Safety-engineered intravenous catheter utilization among Canadian pediatric anesthesiologists

Utilisation des cathéters intraveineux conçus pour la sécurité par les anesthésiologistes pédiatriques canadiens

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Abstract

Introduction Compared with other specialties, anesthesiologists are at increased risk of acquiring a blood-borne pathogen (BBP) through needle-stick injuries (NSIs). Safety-engineered intravenous catheters (SEICs) have been designed to reduce NSIs but have not been well received. Our objective was to determine SEIC usage by pediatric anesthesiologists, including availability, utilization, perceived utility, and sources of NSI before and after legislation mandating their use in Canada.

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Methods After Ethics Committee approval, we conducted two electronic surveys of Canadian pediatric anesthesiologists (CPAs) based in tertiary care settings. Survey responses from May through August 2012 and June through September 2006 were considered. In addition to SEIC use and perceived utility, respondents described factors influencing SEIC adoption and workplace NSIs. Standard metrics of survey validity and reliability were employed.

Results Completed questionnaires were returned by 154 (69%) and 124 (53%) respondents in 2012 and 2006, respectively, representing 15 of 16 Canadian pediatric tertiary care centres. Reported SEIC availability increased in hospitals (82% vs 98%; difference in proportion 16%, 95% confidence interval [CI]: 9 to 24%; $P < 0.001$) and in operating rooms (62% vs 86%; difference in proportion 24%, 95% CI: 13 to 34%; $P < 0.001$). Respondents' report of "routine" personal use of SEICs increased from 43 of 76 (56%) to 112 of 132 (85%) (difference in proportion 29%, 95% CI: 16 to 41%; $P < 0.001$). Attitudes concerning perceived utility of SEICs remained unchanged and evenly split between respondents. "Awkward handling" remained

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the primary reason for non-use. In all, 71 (48%) and 60 (48%) respondents reported recent contaminated NSIs in 2012 and 2006, respectively. The majority were related to a needle on a disposable syringe.

Discussion Despite only moderate perceived utility, SEIC uptake among CPAs is high. However, NSIs remain common. Several opportunities to reduce the risk for work-related BBP transmission among CPAs were evident.

Résumé

Introduction Comparativement à d'autres spécialités, les anesthésiologistes sont exposés à un plus grand risque de contamination par un germe pathogène transporté par le sang (BBP) par le biais d'une piqûre d'aiguille. Des cathéters intraveineux conçus pour la sécurité (CIVS) ont été mis au point pour réduire les piqûres d'aiguilles, mais ils n'ont pas été bien accueillis. Notre objectif était de déterminer l'utilisation des CIVS par les anesthésiologistes pédiatriques, notamment la disponibilité, l'utilisation et l'utilité perçue de ces dispositifs, et les sources de piqûres d'aiguille avant et après l'adoption d'une loi rendant leur utilisation obligatoire au Canada.

Méthodes Après approbation du Comité d'éthique de la recherche, nous avons mené deux enquêtes électroniques des anesthésiologistes pédiatriques canadiens exerçant dans des centres tertiaires. Les réponses à l'enquête reçues de mai à août 2012 et de juin à septembre 2006 ont été prises en compte. En plus de l'utilisation et de l'utilité perçue des CIVS, les répondants ont décrit les facteurs influençant l'adoption des CIVS et les piqûres d'aiguille sur le lieu de travail. Des paramètres standard de validité et de fiabilité de l'enquête ont été employés.

Résultats Des questionnaires remplis ont été renvoyés par 154 (69 %) et 124 (53 %) personnes interrogées en 2012 et 2006, respectivement, représentant 15 des 16 centres pédiatriques canadiens de niveau tertiaire. La disponibilité déclarée des CIVS a augmenté dans les hôpitaux (82 % contre 98 %; différence en pourcentage 16 %, intervalle de confiance [IC] à 95 % : 9 % à 24 %; $P < 0,001$) et dans les salles d'opération (62 % contre 86 %; différence en pourcentage 24 %, IC à 95 % : 13 % à 34 %; $P < 0,001$). La déclaration d'une utilisation personnelle « habituelle » des CIVS par les répondants a augmenté de 43 sur 76 (56 %) à 112 sur 132 (85 %) (différence en pourcentage 29 %, IC à 95 % : 16 % à 41 %; $P = 0,001$). Les attitudes concernant l'utilité perçue des CIVS sont restées inchangées et également réparties entre les répondants. Une « manipulation malaisée » est restée le premier motif de non-utilisation. Globalement, 71 (48 %) et 60 (48 %) des répondants ont déclaré des piqûres d'aiguilles contaminées en, respectivement, 2012 et 2006. La majorité des incidents était due à une aiguille montée sur une seringue à usage unique.

Discussion En dépit d'une utilité perçue qui n'est que modérée, l'adoption des CIVS est élevée parmi les anesthésiologistes pédiatriques canadiens. Les piqûres d'aiguille restent néanmoins fréquentes. Plusieurs possibilités de réduction du risque de transmission des BBP au travail parmi les anesthésiologistes pédiatriques canadiens ont été évidentes.

Hospitals are under increasing pressure to adopt safety-engineered intravenous catheters (SEICs). Following the US Needle-stick Safety and Prevention Act (NSPA) in 2000, data from US hospitals reported a one-third reduction in the incidence of sharps-related injuries.¹ The decrease was sustained and associated with an estimated annual reduction of more than 100,000 injuries and a cost savings of \$69-\$415 million. Savings from reduced testing, treatment, time off work, and counseling resulting from workplace injury offset the acquisition costs of SEICs. Other studies, including those in Europe, have shown similar results.²⁻⁶ Canadian provinces followed suit, with Manitoba first legislating SEICs in 2006, followed by Saskatchewan, Nova Scotia, Ontario, and British Columbia. Alberta was the last province to enact legislation in 2010.⁷ Quebec, Newfoundland, and Labrador have yet to implement similar legislation. Unlike nurses, however, physicians are not bound by this legislation. They have the choice of avoiding SEICs in favour of "traditional" catheters if they think the clinical situation warrants it.

US and Canadian adult-based databases have identified the operating room as the most common location for needle-stick injuries (NSIs),^{7,8} with anesthesiologists being most at risk for infectious pathogen transmission.⁹ That said, anesthesiologists and their surgical colleagues are known to be the least likely to adopt safety-engineered devices.^{10,11} In contrast to the non-operative setting, implementation of the NSPA had no impact on injuries occurring in the operating room. Pediatric anesthesiologists have felt uniquely vulnerable because intravenous access in small children can be particularly technically challenging. Replacement of a familiar "traditional" catheter with an SEIC may paradoxically increase exposure to blood splatter and percutaneous infection by blood-borne pathogens (BBPs).¹² Nevertheless, the American College of Surgeons recently issued a "Statement on Sharps Safety" that endorsed the use of devices with engineered injury-prevention features.¹³ Both adult and pediatric anesthesia societies continue to remain silent on this topic.

There are limited data regarding the perceived utility and attitude toward manual and automated SEICs and the

extent of their adoption among pediatric anesthesiologists. We undertook a survey of Canadian pediatric anesthesiologists (CPAs) in 2006 and 2012, before and after initiation of SEIC legislation in Canada, to determine how SEIC-related measures changed over time, including availability, utilization, perceived utility, type of mechanisms used, opportunities for improvement, and overall satisfaction. In addition, we wanted to capture trends in non-SEIC-related sources of NSIs and physician engagement with the hospitals' occupational health and safety culture.

Methods

Following approval (December 2005) of the Children's Hospital of Eastern Ontario Research Ethics Board (Protocol #05/111X), we surveyed CPAs. The survey population for the 2006 survey was defined by membership in the Canadian Pediatric Anesthesia Society (CPAS) or practice in one of 16 Canadian pediatric tertiary care centres. For the 2012 survey, we narrowed the population to those practising in Canadian hospitals to limit responses from the small number of non-Canadian CPAS members. E-mail addresses were obtained through the CPAS membership list or by contacting the department chiefs for each of the 16 centres. Anesthesiologists in tertiary care centres were included only if they were known for their expertise in pediatrics.

Questionnaire development

Domains and item generation

The 46-item survey was partitioned into sections related to SEIC use, mechanisms of BBP risk reduction, and incidence of NSI among CPAs. Domains specific to SEICs were identified from literature related to needle-stick and sharps-related injuries among health care workers.^{9,12,14-20} They included perceived utility (primary outcome), availability, and mechanism type; physician uptake (usage); opportunities for improvement; and overall satisfaction. Domains related to limiting transmission of BBPs included Occupational Health and Safety Committee (OHSC) engagement, familiarity with related literature and evidence of engineering, work practice, and administrative controls. A list of questions was generated by a group of clinicians with expertise in anesthesiology to address these domains. Additional questions were used (with permission) from a previous survey by Tait *et al.*¹⁴ to capture data on characteristics of recent NSIs, recapping procedures, and post-exposure prophylaxis. One question related to mandatory testing for BBPs was added to the 2012 survey.

Demographic data, including age, sex, duration of anesthesia practice, pediatric exposure, disability insurance ownership, history of hepatitis B virus (HBV) vaccination, and hospital location, were also collected. Questions were arranged to differentiate between users and non-users of SEICs (when available) and were formatted such that skip logic would not allow respondents to answer questions that were not relative to them. Where appropriate, agreement was ranked using a five-point Likert scale ranging from the number 1 "strongly agree" to number 5 "strongly disagree". Demographic information and questions regarding NSI and OHSC engagement were collected using nominal scales. Respondents were able to provide written comments. A copy of the questionnaire is provided in the [Appendix](#).

Questionnaire pilot testing

Validity and clinical sensibility testing

Face and content validity were assessed by 11 individuals with experience in anesthesia (but not involved with the survey development) who were asked to provide survey feedback concerning clarity, comprehensiveness, and omissions. To account for our francophone population of physicians, a hospital-based translator translated the final survey and accompanying information for survey implementation. A francophone anesthesia assistant reviewed all of the documents to ensure clarity.

Test-retest reliability

Eleven individuals – primarily Canadian anesthesiologists and anesthesia assistants – completed the English version of the survey on two occasions several weeks apart. To minimise practice bias, the appearance and order of the survey questions were altered on the second occasion. The test-retest agreement rate was 77% (interquartile range [IQR]: 46-100) and 71% (IQR: 48-89) for binary and Likert-scale based questions, respectively.

Construct validity

The degree of association between SEIC-user status and agreement with measures of perceived utility was used as a measure of construct validity, where SEIC users would have greater agreement with their perceived utility.

Survey administration

The first survey was conducted in June 2006 with a link using Survey Monkey© software sent via e-mail. Non-responders received three delayed repeat survey requests,

the final one in September. Consent was implied by providing a link to a bilingual information site, reading the cover letter, and returning the completed survey. An identical approach was used for the follow-up survey sent in May 2012 via e-mail using Checkbox© software with a final request sent in June. Survey responses were stored in a password-protected Internet server that was accessible only by the principal investigator.

Sample size

Mean survey response rates of 54–61% have been reported for physicians.^{21,22} Based on the combined number of CPAS members and active staff pediatric anesthesiologists available in 2006 ($n = 236$) and assuming a relatively homogeneous response to perceptions related to the primary outcome of SEIC utility (survey questions 1–3), a sample size of 121 respondents was necessary to yield a maximum 95% confidence interval (CI) half-width of 5%.²³ In 2012, under the assumption of heterogeneous responses to survey questions 1–3 (based on 2006 results), we estimated the final sample size to be 141 respondents.

Analyses

The data were analyzed using SPSS 21 (SPSS, Inc., Chicago, IL, USA) and R 3.0.2. Descriptive data were presented as proportions or medians. Inter-rater reliability was assessed using Cohen's kappa and intra-class correlation coefficients, as appropriate. Hospital-specific data within provinces was merged into geographic regions to maintain site anonymity. Construct validity was assessed by testing linear-by-linear associations between SEIC use and perceptions concerning its utility (questions 1–3) using Pearson's Chi square test. $P < 0.05$ was considered to indicate statistical significance.

Results

Survey population

A total of 154 (69%) surveys were returned from 223 administered in 2012 compared to 124 of 236 (53%) in 2006 (Fig. 1). All of the provinces were well represented for both years, with only Quebec having a low response rate. The median (range) response rates within each centre were 71% (33–100%) and 57% (44–88%) for the years 2012 and 2006, respectively. An error resulted in no survey being sent to the smallest Quebec hospital site in 2012. Table 1 provides the demographics of the respondents, which were similar for both years.

Fig. 1 Survey flow diagram, by survey year

Availability, utilization, and perceived utility of SEICs

Between 2006 and 2012, there was a significant increase in the number of respondents who reported SEIC availability in hospitals (82% vs 98%; difference in proportion 16%, 95% CI: 9 to 24%; $P < 0.001$), in the operating room (62% vs 86%; difference in proportion 24%, 95% CI: 13 to 34%; $P < 0.001$), and in routine use (56% vs 85%; difference in proportion 29%, 95% CI: 16 to 41%; $P < 0.001$) (Fig. 2). Notably, utilization increased despite insignificant levels of agreement regarding the utility of SEICs on measures of mandatory use ($P = 0.36$), effectiveness ($P = 0.72$), and quality of care ($P = 0.15$) which remained unchanged between surveys (Fig. 3 a-c). In 2006, the construct of SEIC-user status and perceived utility was not validated based on the lack of an association between the respondent SEIC-user status (yes vs no) and agreement with mandatory use ($P = 0.14$), effectiveness ($P = 0.56$), and impact on quality of care ($P = 0.97$) questions. By 2012, however, non-users had become a minority and were very negative toward SEICs for all three statements ($P < 0.001$). The top three reasons for SEIC avoidance for both years were awkward handling, inadequate blood flashback, and awkward catheter disengagement.

Table 1 Characteristics and demographics of respondents, by survey year

Variable	2006 (<i>n</i> = 124)* No. (%)	2012 <i>n</i> = (154)* No. (%)
Province of practice		
Newfoundland	2 (2)	3 (2)
Nova Scotia	4 (3)	10 (6)
Québec	16 (13)	20 (13)
Ontario	51 (41)	62 (41)
Manitoba	3 (2)	6 (4)
Saskatchewan	4 (3)	10 (6)
Alberta	19 (16)	23 (15)
British Columbia	11 (9)	15 (10)
Missing	14 (11)	5 (3)
Age bracket (yr)		
25-30	2 (2)	2 (1)
31-40	34 (27)	37 (25)
41-50	49 (40)	54 (35)
51-60	34 (27)	53 (34)
>60	4 (3)	8 (5)
Missing	1 (1)	0
Sex		
Female	72 (58)	67 (44)
Male	50 (40)	87 (56)
Missing	2 (2)	0
Duration of practice (yr)		
0-5	7 (6)	3 (2)
6-15	49 (40)	59 (38)
16-25	45 (35)	45 (29)
26-35	20 (16)	41 (27)
>35	2 (2)	6 (4)
Missing	1 (1)	0
Time devoted to administering anesthesia to children (hr/week)		
<10	24 (20)	10 (6)
11-20	16 (13)	22 (14)
21-30	17 (14)	30 (20)
31-40	24 (18)	35 (23)
>40	42 (34)	57 (37)
Missing	1 (1)	0
Proportion pediatric (vs adult) practice (%)		
<10	15 (12)	5 (3)
10-25	21 (17)	13 (8)
26-50	9 (7)	18 (12)
51-75	2 (2)	9 (6)
76-100	76 (61)	109 (72)
Missing	1 (1)	0
Disability insurance		
Yes	115 (93)	146 (95)
No	8 (6)	8 (5)

Table 1 continued

Variable	2006 (<i>n</i> = 124)* No. (%)	2012 <i>n</i> = (154)* No. (%)
Missing	1 (1)	
Blood-borne pathogen insurance rider**		
Yes	73 (63)	85 (58)
No	2 (2)	6 (4)
Do not know	40 (35)	55 (38)
Missing	0	0
Hepatitis B virus vaccination		
Yes	118 (96)	153 (99)
No	3 (2)	1 (1)
Missing	3 (2)	0

*Includes safe intravenous catheters, both available and unavailable

**For those who answered “Yes” to having disability insurance

Types of available SEIC mechanisms and satisfaction

In 2006, manually activated mechanisms were the most commonly reported SEICs (84%), with an automated system accounting for only 16% of SEICs and consisting of either a self-blunting needle (11%) or a sheath (5%). In 2012, there was a decrease in the proportion of manual mechanisms to 54% (difference in proportion 30%, 95% CI: 17 to 41%; $P < 0.001$) and a concurrent significant increase in the availability of automated mechanisms to 36% (difference in proportion 20%, 95% CI: 7 to 30%; $P < 0.001$). Reported satisfaction with SEIC performance remained high among SEIC users (88% and 80%) and moderate in the combined group of users/non-users (55% and 69%) for survey years 2006 and 2012, respectively. Despite increased availability of SEICs, traditional intravenous catheters continued to be available in the hospital operating rooms, with 79% and 86% of the respondents reporting their availability in 2006 and 2012, respectively. During the study period it appeared that only one hospital, located in Ontario, had removed all traditional intravenous catheters from their inventory.

Opportunities to improve SEICs

The structural and functional issues identified relating to user and catheter types are shown in Fig. 4. SEIC users consistently identified three issues in 2006 and 2012: reducing device bulkiness, improving flashback visualization, and allowing for guidewire passage through smaller catheters. SEIC non-users also wanted an improved method for catheter disengagement from the needle. Qualitative comments in 2006 were primarily concerned with developing stiffer catheters, the ability to deactivate

Fig. 2 Canadian availability and utilization of safety engineered intravenous catheters among pediatric anesthesiologists, by survey year. BC = British Columbia; AB = Alberta; SK = Saskatchewan; MB = Manitoba; NS = Nova Scotia and NL = Newfoundland and Labrador

the safety mechanism, and promoting qualities to facilitate arterial and central venous line access. In 2012, the suggestions were fewer in number and non-specific. Improvements for patient benefit were not mentioned.

Sources of NSIs

In 2006, a total of 60 (48%) respondents indicated that they had suffered at least one type of contaminated NSI during the previous three years (Table 2), but only 55% routinely reported them to their OHSC. In 2012, an identical percentage of respondents indicated that they had suffered an NSI, although OHSC reporting had increased to 70%. Injuries related to needles on disposable syringes were consistently the most common type of NSI. Needlestick injuries during intravenous access were reported by seven (6%) and 9 (6%) respondents in 2006 and 2012, respectively. Only one intravenous access injury, reported in 2012, was related to an SEIC. NSIs related to intravenous port injections were reported by 21 (17%)

and 11 (7%) respondents in 2006 and 2012, respectively (difference in proportion 10%; 95% CI: 2 to 18%, $P = 0.01$). Needleless intravenous injection ports were reported by 144 (94%) respondents, an 11% (95% CI: 4 to 20%, $P < 0.01$) increase from the 101 respondents (82%) in 2006. There were no differences in NSI sources between SEIC users and non-users for the two years.

Occupational health and safety awareness and engagement

From 2006 to 2012, both OHSC awareness (42 respondents [34%] vs 125 respondents [81%], difference in proportion 47% [95% CI: 36 to 57%], $P < 0.001$) and an anesthesiologist's role in SEIC purchase increased (11 respondents [14%] vs 79 respondents [60%], difference in proportion 46%, [95% CI: 33 to 56], $P < 0.001$), although less than two-thirds reported receiving formal SEIC training in both 2006 and 2012. Active OHSC engagement was reported by only 44% and 34% of the 2012 and 2006

Fig. 3a-c Responses to questions related to perceived utility of safety-engineered intravenous catheters, by survey year. Note: IVs = intravenous catheter

respondents, respectively. Reading guidelines on infection control was not associated with an increase in SEIC use. Notably, non-SEIC users did not have a unique profile and did not differ on measures of risky behaviour, such as non-HBV vaccination ($P = 0.30$), lacking disability insurance ($P = 1.00$), or increased contaminated NSIs ($P = 0.75$). Also, the SEIC non-users had demographic features comparable to those of the SEIC users. Finally, the majority (n, %) of 2012 respondents (115, 75%) disagreed with annual mandatory testing for BBPs.

Discussion

We found a marked increase in availability and utilization of SEICs by CPAs over a six-year period beginning in 2006. When SEICs were available, 85% of respondents reported routine use, although traditional catheters continued to be available in the majority of hospitals. SEIC unavailability

was most prominent in Quebec, which has not legislated their use. Our results suggest that CPAs' attitudes toward SEICs are more positive and their level of adoption higher than was suggested by earlier related adult and pediatric anesthesia literature.^{12,24,25} The majority routinely used SEICs in their daily practises, although they remained divided on their perceived utility and impact on patient care. Increased adoption of automated SEICs was encouraging, given their efficacy over manual mechanisms,²⁶ but key issues for catheter improvement remain. Nevertheless, satisfaction with SEICs was consistently reported by more than 80% of users. CPAs continued to be susceptible to injuries related to needles on disposable syringes, and they appear to have an inconsistent appreciation of the risk of acquiring a BBP through their practices. Higher rates of SEIC adoption and injury reporting were countered by low OHSC engagement, limited familiarity with related literature, and ignorance regarding disability insurance coverage. Variable compliance to basic guidelines to limit

Fig. 4 Suggested safety engineered intravenous catheter improvements according to user status, by survey year. Note: * “Manual” refers to a mechanism that requires initiation by the operator; ** “Automatic” refers to a mechanism that initiates automatically. SEIC = safety engineered intravenous catheter

Table 2 Sources of contaminated needle-stick injuries reported during the previous 3 years, by survey year

Etiology of needle-stick injury	2006	2012
	Yes/total (%)	Yes/total (%)
Needle injection into intravenous tubing port	21/122 (17)	11/154 (7)
Accessing a medical vial	16/122 (13)	16/154 (10)
Recapping a needle	12/123 (10)	16/154 (10)
Handling a suture needle	9/121 (7)	13/154 (8)
Handling an intravenous catheter	7/124 (6)	9/154 (6)
Subcutaneous injection of local anesthetic	5/123 (4)	5/154 (3)
Working with a central venous line	4/123 (3)	4/154 (3)
Working with an arterial line	3/123 (2)	3/154 (2)
During a peripheral nerve block	1/123 (1)	1/153 (1)
During a subarachnoid block	0/120 (0)	1/154 (1)
During an epidural block	1/122 (1)	1/154 (1)
Other	*11/124 (9)	**2/154 (1)

*Common themes included injuries caused by overfull sharps containers, intramuscular ketamine injection, and somatosensory evoked potential needles

**Injury caused by overfull sharps container or intramuscular ketamine injection

the transmission of BBPs in the workplace¹⁷ was also noted, possibly reflecting limited engagement with local OHSCs.

Remarkably, approximately half of our respondents in both surveys admitted to recent contaminated NSIs. Even though only a small number were at high risk for BBP transmission (i.e., hollow-bore needles filled with blood),²⁷ one should not be complacent because any injury can create a portal of entry for infection from body fluids.^{28,29} The reluctance to adopt

safety-engineered medical devices is unfortunate because it may put one at increased risk of infection with the hepatitis C virus, the greatest concern for anesthesiologists managing children or adults.³⁰ Also, children are living longer with perinatal acquired human immunodeficiency virus (HIV), making HIV infection an ever-present risk.^{31,32}

Lack of available SEICs or reluctance to use them may affect the health and safety of trainees, co-workers, and

patients. Anesthesia-specific^{15,16,33} and non-specific^{7,8} articles clearly show that trainees have at least the same if not a greater risk for NSIs. Nurses are mandated by legislation to use SEICs. Injury from traditional devices may make them ineligible for disability claims. If we expect their assistance, we should use the same devices. Furthermore, 31% of injured hospital workers are not the original user of the sharp item.⁸ Inadvertent NSIs also can occur in staff involved with hospital maintenance, including waste management, housekeeping, and laundry services, as well as the general public itself. The latest SEIC prototypes are designed to reduce catheter-related bacterial infection,³⁴ which are responsible for an estimated 10% of nosocomial infections,³⁵ and are clinically acceptable for delivering high flows.³⁶

Respondents offered many suggestions for improving the design of SEICs for pediatric practise. Strauss *et al.*³⁴ identified a need for instantaneous blood flashback and total elimination of blood exposure to the provider. Pediatric SEIC-related anesthesia publications lament their inappropriateness for arterial line access, awkward handling, and blood-splatter exposure.^{12,25} The latter is a problem with manual needle retraction systems that lack a catheter hub-placed valve designed to prevent retrograde blood flow. Our findings were similar. A need to pass a guidewire through small gauges suggests that pediatric anesthesiologists are eager to use SEICs for arterial access. An adult study showed that safety catheters, compared to traditional catheters, were not more difficult to place even though the operator felt uncomfortable with them.³⁷ Interestingly, blood splatter was not a major concern, likely because of an increase in market penetration of automated self-blunting and blood-splash reduction technology that has been shown to reduce blood-splatter exposure.³⁴ The main advantage of an automated safety mechanism is the inability to bypass it. Non-activation of manual safety mechanisms is responsible for as many as 80% of NSIs.^{7,8} A large French, two-year multicentre trial involving 61 hospitals and 22 million safety-engineered devices showed that the fully automated devices were associated with the lowest incidence of NSIs.²⁶ Other benefits of automated SEICs include efficacy comparable to that of traditional catheters and ease of venous insertion.³⁷

The persistence of NSIs related to needles on disposable syringes was disappointing and supports recent data reporting them as the major source of injury inside and outside of the operating room.⁸ In fact, this pattern is identical to that in 20-yr-old adult anesthesia literature.^{15,16} Remarkably, even though recapping needles is a common, well-known cause for NSIs, it remained among the top three causes for syringe-related injuries for both years of our survey. Our study's findings of intravenous access-related injuries occurring primarily after use but before disposal – with the majority considered preventable – mirrors findings of previous studies.^{9,15,16} The reported rise

in needleless intravenous tubing associated with a decline in associated NSIs, however, was encouraging.

The strengths of our study include national pediatric anesthesia representation, bilingual format, robust longitudinal survey design,^{23,38} and its clinical relevance to defining SEIC uptake, identifying sources of NSIs, and highlighting opportunities to reduce BBP transmission risk among frontline physicians. Our study results may not reflect the approximately one-third of tertiary care specialists who did not respond or those who manage children in combined adult and pediatric practices. The concordance rate (> 70%) in the test–retest reliability was moderate and may reflect evolving experience (and the associated perception of the impact on patient care) with a novel device at the time. The validation phase of the questionnaire may have been affected as a consequence. This study was subject to recall bias concerning catheter performance and the source and number of previous NSIs. It is possible for sites to have tried and then rejected SEICs in the interim – that is, sites perceived as not having catheters may have actually tried some or the respondents commented on only the most recent SEIC used. The true SEIC adoption rates may be lower than those reported as suggested by previous studies in settings where both SEICs and traditional catheters were available.³⁹

In conclusion, implementing safety-engineered medical devices is a key component to reducing BBP transmission among health care workers. Canadian pediatric anesthesiologists are increasingly adopting SEICs in provinces where they are legislated. Automated devices, resembling traditional catheters and safer than manual ones, are becoming more prominent. However, an unacceptable rate of NSIs persists among pediatric anesthesiologists. Opportunities for device improvement through industry engagement include designs to accommodate peripheral arterial lines in infants and safety-engineered needles on disposable syringes, sutures, and surgical blades. Practice controls that promote safe intravenous insertion techniques, one-handed needle capping, or use of blunt-tip needles should be encouraged, as should the appropriate use of sharps containers and timely and accurate NSI reporting. Embedding an NSI report within the surgical debrief would facilitate the latter.⁴⁰ Anesthesiologists have long been known to be leaders in implementing patient-safety initiatives. Accordingly, we believe that it is time for the Canadian Pediatric Anesthesia Society to step forward and publicly endorse SEICs as a safety initiative for both providers and potentially patients.

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Conflicts of interest None declared.

Appendix: English survey

Name: _____ Date: _____ Reliability 1 of 2

1. Please indicate the extent to which you agree or disagree with the following statement: "the use of safety intravenous catheters should be mandatory for pediatric anesthesiologists"

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

2. Please indicate the extent to which you agree or disagree with the following statement: "safety intravenous catheters significantly reduce the frequency of needlestick injuries to Pediatric Anesthesiologists."

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

3. Please indicate the extent to which you agree or disagree with the following statement: "safety intravenous catheters reduce the quality of patient care."

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

4) Please indicate the extent to which you agree or disagree with the following statement: "anesthesiologists who perform procedures prone to exposure to patient blood MUST be tested annually for HBV, HCV, and HIV."

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

5. Are you aware of the government legislation which mandates the use of safety intravenous catheters in your province?

- ☐ Yes
- ☐ No

6. Does your Hospital have an Occupational Health and Safety Committee?

- ☐ No → **SKIP TO 8**
- ☐ Don't Know → **SKIP TO 8**
- ☐ Yes

7. If Yes, Please indicate the extent to which you agree or disagree with the following statement: "the Occupational Health and Safety Committee in our hospital has an active relationship with our department"

- ☐ Strongly agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Strongly disagree

8. Are safety intravenous catheters engineered to reduce needle stick injuries available in your hospital?

- ☐ Yes
- ☐ No

9. Are safety intravenous catheters engineered to reduce needle stick injuries available in your operating rooms?

- ☐ No → **SKIP TO 20**
- ☐ Yes

10. (If Yes), approximately how long have safety intravenous catheters been available to anesthesiologists in your operating rooms?

- ☐ Up to 1 year
- ☐ 1-2 years
- ☐ 2-3 years
- ☐ 4-5 years
- ☐ > 5 years

11. In what manner is the safety mechanism engaged (*one answer only please*)?

- ☐ Active (you have to initiate it your self)
- ☐ Passive (it occurs automatically)

12. Please indicate the specific mechanism of action of the safety intravenous catheter available to you.

- ☐ Needle physically retracts
- ☐ Entire needle stylet is encased by sheath (no retraction)
- ☐ Only needle tip protected (ie self blunting)

- ☐ Valve in hub of catheter prevents retrograde blood spillage
- ☐ Other (specify): _____

13. Concerning the safety IV catheter that is used by your department, how easy is it to deactivate the safety mechanism without rendering the catheter unusable?

- ☐ Very Easy
- ☐ Easy
- ☐ Difficult
- ☐ Very Difficult
- ☐ Impossible to deactivate

14. Did your department have an active role in determining which safety intravenous device was to be purchased?

- ☐ Yes
- ☐ No
- ☐ Don't Know

15. Did you receive a formal in-service regarding the proper use of the safety intravenous catheter that is available to you?

- ☐ Yes
- ☐ No

16. How often do you use safety intravenous catheters in your everyday pediatric practice?

- ☐ All of the time
- ☐ Most of the time
- ☐ Some of the time
- ☐ Rarely
- ☐ Never
- ☐

17. Do you routinely (on a daily basis) use safety intravenous catheters in your practice?

- ☐ Yes → **SKIP TO 19**
- ☐ No

18. (If No) please indicate the reason(s) that best explain why you don't use the safety intravenous catheters available to you.

a) Limited availability?

- ☐ Yes
- ☐ No

b) Awkward to handle?

- ☐ Yes
- ☐ No

c) Inconsistent mechanical function?

- ☐ Yes
- ☐ No

d) Inadequate visualization of blood flashback?

- ☐ Yes
- ☐ No

e) Excessive operator exposure to blood (example: blood splash)?

- ☐ Yes
- ☐ No

f) Awkward to disengage catheter from needle?

- ☐ Yes
- ☐ No

g) Inappropriate length?

- ☐ Yes
- ☐ No

h) Inappropriate gauge available?

- ☐ Yes
- ☐ No

i) Haven't got around to trying them?

- ☐ Yes
- ☐ No

j) Other (specify): _____

19. Please indicate the extent to which you are either satisfied or dissatisfied with the performance of the current safety intravenous catheter you are using.

- ☐ Very satisfied
- ☐ Somewhat satisfied
- ☐ Neither satisfied or dissatisfied
- ☐ Somewhat dissatisfied
- ☐ Very dissatisfied

20. Are conventional (no safety mechanism) intravenous catheters readily available to you?

- ☐ Yes
- ☐ No

21. If given the opportunity, in regards to the current safety intravenous catheter you use, please indicate which aspects you would improve upon.

- ☐ Encourage a passive mechanism (occurs automatically)
- ☐ Improve the reliability of the mechanism
- ☐ Reduce the bulkiness of the device
- ☐ Improve flashback visualization
- ☐ Encourage active mechanism (initiate yourself)
- ☐ Make smaller gauges available
- ☐ Increase the length of the needle
- ☐ Reduce the length of the needle

- ☐ Make the needle sharper
- ☐ Make the needle duller
- ☐ Improve the means of catheter disengagement from the needle
- ☐ Ensure that a guide wire can pass through the smaller catheter sizes
- ☐ Reduce blood splatter
- ☐ Other: _____

22. Have you received a contaminated (ie. in contact with the patient) needle stick injury related to attempting intravenous access in a pediatric patient (< 18yrs) during the last three (3) years?

☐ No → **SKIP TO 29**

☐ Yes

23. (If Yes), how many pediatric contaminated needle stick injuries related to gaining intravenous access have you had in the last three (3) years?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 or more

24. When did the contaminated needle stick injury occur? If reporting more than one injury, when did the majority of injuries occur (one answer only, please)?

- ☐ During IV access
- ☐ After IV access but before needle disposal
- ☐ During needle disposal

25. Did any involve recapping the needle?

- ☐ Yes
- ☐ No

26. Did any involve a safety intravenous catheter?

- ☐ Yes
- ☐ No

27. In your opinion, were the majority of the injuries preventable?

- ☐ Yes
- ☐ No
- ☐ Don't know

28. Did you seek antiviral treatment after any needle stick injury?

- ☐ Yes
- ☐ No

29. Please indicate other situations that have caused you a contaminated (ie. in contact with the patient) needle stick injury in a pediatric patient (< 18yrs) during the last three (3) years?

a) Arterial line access

- ☐ Yes
- ☐ No

b) Central venous line access

- ☐ Yes
- ☐ No

c) Subcutaneous injection of local anesthetic

- ☐ Yes
- ☐ No

d) Peripheral nerve block

- ☐ Yes
- ☐ No

e) Subarachnoid block

- ☐ Yes
- ☐ No

f) Epidural block

- ☐ Yes
- ☐ No

g) Suture needle

- ☐ Yes
- ☐ No

h) Needle injection into intravenous tubing port

- ☐ Yes
- ☐ No

i) Recapping a needle

- ☐ Yes
- ☐ No

j) Access medication vial

- ☐ Yes
- ☐ No

k) Other (specify): _____

30. If applicable, have you routinely reported your own contaminated needle stick injuries to the occupational health and safety department?

- ☐ Yes
- ☐ No
- ☐ Not applicable

31. Is intravenous tubing with needle less injection ports available in your operating room theaters?

- ☐ Yes
- ☐ No

32. Have you read the Health Canada Guidelines regarding transmission of blood borne pathogens and standard precautions (formerly universal precautions) for HIV/HBV or HCV?

☐ Yes → **SKIP TO 34**

☐ No

33. (If No), are you aware of the content of these guidelines?

☐ Yes

☐ No

34. Have you read the ASA's recommendations for Infection Control?

☐ Yes → **SKIP TO 36**

☐ No

35. (If No), are you aware of the content of these guidelines?

☐ Yes

☐ No

36. Have you been fully vaccinated against the Hepatitis B virus?

☐ Yes

☐ No

37. Are sharps boxes *routinely* available to you, *within arms reach*, when administering anesthesia to pediatric patients?

☐ Yes

☐ No

The following questions are designed to provide background information on the anesthesiologist completing this survey.

38. What is your age bracket?

☐ 25-30 years

☐ 31-40 years

☐ 41-50 years

☐ 51-60 years

☐ > 60 years

☐

☐

39. Your gender?

☐ Female

☐ Male

40. How many years (including training) have you been practicing anesthesia?

☐ 0-5 years

☐ 6-15 years

☐ 16-25 years

☐ 26-35 years

☐ > 35 years

41. Approximately how many hours per week do you administer anesthetics to children?

☐ < 10 hours

☐ 11-20 hours

☐ 21-30 hours

☐ 31-40 hours

☐ > 40 hours

42. How would you describe your pediatric practice environment?

☐ Tertiary Care Pediatric Center (free standing hospital)

☐ Tertiary Care Referral Center (combined with adult hospital)

☐ Other (describe): _____

43. What percentage of your practice is pediatric based?

☐ < 10 %

☐ 10-25%

☐ 26-50%

☐ 51-75%

☐ 76-100%

44. Do you carry disability insurance?

☐ No → **SKIP TO 46**

☐ Yes

45. (If Yes), does your disability insurance include an occupational rider that protects you against infections (eg. HIV) acquired through your work?

☐ Yes

☐ No

☐ Don't know

46. Please indicate in which hospital you practice pediatric anesthesia (Note: data related to specific hospitals will remain *anonymous* in the published results).

☐ Alberta Children's Hospital Calgary Regional Health

☐ British Columbia Children's Hospital

☐ Centre Hospitalier de l'Universite Quebec

- ☐ Centre Hospitalier de l'Université Sherbrooke
- ☐ Children's Hospital of Eastern Ontario
- ☐ Hopital Ste Justine
- ☐ Izaak Walton Killam Hospital
- ☐ Janeway Children's Hospital
- ☐ Kingston General Hospital
- ☐ London Health Sciences Center
- ☐ McMaster University Medical Center
- ☐ Montreal Children's Hospital
- ☐ Royal University Hospital
- ☐ Stollery Children's Health Center
- ☐ The Hospital for Sick Children
- ☐ Winnipeg Children's Hospital

Thank you for your time and effort to complete this questionnaire.

Sincerely,

Kimmo Murto, Sophie Breton, Kelly-Ann Ramakko, Kathryn Williams, Rob Perverseff and Greg Bryson

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