligible surgeons and residents (143 from UWO and 188 from McMaster), 162 filled out the questionnaire. Inclusion in the analysis required answering the question on use of DG; 155 answered that question. Thus, the overall response rate was 47%; rates for UWO and McMaster surgeons were 50% and 39%, respectively, and for UWO and McMaster residents they were 52% and 47%, respectively. A total of 47% of the study respondents were from UWO and 53% were from McMaster.

For specialties (those with at least 5 participants), response rates varied from as high as 64% in plastic

surgery to as low as 25% in ophthalmology. General, orthopedic and plastic surgery specialties were the most represented, totaling 75% of participants; for use in further analyses, the remaining specialties were classified as “other.” Table 1 shows the distribution of participants by university and by specialty.

Of all respondents, 43% reported DG in 75% or more of procedures (50% from McMaster and 36% from UWO). As well, 69% of respondents were under 40 years of age, 59% were residents and 18% were women.

Participants were injured, on average, 3.3 times per year by sharp items (2.2 at McMaster and 4.5 at UWO). The mean number of sharp injuries per 100 procedures was 0.5 at McMaster and 0.9 at UWO. Almost 77% of participants reported having at least 1 injury per year (69% at McMaster and 85% at UWO). Among specialties, the number of injuries per year was highest in cardiothoracic and vascular surgery (8.3 and 10.4, respectively). Similarly, the injury rate per 100 procedures was highest in these specialties (2.2 and 3.3, respectively). They were also the only specialties in which all participants reported having at least 1 injury per year. Almost 67% of participants said that they never reported sharp injuries to either employee health or the emergency department.

The associations between DG and sex, age, surgical specialty, status as resident or surgeon and study site are displayed in Table 2. The percentage of participants (88%) reporting routine DG in orthopedic surgery was much higher than in other specialties, but the percentage did not differ significantly by university, sex, age or status as resident or surgeon (Table 2). Table 3 demonstrates the influence of these characteristics on DG when simultaneously adjusted using logistic regression.

The greater frequency of DG in 75% or more surgeries in orthopedic surgery was confirmed by the high OR of 48.89 (95% CI 12.37–192.98) when compared with the “other” category of specialties; however, general and plastic surgery did not differ from the “other” category. The regression also revealed that, when adjusted for other respondent characteristics, routine DG was more frequent

**Table 1. Distribution of participants in a survey on double-gloving practices by university and by specialty**

Specialty	UWO	McMaster	Total no. (%)
Cardiothoracic surgery	9	4	13 (8)
General surgery	22	27	49 (32)
Neurosurgery	1	5	6 (4)
Orthopedic surgery	22	20	42 (27)
Plastic surgery	8	17	25 (16)
Urology	8	5	13 (8)
Vascular surgery	3	1	4 (3)
Otolaryngology	0	2	2 (2)
Ophthalmology	0	1	1
Total	73	82	155 (100)

UWO = University of Western Ontario.

at McMaster than at UWO, with an OR of 3.32 (95% CI 1.35–8.17). None of the other characteristics was independently associated with routine DG.

The regression model explained a substantial percentage of variability in the study data, as shown by the Nagelkerke  $R^2$ <sup>27</sup> of 47%, which is a measure of the percentage of variability in a data set that is accounted for by a logistic regression model; it is analogous to the coefficient of determination,  $R^2$ , in multiple linear regression. In addition, the Hosmer–Lemeshow  $\chi^2$  statistic<sup>28</sup> did not indicate lack of fit, suggesting that there was no evidence that the values predicted by the model differed substantially from the observed values.

**DISCUSSION**

Overall, 43% of study participants double-gloved in 75% of procedures in this 2005 study. In comparison, the overall rate in 1992 among University of Toronto surgeons and residents studied by Wright and colleagues<sup>24</sup> was 24%. In the 2001 study by St. Germaine and colleagues,<sup>25</sup> 43% of University of Alberta surgeons and residents responded “yes” to “Do you double-glove in the operating room?” Since the percentage of surgeries in which double gloves were worn was not determined in the study by St. Germaine and colleagues, further discussion will focus only on comparisons with the University of Toronto study.

Whereas Wright and colleagues<sup>24</sup> reported that their overall routine DG rate was 24%, they did not provide routine DG rates by specialty. Rather, they reported mean percentages of procedures in which DG was used; these were

calculated by multiplying the number of participants who reported DG in each of the 5 categories of percentages of surgeries (0%, 25%, 50%, 75%, 100%) by the value of the category, summing these products and dividing by the total number of participants in the specialty. For example, in a specialty with 40 respondents, if 20, 10, 5, 3 and 2 respondents, respectively, answered in the 0%, 25%, 50%, 75% and 100% categories, the mean would be:  $([20 \times 0] + [10 \times 0.25] + [5 \times 0.5] + [3 \times 0.75] + [2 \times 1.00]) \div 40 = 0.23$  or 23%. The mean percentages of procedures in which DG was used in the study by Wright and colleagues<sup>24</sup> were 89%, 26% and 29% in orthopedic, plastic and general surgery, respectively; for other specialties combined, the mean percentage was 17%.

In the present study, the rate of DG in 75% or more of orthopedic surgeries was also highest at 88%, and rates in plastic and general surgery were 40% and 29%, respectively. For comparison purposes, we also applied the method of Wright and colleagues, and the mean percentages of procedures in which DG was used were 86%, 49% and 34% in orthopedic, plastic and general surgery, respectively; for other specialties combined, the mean was 20%. These results suggest that substantial increases in DG in Ontario teaching hospitals have occurred in plastic surgery since 1992 (49% v. 26%), with modest increases in other specialties except orthopedic surgery in which DG remained high.

Rates of routine DG in our study were higher at

**Table 2. Frequency and percentage of double-gloving  $\geq$  75% of surgeries and total number of participants by characteristics**

Characteristic	Double-gloving $\geq$ 75%,		p value
	no. (%)	No. participants	
Study site			0.08
McMaster	41 (50)	82	
UWO	26 (36)	73	
Sex			0.14
Female	16 (57)	28	
Male	51 (40)	127	
Age, yr			0.08
20–29	16 (42)	38	
30–39	36 (53)	68	
40–49	11 (38)	29	
> 49	4 (21)	19	
Status			0.14
Resident	44 (48)	91	
Surgeon	23 (36)	64	
Specialty			0.010
Orthopedic surgery	37 (88)	42	
General surgery	13 (29)	45	
Plastic surgery	10 (40)	25	
Other	7 (16)	43	

UWO = University of Western Ontario.

**Table 3. Multiple logistic regression: effect of participant characteristics on double-gloving\***

Characteristic	OR (95% CI)
Study site	
McMaster	3.32 (1.35–8.17)
UWO	1
Sex	
Female	2.04 (0.74–5.62)
Male	1
Age, yr	
20–29	1.92 (0.27–13.95)
30–39	2.43 (0.46–12.92)
40–49	2.47 (0.52–11.71)
> 49	1
Status	
Resident	0.65 (0.19–2.24)
Surgeon	1
Specialty	
Orthopedic surgery	48.89 (12.37–192.98)
General surgery	1.98 (0.64–6.07)
Plastic surgery	2.45 (0.70–8.56)
Other	1

CI = confidence interval; OR = odds ratio; UWO = University of Western Ontario. \* $n = 154$ ; Nagelkerke  $R^2 = 0.47$ ; Hosmer–Lemeshow goodness of fit test  $p = 0.74$ .

McMaster than at UWO (50% v. 36%), and the regression analysis with simultaneous adjustment for other participant characteristics confirmed that routine DG differed significantly between the universities. This may reflect greater incorporation of research evidence into clinical practice at McMaster, which has been recognized as an originator of “evidence-based medicine.”<sup>29</sup>

Even so, our study found that most surgeons and surgical residents did not double-glove in most operations despite the fact that randomized controlled trials have consistently demonstrated its effectiveness.<sup>1</sup> Although uptake was higher at McMaster, half of the participants did not double-glove in most of the surgeries they carried out.

Using regression analysis, Wright and colleagues<sup>24</sup> also found that residents double-gloved significantly more often than surgeons in active practice, but that DG did not vary by sex or number of years in practice. Using regression analysis, our study also found that DG did not vary according to sex or age, but unlike Wright and colleagues, we did not find a difference in DG between surgeons and residents.

Some surgeons have resisted routine DG, citing a reduction in dexterity and sensation when performing surgical procedures.<sup>25,30,31</sup> For some surgeons, the risk status of patients influences their practice; only if a patient is known or considered to be “high risk” do they institute DG.<sup>32</sup> However, the ACS has recently renewed its recommendation for the universal adoption of DG, recognizing that some surgeons will require a period of adaptation and retraining.<sup>21</sup>

The average number of PIs per 100 procedures in our study was lower than that reported by Wright and colleagues<sup>24</sup> (0.7 v. 4.3). As the proportion of participants in the higher risk specialties of cardiothoracic or vascular surgery was similar in the 2 studies (11% and 9%, respectively), the distribution of specialties does not seem to account for the difference in the overall rate of injury in the 2 studies. As Wright and colleagues did not report injury rates by specialty, it is not possible to explore the degree to which increased DG within specialties may have contributed to a reduction in rates of PIs. It is more likely that the difference in PIs is related to the higher response rate in the study by Wright and colleagues than in the present study (93% v. 47%); the large numbers of nonrespondents in our study may have experienced more injuries than respondents. This is consistent with reports from Jagger and colleagues.<sup>33</sup> Using EPINet data from 87 American hospitals, they demonstrated that the PI rate for the surgical setting remained essentially unchanged between 1993 and 2003. During this interval, the PI rate decreased by 34% in hospital settings with the exception of the operating room as a result of the growing uptake of re-engineered sharp safety devices. In any event, our finding that 77% of participants in the present study had at least 1 injury per year, represents a substantial burden of risk.

Consistent with previous studies,<sup>19,20</sup> two-thirds of participants in this study also stated that they did not report

occupational PIs to the appropriate employee health service. The potential repercussions related to nonreporting, such as not receiving or delaying treatment, are substantial.<sup>34</sup>

### Limitations

One main limitation of this study was that all information was self-reported. Whereas participants were assured of confidentiality, their responses may not have fully reflected their experiences or perceptions. Another limitation was that, although the response rate of 47% was in or above the usual range for studies among physicians, data were not obtained from over half of the eligible participants. Nonetheless, the results for DG by specialty and for the factors related to DG were consistent with those reported by Wright and colleagues.<sup>24</sup>

### CONCLUSION

This study’s results demonstrate that more needs to be done to increase the performance of evidence-based risk reduction methods among surgeons and surgical residents. Although they would be the primary beneficiaries of a reduction in PIs, patients would also benefit as indicated in previous operating room studies documenting that 32% and 11%, respectively, of the sharp items causing PIs in surgical personnel recontacted the patient wound.<sup>12,13</sup>

At the conclusion of their 2003 publication on DG among University of Alberta surgeons, St. Germaine and de Gara, both surgeons, stated: “One wonders whether in matters of personal safety, legislation as was required for the use of seat belts or even smoking would be necessary for surgeons to change the way they do business.”<sup>25</sup> The limited progress observed in our study corroborates such a position.

**Competing interests:** None declared.

**Contributors:** All authors helped design the study, reviewed the article and approved its publication. Mr. Herring acquired the data. Drs. Haines and Stringer and Mr. Herring wrote the article.

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