



## A survey of medication preparation and administration practices among members of the Canadian Anesthesiologists' Society

## Enquête sur la préparation et les pratiques d'administration des médicaments auprès des membres de la Société canadienne des anesthésiologistes

Sophie Breton, MD · Janet van Vlymen, MD, FRCPC · Sean Xia, MD candidate ·  
Ronald R. Holden, PhD · Rachel Phelan, MSc · Selena M. Sagan, PhD ·  
Melanie Jaeger, MD, FRCPC

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### Abstract

**Purpose** Recommendations for safe medication injection practices to eliminate the risk of patient-to-patient transmission of blood-borne infections have been in place for many years. The purpose of our study was to evaluate the medication administration practices of Canadian anesthesiologists relative to current safe practice guidelines.

**Methods** An anonymous 17-question online survey was sent to all members of the Canadian Anesthesiologists'

Society (CAS) via the membership email list. Data pertaining to respondent demographics, practice characteristics, and medication preparation and administration practices were collected and analyzed descriptively using frequencies and percentages as well as Fisher's exact tests followed by post hoc multiple comparisons.

**Results** Of the 2,656 CAS members, 546 (21%) responded. The practice of reusing needles (2%) and/or syringes (7%) between patients is reported by only a minority of practitioners; however, sharing a medication vial between more than one patient using new needles and syringes is still widely practiced with 83% doing this sometimes or routinely. The main reasons for sharing medications include the desire to reduce medication waste and the associated costs.

**Conclusion** Sharing medication vials between multiple patients is common practice in Canada, with new needles and syringes used for each patient. Unfortunately, a small minority of anesthesiologists continue to reuse needles and/or syringes between patients, and this may pose a significant risk of patient-to-patient infection transmission.

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S. Breton, MD · J. van Vlymen, MD, FRCPC ·  
M. Jaeger, MD, FRCPC

Department of Anesthesiology and Perioperative Medicine,  
Queen's University, Kingston, ON, Canada

S. Xia, MD candidate  
Queen's University School of Medicine, Queen's University,  
Kingston, ON, Canada

R. R. Holden, PhD · R. Phelan, MSc  
Department of Psychology, Queen's University, Kingston, ON,  
Canada

S. M. Sagan, PhD  
Department of Microbiology & Immunology and Department of  
Biochemistry, McGill University, Montreal, QC, Canada

M. Jaeger, MD, FRCPC (✉)  
Department of Anesthesiology and Perioperative Medicine,  
Kingston Health Sciences Centre, Kingston General Hospital  
Site, 76 Stuart Street, Kingston, ON K7L 2V7, Canada  
e-mail: Melanie.Jaeger@kingstonhsc.ca

### Résumé

**Objectif** Les recommandations concernant les pratiques sécuritaires d'injection des médicaments visant à éliminer la transmission inter-patients d'infections transmises par le sang sont en vigueur depuis de nombreuses années. L'objectif de notre étude était d'évaluer les pratiques d'administration des médicaments des anesthésiologistes canadiens par rapport aux lignes directrices actuelles pour une pratique sécuritaire.

**Méthodes** *Un questionnaire anonyme en ligne comportant 17 questions a été envoyé à tous les membres de la Société canadienne des anesthésiologistes (SCA) via la liste de courriels des membres. Les données concernant la démographie, l'activité professionnelle, les pratiques de préparation et d'administration des médicaments ont été collectées et analysées de manière descriptive en utilisant les fréquences et pourcentages, ainsi que des tests exacts de Fisher, suivis de comparaisons multiples post hoc.*

**Résultats** *Sur les 2 656 membres de la SCA, 546 (21 %) ont répondu. La pratique de réutilisation des aiguilles (2 %) et/ou des seringues (7 %) entre des patients n'est signalée que par une minorité de praticiens; en revanche, le partage d'un fiole de médicament entre plusieurs patients en utilisant des aiguilles et seringues neuves est toujours largement pratiqué par 83 % des cliniciens qui le font parfois ou régulièrement. Les principales raisons du partage des médicaments sont, notamment, le désir de réduire leur perte et les coûts associés.*

**Conclusion** *Le partage de fioles de médicaments entre plusieurs patients est une pratique courante au Canada, avec l'utilisation d'aiguilles et de seringues neuves pour chaque patient. Malheureusement, une petite minorité d'anesthésiologistes continue de réutiliser des aiguilles et/ou seringues entre patients et cela pourrait constituer un risque significatif de transmission des infections d'un patient à l'autre.*

Anesthesiologists prepare and administer dozens of medication doses in a single day and are trained to use safe medication practices to reduce drug error and prevent nosocomial infections. Our practice is influenced heavily by drug shortages, budget cuts, and operating room production pressure. Operating room (OR) time is a precious resource and anesthesiologists experience significant pressures to limit OR turnover times, optimize workflow, and improve productivity.<sup>1</sup> Perhaps partly due to these constraints, medication sharing, in which the provider enters a vial more than once to obtain additional doses for multiple patients, seems to have persisted in our practice.<sup>2-4</sup> It is, however, unclear how often and under which circumstances medications are shared between more than one patient.

Our current understanding of safe medication injection practices has evolved substantially. Historically, using the same syringe to administer medication to multiple patients was common practice.<sup>5</sup> With increasing awareness of the preventable risks posed by such practices over the past several decades, the Centers for Disease Control and Prevention (CDC) created guidelines for safe injection

practices. The “Core Infection Prevention and Control Practices for Safe Healthcare Delivery in All Settings” were last updated by the CDC in 2017 (although largely unchanged from the last publication in 2007) and include the following guidelines for injection and medication safety: “1) use aseptic technique when preparing and administering medications; 2) disinfect the access diaphragm of medication vials before entering the vial; 3) use needles and syringes for one patient only; 4) enter medication containers with a new needle and syringe even for additional doses for the same patient; 5) ensure single-dose vials, ampoules, and solution bags are used for only one patient; and 6) dedicate multidose vials to a single patient whenever possible. If multidose vials are used for more than one patient, restrict them to a centralized medication area and do not bring them into the immediate patient treatment area (e.g., operating room)”.<sup>6</sup> The American Society of Anesthesiologists (ASA) Committee on Occupational Health Task Force on Infection Control supports all of these recommendations, and they have also been endorsed by Public Health agencies, regulatory authorities, and others.<sup>7-10</sup> The CDC guidelines further specify that prior to accessing a multidose vial, the diaphragm should be scrubbed with 70% alcohol with subsequent time to dry before entering the vial with a clean needle and syringe.<sup>6</sup> The prevalence of syringe reuse saw a sharp decline from roughly 30% in the 1990s to 2% by 2002.<sup>11</sup> Despite these significant reductions, however, over 50 known outbreaks of viral and bacterial infections as a result of unsafe injection practices have occurred since 1998 in the United States, infecting more than 700 patients.<sup>7</sup>

Despite attempts to re-educate healthcare providers,<sup>2</sup> recent American surveys have shown that some physicians still report using the same syringe for more than one patient and many share multidose medication vials using clean needles and syringes.<sup>3,4</sup> The current practice environment in Canada may differ as Canadian clinicians face different resource and infrastructure constraints than our American colleagues. The purpose of this study was to collect information on the self-reported medication administration practices of members of the Canadian Anesthesiologists' Society to evaluate their compliance with the updated safe practice guidelines published by the CDC in 2017.

## Methods

### Participants

This cross-sectional survey investigation was approved by the Queen's University Faculty of Health Sciences and Affiliated Teaching Hospitals Research Ethics Board

(ANAE-310-17, February 22, 2017). A survey of medication preparation and administration practices was distributed *via* the Canadian Anesthesiologists' Society (CAS) membership email list. This provided a sampling frame of 2,656 active members providing anesthetic care.

### Survey development and content

Important themes in medication administration practices were identified through review of infection control guidelines<sup>6,8,12</sup> and input from local anesthesiologists. Principles of effective survey design were followed in its creation.<sup>13</sup> The final survey was translated from English to French by a francophone member of the team (S.B.) and reviewed by a team of French-speaking scientists at McGill University. The 17-item survey was available in both official languages and contained two categories of questions: 1) participant characteristics and 2) practice patterns. Participant characteristics included practitioner age, sex, province, time in practice, and medical environments. Practice environments were divided into community, academic, private, multiple, and other. Practice patterns identified the frequency of certain habits, such as reuse of needles and syringes, medication sharing, disinfection measures taken prior to medication reuse, and factors that drive medication sharing. The final version of the surveys is available as Electronic Supplementary Material (ESM): Table S1.

### Survey testing

The full pilot survey was circulated to 30 local anesthesiologists for preliminary review of content comprehensiveness and intelligibility. Modifications of question wording were made in response to expert feedback.

### Survey administration

The online survey was created using FluidSurveys™ software (Ottawa, ON, Canada). The survey link was distributed electronically through the CAS membership email list on 4 July 2017. A letter of intent, contained within the body of the email, described survey objectives and ensured the anonymity and confidentiality of all responses. Members were made aware that participation was entirely voluntary and no incentives would be offered to survey participants for successful completion. The CAS sent out two reminders to all CAS mailing list members on 18 July and 1 August 2017. The survey link was closed on 22 August 2017.

### Sample size

The most feasible mechanism currently in place for contacting all anesthesiologists across Canada is *via* the CAS membership email list. As this investigation is purely descriptive (without a pre-specified hypothesis), sample size calculations based upon primary outcome measures were not undertaken. A 30% response rate was targeted based upon previous electronic survey studies using this mechanism.<sup>14,15</sup>

### Data analysis

Descriptive statistics were calculated using the statistical software package SPSS 23 (IBM SPSS 23.0. For Windows, SPSS Inc., Chicago, IL, USA). Regions were collapsed into West, East, Ontario, Quebec, and Other because of the low response rates from some provinces. Responses to each question in the survey were compared across age, geographical location, sex, and hospital practice using Fisher's exact tests followed by *post hoc* multiple comparisons with significance set at  $P < 0.05$  (Table S2, available as ESM). Arbitrary corrections were not made to adjust for the inflated type I error associated with multiple tests of significance. Instead, the actual  $P$  values are presented so the reader can determine how much weight they wish to place on the  $P$  values in the context of multiple comparisons. Missing data were excluded from the analyses; the number of respondents included in the analyses is indicated on each table. In addition, demographic data from our sample were compared with anesthesiology population data at the national level. Respondents could write comments in addition to (or instead of) using one of the pre-populated choices depending upon the question, and comments were triaged as determined appropriate by the authors (Table S3, available as ESM).

## Results

The survey was sent to the 2,656 members of the CAS; after two reminders, 546 (21%) responded. Of these, 74 (14%) responded in French. In total, 532 filled the survey to completion for an overall response rate of 20%. Demographic and practice characteristics of respondents are detailed in Table 1. Of the respondents, 249 (46%) practiced solely in an academic environment, 155 (28%) solely in a community hospital, and 134 (25%) in multiple environments. The majority (75%) had been in practice for at least 11 years.

We found that reusing needles (2%) and/or syringes (7%) between patients is still practiced by a small minority

**Table 1** Demographic characteristics for all respondents ( $n = 546$ )

<i>n</i> /(%)	<i>Practice environment</i> <sup>1</sup>					<i>Total</i>
	<i>Community</i>	<i>Academic</i>	<i>Private</i>	<i>Other</i> <sup>2</sup>	<i>Multiple</i> <sup>3</sup>	
<b><i>Sex</i></b> <sup>4</sup>						
Male	106 (30)	158 (45)	4 (1)	4 (1)	82 (23)	354 (100)
Female	47 (26)	86 (47)	0 (0)	0 (0)	50 (27)	183 (100)
Other	1 (50)	1 (50)	0 (0)	0 (0)	0 (0)	2 (100)
Prefer not to answer	1 (14)	4 (57)	0 (0)	0 (0)	2 (29)	7 (100)
<b><i>Age</i></b>						
25-30	2 (6)	31 (89)	0 (0)	0 (0)	2 (6)	35 (100)
31-40	26 (24)	52 (47)	0 (0)	0 (0)	32 (29)	110 (100)
41-50	40 (28)	68 (47)	0 (0)	0 (0)	36 (25)	144 (100)
51-60	52 (35)	57 (38)	0 (0)	0 (0)	24 (17)	150 (100)
> 60	35 (33)	41 (38)	4 (4)	4 (4)	23 (21)	107 (100)
<b><i>Anesthesia practice (years)</i></b>						
0-5	4 (7)	42 (78)	0 (0)	0 (0)	8 (15)	54 (100)
6-10	23 (29)	39 (49)	0 (0)	0 (0)	18 (23)	80 (100)
11-20	37 (28)	60 (45)	0 (0)	0 (0)	35 (27)	132 (100)
21-35	71 (33)	85 (40)	0 (0)	0 (0)	58 (27)	214 (100)
> 35	20 (30)	23 (35)	4 (6)	4 (6)	15 (23)	66 (100)
<b><i>Region</i></b> <sup>5</sup>						
East	13 (25)	27 (53)	0 (0)	1 (2)	10 (20)	51 (100)
West	48 (26)	71 (38)	3 (2)	2 (1)	62 (33)	186 (100)
Ontario	65 (29)	111 (50)	1 (< 1)	1 (< 1)	43 (19)	221 (100)
Quebec	29 (34)	39 (46)	0 (0)	0 (0)	17 (20)	85 (100)
Territories	0 (0)	1 (100)	0 (0)	0 (0)	0 (0)	1 (100)
United States	1 (50)	0 (0)	0 (0)	0 (0)	1 (50)	2 (100)

East = Newfoundland and Labrador, Nova Scotia, New Brunswick, Prince Edward Island; West = Manitoba, Saskatchewan, Alberta, British Columbia

<sup>1</sup> Respondents could select > one practice environment. While 45 indicated “ambulatory”, 43 of these also indicated additional practice environments and are therefore included within the “multiple” category. The other two also selected the “other” classification and are therefore included within the “other” category

<sup>2</sup> Includes two retired and two from community teaching hospitals

<sup>3</sup> Of the 134 who were included in the “multiple” category, 95 selected two responses, 27 selected four responses, and 12 selected four responses

<sup>4</sup> The respondents who selected “other” ( $n = 2$ ) or “Prefer not to answer” ( $n = 7$ ) were excluded from the Fisher’s exact analyses for Sex because the group was too small to be adequately represented

<sup>5</sup> The three respondents from the United States and the Territories were excluded from the Fisher’s exact analysis for Region because the group was too small to be adequately represented

of anesthesiologists (Table 2). No significant differences were observed across demographic variables in terms of who reuses needles (Table S2, available as ESM).

Although reusing needles and syringes is a reportedly uncommon practice, sharing a medication vial between more than one patient with *new* needles and syringes is very common. For more than half of respondents, this practice is routine and 90% report doing it rarely, sometimes, or routinely (Table 2). Of all respondents, 79% believe there is no potential infection risk so long as a

new sterile needle and syringe are used when sharing medications between patients. Additional comments reflect the belief that provided sterile needles/syringes were used each time and vials were disinfected with alcohol, the risk of pathogen transmission was felt to be negligible.

Furthermore, when practitioners are the only user, many do not routinely disinfect the diaphragm before re-entry to get doses for another patient, and regional differences were observed (i.e., East 49%, Ontario 50%, Quebec 14%, and West 47%;  $P < 0.001$ ). The difference lies with Quebec

**Table 2** Frequency of medication sharing practices among Canadian Anesthesiologists ( $n = 546$ ) as indicated from responses to survey questions 5-9, 13-15<sup>1</sup>

<b>IN YOUR ANESTHESIA PRACTICE, HOW OFTEN DO YOU...</b>					
<i>n (%)</i>	<i>Never</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Routinely</i>	<i>Other</i>
5. Reuse needles between patients?	534 (98%)	2 (< 1%)	8 (2%)	2 (< 1%)	-
6. Reuse syringes between patients?	508 (93%)	16 (3%)	21 (4%)	1 (< 1%)	-
7. Enter a medication vial with a clean needle and syringe more than once to obtain additional doses for the SAME PATIENT?	24 (4%)	56 (10%)	192 (35%)	269 (49%)	5 (< 1%)
8. Enter a medication vial with a clean needle and syringe more than once to obtain additional doses for MORE THAN ONE PATIENT?	47 (9%)	38 (7%)	162 (30%)	292 (54%)	7 (1%)
9. Dilute a medication in a minibag/vial of saline for use for more than one patient, accessing it with a clean needle and syringe?	28 (5%)	32 (6%)	103 (19%)	381 (70%)	2 (< 1%)
13. If you are the only practitioner using a medication vial, do you disinfect the vial top when using it for more than one patient?	40 (8%)	55 (10%)	135 (25%)	293 (55%)	9 (2%)
	<i>Visually inspect to determine if cleaning is required</i>	<i>Wipe the vial once with an alcohol swab</i>	<i>Scrub the vial for 2-3 seconds with an alcohol swab</i>	<i>Scrub the vial for 10 seconds with alcohol</i>	<i>Not applicable—I never share vials opened by another practitioner</i>
14. Before using the same vial for more than one patient, I typically: <sup>2</sup>	115 (22%)	171 (32%)	184 (35%)	27 (5%)	35 (7%)
15. For medication vials that have been opened by another practitioner, and before using it for another patient, I typically:	22 (4%)	60 (11%)	67 (13%)	16 (3%)	367 (69%)

<sup>1</sup> All distributions are based on  $n = 546$  responses except for those in Q 13-15, which are based on  $n = 532$  responses

<sup>2</sup> Although “other” was an available response option, no one selected it for Q14 or Q15

where 84% reported routinely disinfecting the diaphragm before re-entry, whereas 48-55% of practitioners from other regions reported routine disinfection, albeit there was variation in how vials were determined to be clean. When practitioners were the only users, 83-89% reported visually inspecting the vial to determine if cleaning was required, wiping it once or wiping it for two to three seconds with an alcohol swab. The proportion of practitioners who only visually inspect the vial was significantly lower in Quebec (7%) compared with all other regions (i.e., 22-26%). If another practitioner opened the vial, the majority of respondents selected “not applicable” to indicate they never use vials opened by another practitioner (East, 73%; Ontario, 77%; Quebec, 41%; West, 72%) (Table S2, available as ESM).

Practice types were not significantly different from one another in terms of reusing vials for different patients if they were the only user (i.e., community, 88%; multiple, 95%; academic, 90%;  $P = 0.26$ ) (Table S2, available as ESM). Overall, respondents from Ontario were found to reuse vials for the same and for different patients

significantly less than other regions ( $P < 0.001$ ) and anesthesiologists working at academic centres were more likely to report the existence of a system to divide medications into smaller doses than anesthesiologists working at community hospitals ( $P = 0.005$ ). For specific multiple comparisons, see Table S2 (available as ESM).

To further characterize the sharing of anesthetic drugs, we compiled a list of commonly used medications that come in both single- and multidose vial formats (distinction not made on survey). The respondents' practices of reusing vials of common anesthetic medications for more than one patient are summarized in Table 3. The four medications most commonly used for more than one patient were neostigmine, phenylephrine, dexamethasone, and remifentanyl (83%, 83%, 81%, and 75%, respectively), either sometimes or routinely. Importantly, these medications are typically supplied in quantities that are often larger than the dose needed for a single patient.

The most common reasons cited for using medications for more than one patient were the desire to reduce waste

**Table 3** Frequency of sharing common anesthetic medications (obtained from the responses to survey question 10)<sup>1</sup>

<b>HOW OFTEN DO YOU USE THE FOLLOWING MEDICATIONS FOR MORE THAN ONE PATIENT?</b>				
<i>n (%)</i>	<i>Never</i>	<i>Rarely</i>	<i>Sometimes</i>	<i>Routinely</i>
Phenylephrine	65 (12%)	28 (5%)	88 (16%)	364 (67%)
Ephedrine	198 (36%)	64 (12%)	113 (21%)	170 (31%)
Neostigmine	74 (14%)	18 (3%)	83 (15%)	370 (68%)
Dexamethasone	80 (15%)	23 (4%)	88 (16%)	353 (65%)
Lidocaine	228 (42%)	69 (13%)	79 (15%)	169 (31%)
Propofol	241 (44%)	126 (23%)	95 (17%)	83 (15%)
Remifentanyl	104 (19%)	33 (6%)	110 (20%)	298 (55%)
Fentanyl	135 (25%)	104 (19%)	136 (25%)	170 (31%)
Intrathecal morphine	332 (61%)	53 (10%)	77 (14%)	83 (15%)

<sup>1</sup> Distributions for all medications were based on 545 responses except for dexamethasone, which was based upon  $n = 544$

**Table 4** Reasons for using a medication for more than one patient

Reason	Number of respondents <i>n (%)</i> <sup>1</sup>
Desire to reduce medication costs	437 (83)
Desire to reduce medication waste	485 (92)
Insufficient stock on anesthetic cart to allow for one vial per patient	107 (20)
The medication dose supplied is significantly larger than most patients require	469 (89)
Medications are labeled as multidose	276 (52)

<sup>1</sup> More than one response could be provided by each respondent. Of the 546 respondents, 18 did not provide any reason. Of the 528 who provided reasons, 32, 53, 192, 193, and 57 respondents selected 1, 2, 3, 4, or 5 reasons, respectively

and decrease costs (Table 4). Note that respondents were free to select as many answers as they felt appropriate to this question.

Chi-square analyses comparing the demographic profile of the current sample with that of all licensed anesthesiologists across Canada indicated significant differences in region, practice environment, and age (Table 5). Post-hoc multiple comparisons further revealed that our sample over-represented clinicians in the East and those working in “other” and “private” practice environments and under-represented clinicians in Quebec and those working in academic centres. Finally, our sample under-represented anesthesiologists  $\geq 64$  yr of age and over-represented those  $\leq 34$  yr of age compared with the national sample.

Data for all survey questions are available as supplemental material (Table S2, available as ESM) along with the *P* values from Fisher’s exact tests and the *post hoc* multiple comparisons. In addition, all comments written in response to all questions are included as supplementary material (Table S3, available as ESM)

along with an explanation of how the comment was recorded for analyses or not.

## Discussion

Our study illustrates that the practice of medication sharing is widespread, with 83% of respondents reporting “sometimes” or “routinely” sharing medications between patients. This practice, however, is almost always done using clean sterile needles and syringes. It is very concerning, though, that there are still anesthesiologists who admit to reusing needles or syringes for more than one patient despite the existence of clear guidelines from both infection control and anesthesia associations that have been in place for many years.

A 2011 survey administered to anesthesiologists practicing in New York State revealed that 50% used a medication vial for more than one patient at least sometimes and 15% left a needle, cannula, or spike device in place for later reuse.<sup>3</sup> A similar US survey in

**Table 5** Comparison of our sample with 2016 Canadian Medical Association (CMA) Masterfile Data<sup>27</sup>

<i>n</i> (%)	<i>Our sample</i>	<i>CMA</i>	<i>P value</i>
<b>Gender</b>			
<i>Male</i>	354 (66%)	2226 (68%)	<i>P</i> = 0.37
<i>Female</i>	183 (34%)	1048 (32%)	
<b>Total</b>	<b>537 (100%)</b>	<b>3274 (100%)</b>	
<b>Region</b>			
<i>West</i>	186 (34%)	1057 (32%)	<i>P</i> < 0.001
<i>Ontario</i>	221 (41%)	1218 (37%)	
<i>Quebec</i>	85 (16%)	761 (23%)	
<i>East</i>	51 (9%)	237 (7%)	
<b>Total</b>	<b>543 (100%)</b>	<b>3,273 (100%)</b>	
<b>Practice environment</b>			
<i>Community</i>	250 (34%)	1113 (34%)	<i>P</i> < 0.001
<i>Academic</i>	355 (49%)	1899 (58%)	
<i>Private</i>	68 (9%)	131 (4%)	
<i>Other</i>	57 (8%)	131 (4%)	
<b>Total</b>	<b>730 (100%)</b>	<b>3,274 (100%)</b>	
<b>Age<sup>1</sup></b>			
≥ 65	53 (10%)	392 (12%)	<i>P</i> < 0.001
55-64	129 (24%)	904 (29%)	
45-54	147 (27%)	848 (27%)	
35-44	127 (23%)	840 (27%)	
≤ 34	90 (17%)	187 (6%)	
<b>Total</b>	<b>546 (100%)</b>	<b>3,171 (100%)</b>	

<sup>1</sup> Because our survey used different age groupings than the CMA data, we split each ten-year grouping evenly into two five-year subgroupings and then added subgroupings so it would be similar to the CMA age groupings

2017 showed that 12% of physicians reported using the same syringe for more than one patient. In addition, 43% of the survey respondents re-entered a multidose medication vial with the same syringe for multiple doses for the same patient, yet only a quarter of those physicians indicated that they never use multidose vials for more than one patient.<sup>4</sup> This is a consistent pattern in our survey and those cited above. There are still some Canadian anesthesiologists reusing needles or syringes for more than one patient, which is clearly an unsafe practice. There also continues to be a widespread practice of sharing medication vials for more than one patient, usually prepared in the immediate patient care area, which is not supported by the guidelines. One could hypothesize that anesthesiologists may not feel that these particular CDC guidelines pertain specifically to them compared with medication preparation areas on a hospital ward that are shared with multiple healthcare personnel. Perhaps many feel that they can prevent infection breaches as effectively within their controlled environment by incorporating strict workflow and aseptic practices involving clean needles and syringes—or they

simply are not aware of the contamination risks that exist within an anesthesia workspace.<sup>16</sup> There are currently no published guidelines or recommendations that support this practice. In fact, the CDC and ASA Recommendations for Safe Injection Practices are to use single-dose vials (for a single patient) whenever possible and, if multidose vials *must* be used, they should not be kept in the immediate patient care area if used for more than one patient.<sup>8,12</sup> “For the practice of anesthesiology, the CDC defines the ‘Immediate Patient Treatment Area’ to include, at minimum, surgery/procedure rooms where anesthesia is administered and any anesthesia medication carts used in or for those rooms”.<sup>8</sup> The purpose is to ensure geographic separation; therefore, “a cart would not be an appropriate place for MDV aliquotting for multiple patients, regardless of where it is [located] at the time”.<sup>8</sup> Despite these clearly worded guidelines, many Canadian anesthesiologists clearly believe that this is an acceptable practice.

In any event, the fact is that transmission of blood-borne pathogens continues to occur.<sup>17,18</sup> Within the past five years, four hepatitis C virus (HCV) outbreaks have

occurred in endoscopy clinics across Ontario, resulting in 16 identified HCV-infected patients from four independent source cases.<sup>19-22</sup> In each case, following a thorough investigation, the mechanism for disease transmission was linked to medications administered by the anesthesiologist to multiple patients. Most of the anesthesiologists involved adamantly denied reusing needles or syringes and the investigators were unable to determine the precise mechanism of viral transmission. They were, however, able to categorically rule out the colonoscope as the mode of transmission, which left the only other possible mechanism being nosocomial transmission through contaminated intravenous medication, likely lidocaine.<sup>21</sup> Whether these medications were contaminated because of a breach in medication preparation practices (reuse of needles or syringes) or a contaminated workspace (from the patient care area to the medication preparation area) we may never know. The anesthesiologists involved may not have even appreciated this potential breach (as supported by the responses to Q. 16, Table S3, available as ESM). Nevertheless, it underscores the importance of proper medication preparation.

The economic burden of a single HCV infection in Canada, including treatment, extrahepatic manifestations, and work and productivity losses is estimated to be \$64,694.<sup>23,24</sup> Even acknowledging the added cost of pharmacy-prepared medication, or the purchasing of single-patient-use medication vials, a dollar value cannot balance the undo stress, anxiety, and suffering of infected patients.

Of all respondents who indicated reasons for reusing medication vials between patients, 52% indicated it was because the medications were distributed in multidose vials. Most likely there were other reasons influencing this practice as well, but some clinicians may feel that if a vial is labeled “multidose” it gives them implicit permission to use it for both multiple doses and multiple patients. In reality, multidose vials are labeled as such because there is either a preservative added to maintain the shelf life of the medication or an antibacterial agent has been added to minimize bacterial contamination, neither of which help prevent viral contamination and spread.<sup>25</sup> In fact, in response to HCV outbreaks in the United States, clinicians from the CDC have advocated for the elimination of multidose vials altogether.<sup>26</sup>

Another reason anesthesiologists may feel that it is acceptable practice to share medication vials is the cost. Most respondents identified the desire to reduce medication costs and waste as reasons for reusing medications between patients. The fact that at least one respondent reported that “our pharmacy encourages us to retain multi-dose vials as

a cost saving” suggests that in at least some centres, this practice is supported at the institutional level. Many (89%) also identified that the medication packaging (the dose supplied is significantly larger than most patients require) encourages reuse of these medications. Accordingly, drugs that are distributed in larger volumes (neostigmine, dexamethasone) or made for dilution (phenylephrine, ephedrine, remifentanyl) are reused more frequently than those packaged in smaller quantities (lidocaine, propofol, fentanyl). With most centres lacking a system for dividing medications into unit patient doses outside the operating room, providers who seek to minimize waste are driven to reenter medication vials in the patient care area multiple times between multiple patients.

Our response rate of 21% is a limitation of this study; yet this rate is only slightly lower than those of similar online surveys (i.e., 26%<sup>14</sup> and 39%).<sup>15</sup> Thus, our results are potentially impacted by the large number of non-responders, but it is possible that anesthesiologists who feel that they have acceptable medication administration practices would be more willing to complete the survey, potentially resulting in an over-representation of practices that are compliant with the guidelines. Furthermore, the goal of this study was not to exhaustively delineate all anesthesiologists’ medication preparation and administration practices, but rather to determine if potentially unsafe practices still exist. Our sample of over 500 anesthesiologists answers this question; thus, the actual number of responders is *as* important and relevant as the actual response rate. Another limitation is that, as outlined in our results, there are several differences in our sample compared with all licensed anesthesiologists across Canada as reported by the Canadian Medical Association<sup>27</sup> (Table 5).

Additional limitations include the lack of differentiation between multi- and single-dose vials in items 7 and 8. Practice guidelines recommend avoiding reusing multidose vials for multiple patients.<sup>6,8,12</sup> Because of this, and the fact that antimicrobials that are often used in multidose vials are inadequate to prevent disease transmission, we avoided the distinction.<sup>25</sup> We also recognize that the survey could have undergone more rigorous validation testing, including face validity, content validity, and test-retest reliability. Furthermore, when it was considered appropriate, the authors triaged “other” comments entered by the respondents into the predetermined categories as described in Table S3 and, as this process is largely subjective, some of the triage decisions may be open to debate. Finally, as indicated by the written comments (Table S3, available as ESM), some respondents reported that several questions were unclear.



Over the past 20 years, a significant effort has been made to reduce the risk of blood-borne pathogen transmission from patient to patient. We have come a long way from a 1995 survey revealing that only 58% of anesthesiologists washed their hands after patient contact, 20% frequently or always reused syringes between patients, and 34% did not disinfect the vial septum before use.<sup>28</sup> Nevertheless, this push to eliminate all risk comes at the cost of potentially diverting resources from other areas of the healthcare system. The primary barriers to safer medication administration practices identified in our study are largely systemic constraints such as medication costs, shortages, and waste. Tackling systemic issues such as drug shortages would be overly ambitious; easier fixes in the short term could be hospital pharmacy-prepared unit dose syringes, with longer term solutions sought by engaging the pharmaceutical industry to package medications in single-use vials containing an appropriate single-patient dose without added cost. Meanwhile, more research into quantifying the risk of disease transmission may help identify when further interventions have minimal return on investment or, in fact, detract from overall healthcare delivery in our country. That being said, preventing the spread of infectious diseases through proper medication handling in anesthetic practice needs to become a national priority. We must strive to be fully compliant with safe injection practice guidelines.

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