

Surgical site infection prevention: a survey to identify the gap between evidence and practice in University of Toronto teaching hospitals

Cagla Eskicioglu, MD^{*†‡}
 Anna R. Gagliardi, PhD^{*†§}
 Darlene S. Fenech, MD^{*§}
 Shawn S. Forbes, MD^{*†}
 Marg McKenzie, RN[‡]
 Robin S. McLeod, MD^{*†‡}
 Avery B. Nathens, MD^{*†¶}

From the Departments of *Surgery and †Health Policy, Management and Evaluation, University of Toronto, and the Departments of Surgery at ‡Mount Sinai Hospital, §Sunnybrook Health Sciences Centre and ¶St. Michael's Hospital, Toronto, Ont.

Accepted for publication
 Dec. 5, 2011

Presented at the Surgical Infection Society Annual Meeting, May 8, 2008, Hilton Head, South Carolina

Correspondence to:

A. Nathens
 St. Michael's Hospital
 Queen Wing, 3N-073
 30 Bond St.
 Toronto ON M5B 1W8
 NathensA@smh.toronto.on.ca

DOI: 10.1503/cjs.036810

Background: A gap exists between the best evidence and practice with regards to surgical site infection (SSI) prevention. Awareness of evidence is the first step in knowledge translation.

Methods: A web-based survey was distributed to 59 general surgeons and 68 residents at University of Toronto teaching hospitals. Five domains pertaining to SSI prevention with questions addressing knowledge of prevention strategies, efficacy of antibiotics, strategies for changing practice and barriers to implementation of SSI prevention strategies were investigated.

Results: Seventy-six individuals (60%) responded. More than 90% of respondents stated there was evidence for antibiotic prophylaxis and perioperative normothermia and reported use of these strategies. There was a discrepancy in the perceived evidence for and the self-reported use of perioperative hyperoxia, omission of hair removal and bowel preparation. Eighty-three percent of respondents felt that consulting published guidelines is important in making decisions regarding antibiotics. There was also a discrepancy between what respondents felt were important strategies to ensure timely administration of antibiotics and what strategies were in place. Checklists, standardized orders, protocols and formal surveillance programs were rated most highly by 75%–90% of respondents, but less than 50% stated that these strategies were in place at their institutions.

Conclusion: Broad-reaching initiatives that increase surgeon and trainee awareness and implementation of multifaceted hospital strategies that engage residents and attending surgeons are needed to change practice.

Contexte : On constate un écart entre les preuves exemplaires et la pratique en ce qui a trait à la prévention de l'infection des plaies chirurgicales. La dissémination des preuves constitue la première étape du transfert des connaissances.

Méthodes : On a fait parvenir un questionnaire web à 59 chirurgiens généraux et 68 résidents d'hôpitaux affiliés à l'Université de Toronto. Le questionnaire portait sur 5 facettes de la prévention de l'infection des plaies chirurgicales, notamment la connaissance des stratégies de prévention, l'efficacité des antibiotiques, les stratégies de modification des pratiques et les obstacles à l'application des stratégies de prévention de l'infection des plaies chirurgicales.

Résultats : Soixante-seize personnes (60 %) ont répondu. Plus de 90 % des répondants ont affirmé que des preuves appuient le recours à l'antibioprophylaxie et à la normothermie périopératoire et ont déclaré utiliser ces stratégies. On a noté un écart entre les preuves perçues et les déclarations des répondants quant à l'hyperoxie périopératoire, l'omission du rasage et la préparation intestinale. Quarante-vingt-trois pour cent des répondants ont estimé important de consulter les lignes directrices publiées avant de prendre des décisions relatives à l'antibiothérapie. On a également noté un écart entre les stratégies jugées importantes par les répondants pour veiller à l'administration de l'antibiothérapie en temps voulu et les stratégies réellement en place. Ce sont les listes de vérification, les ordonnances standardisées, les protocoles et les programmes de surveillance formels qui ont été jugés les plus importants par 75 %–90 % des répondants, mais moins de 50 % ont affirmé que de telles stratégies étaient en place dans leur établissement.

Conclusion : Il faut appliquer des initiatives à large portée pour mieux sensibiliser les chirurgiens et les résidents et mettre en œuvre des stratégies hospitalières diversifiées pour inciter les résidents et les chirurgiens à modifier leur pratique.

Surgical site infections (SSIs) are the most common complication following surgery, with reported rates ranging from 5% to 30%.¹ The attributable morbidity and mortality is significant, with patients who experience SSIs being 60% more likely to spend time in the intensive care unit, 5 times more likely to be readmitted to hospital and twice as likely to die than patients without SSIs.² Whereas many risk factors for the development of SSIs are related to patient characteristics that cannot be easily modified, there are a variety of system or hospital factors that can be manipulated. These include improper selection and administration of antibiotic prophylaxis, intraoperative hypothermia and intraoperative hyperglycemia.³

Despite clear evidence and guidelines to direct SSI prevention strategies, compliance is uniformly poor.⁴ For example, Hedrick and colleagues³ reported baseline compliance with appropriate timing of antibiotic prophylaxis in only 68% of patients having elective colorectal surgery. This same study also revealed that 36% of patients arrived in the postanesthetic care unit with core temperatures less than 36°C.³ Forbes and colleagues⁵ found that as few as 5% of patients received their preoperative antibiotics within 60 minutes of surgery and that as many as 40% were admitted to the recovery room with core temperatures below 36°C. Another audit of 1763 patients at 13 Dutch hospitals revealed that overall adherence to a hospital guideline for antibiotic prophylaxis was achieved in only 28% of patients.⁶ These studies are just a few examples that highlight the gap between evidence and practice and emphasize the importance and need for tailored knowledge translation strategies to improve adherence to guidelines.

Knowledge translation has been defined as follows: “the exchange, synthesis and ethically sound application of knowledge (...) to accelerate the capture of the benefits of research, is the field of study which examines the effectiveness of various strategies for achieving quality improvement among different stakeholders in a variety of settings.”⁷ Unfortunately, this process can be slow, incomplete and faced with many barriers.⁸ It has been established that educational materials and meetings on their own have unreliable or minimal influence on care delivery, therefore other mechanisms are required to achieve desirable changes in practice.⁴ Some guidance for strategy selection is provided by the Pathman model, which describes 4 key steps to knowledge translation: awareness, agreement, adoption and adherence.⁹ While not necessarily a linear process, a different approach may be necessary for each step to influence change.^{4,9} Hence, to select the most appropriate implementation strategy, it is crucial to perform a needs assessment to identify the level of stakeholders on the knowledge translation continuum for the particular clinical problem of interest.^{10,11}

The present study describes the results of a survey used to gauge awareness, agreement, adoption of and adherence to SSI prevention strategies among general surgeons and general surgery residents. The survey was designed to

identify the type of implementation strategies needed to increase adherence to recommended SSI prevention practices. It was part of a more comprehensive initiative designed to improve SSI prevention among teaching hospitals affiliated with the University of Toronto.¹²

METHODS

Participants and environment

All attending general surgeons and general surgery residents affiliated with the University of Toronto were invited to participate in this study. The staff surgeons practised at 1 of 5 academic teaching hospitals or 2 community-affiliated hospitals. The surgical residents typically rotated through all of these sites. The survey was distributed to 59 attending surgeons and 68 residents.

Survey design

A group of experts, including surgeons, residents and knowledge translation experts, designed the survey to assess beliefs, knowledge and practices of attending general surgeons and general surgery residents on issues related to SSI prevention, abdominal wound closure, deep vein thrombosis prophylaxis, mechanical bowel preparation, ventral hernia repair and the use of drains. The present study reports only the results of the 16 questions in 5 domains pertaining to SSI prevention. These 5 domains included methods used to prevent SSIs in general surgery patients, types of SSIs that surgeons believe are prevented by the use of antibiotic prophylaxis, specific factors that are important to consider when making decisions about antibiotic prophylaxis, perceived barriers preventing patients from receiving appropriate timing and duration of antibiotics and strategies already in place or that should be implemented to reduce SSI rates at respondents' hospitals.¹³

Survey distribution

The survey was distributed along with an email invitation to participate. A reminder email was sent out 3 weeks after the initial email. A paper copy of the survey was also mailed with a self-addressed, stamped envelope. Finally, another email reminder was sent to all nonresponders 6 weeks after the initial email. Completion of the survey was voluntary. Results were collected and compiled by a web-based program (ASP.NET). Responses were then transferred to a Microsoft Access database for analysis. Ethics approval was granted by the research ethics boards of all participating hospitals.

RESULTS

The overall response rate was 60%. The distribution of

response rates is shown in Table 1; the rate was 68% (40 of 59) among attending surgeons and 53% (36 of 68) among residents. There was a higher response rate among residents in postgraduate year (PGY)-3 and above. The response rate of attending surgeons was distributed across the participating hospitals. In general, the responses of the attending surgeons and residents were similar and are therefore aggregated. All respondents answered all of the questions.

Knowledge and perceptions regarding evidence supporting SSI prevention strategies

Figure 1 shows evidence-based strategies for preventing SSIs, the perception of the evidence and the extent to which the strategies are used by the respondents. There

Respondent	No. (%)
Residents	36 (53)
PGY-1	3 (21)
PGY-2	10 (71)
PGY-3	8 (89)
PGY-4	4 (44)
PGY-5	11 (50)
Attending surgeons	40 (68)
AH-1	15 (79)
AH-2	7 (70)
AH-3	4 (67)
AH-4	8 (62)
CA-1	4 (80)
CA-2	2 (33)

AH = academic hospital; CA = community-affiliated hospital; PGY = postgraduate year; SSI = surgical site infection.

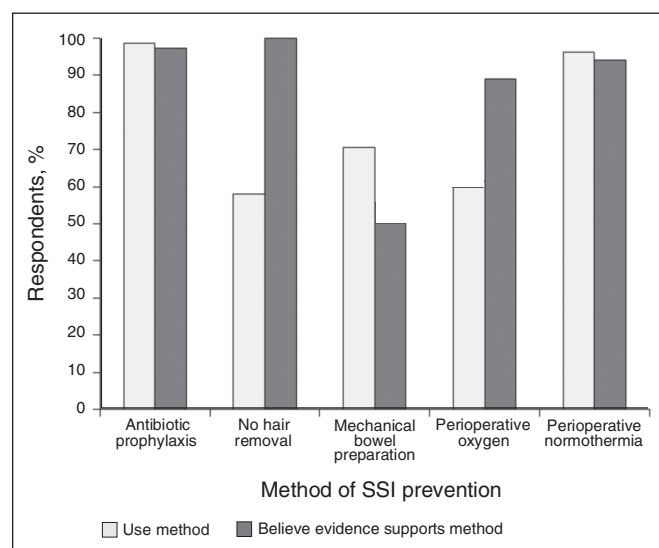


Fig. 1. Beliefs and practice patterns regarding methods to prevent surgical site infections (SSIs).

was inconsistency in some areas between the perception of evidence and the rate of strategy use. For example, more than 90% of respondents believed there was strong evidence to support the use of antibiotic prophylaxis and perioperative normothermia, and consistent with this perception, rates of reported use of this strategy were similarly high. By contrast, there appears to be a gap between perception and practice in the area of preoperative bowel preparation, hair removal and perioperative oxygen supplementation. For example, 71% of respondents reported prescribing preoperative bowel preparation even though less than 50% of respondents believe that evidence supports this practice. Conversely, the responses pertaining to no preoperative hair removal and perioperative hyperoxia indicated that although surgeons are aware of the evidence supporting these SSI prevention measures, they are not being used.

Types of infections that surgeons believe are prevented by the use of antibiotic prophylaxis

Almost 90% of respondents believed that antibiotic prophylaxis is “important” or “very important” in preventing superficial SSIs. However, a much smaller proportion of respondents were aware that antibiotic prophylaxis is important in the prevention of other SSIs (deep or organ space). In addition, there was limited awareness that appropriate antimicrobial prophylaxis reduced rates of hospital readmission and shortened length of stay in hospital (Table 2). Only 8% of respondents felt that antibiotic prophylaxis was “important” or “very important” in preventing death.

Factors considered to be important in making decisions about antibiotic prophylaxis

When asked how decisions regarding antimicrobial prophylaxis were made, respondents reported that published practice guidelines were “important” or “very important” in influencing practice (Table 3). By contrast, hospital policies or protocols, computerized decision-support tools

Table 2. Respondents' ratings of “important” or “very important” for the administration of antibiotic prophylaxis to prevent the adverse postoperative outcomes*

Outcome	No. (%)
SSI, superficial	66 (88)
SSI, deep	40 (53)
Prolonged hospital stay	36 (48)
Hospital readmission	24 (32)
Infection with antibiotic-resistant bacteria	15 (22)
Death	8 (8)

SSI = surgical site infection.

*Responses to the question: “How important is antibiotic prophylaxis in preventing the following postoperative outcomes?” Scale: 1 = very little and 5 = very much.

and standard pharmacy medication sets were considered to be less important by most respondents.

Perceived barriers preventing patients from receiving appropriate timing and duration of antibiotics

As shown in Table 4, most respondents felt that performing concurrent tasks and lack of verbal communication among staff were the most common reasons for failing to administer antimicrobials within the effective time window. However, the range of responses suggests that multiple factors contribute, including a lack of clarity on who is responsible for administering the antibiotics, unanticipated changes in cases and the inconvenience of mixing antibiotics.

Implementation of strategies to reduce SSI rates

This aspect of the survey demonstrated a large disparity between existing practices and strategies that are thought to be helpful in reducing SSIs. Operating room checklists, standardized written orders, departmental protocols or clinical pathways and formal surveillance programs were felt to be the most useful strategies for reducing SSI rates. More than 75% of respondents felt these should be implemented, yet less than half indicated that these strategies were already in place at their hospitals. Two-thirds of respondents felt that provider-specific feedback should be implemented at their hospitals, but only 10% reported that a mechanism for feedback was currently in place. These responses are summarized in Table 5.

Table 3. Respondents' ratings of "important" or "very important" for factors to consider when making decisions about antibiotic prophylaxis*

Factor	No. (%)
Published practice guidelines	62 (83)
Hospital policy or protocol	35 (47)
Computerized decision support	22 (30)
Pharmaceutical standard medication set	18 (24)

*Responses to the question "To what extent do you consider the following factors when making decisions about antibiotic prophylaxis?" Scale: 1 = very little and 5 = very much.

Table 4. Respondents' ratings of "important" or "very important" for factors influencing the timing of initiation and duration of antibiotic prophylaxis administration*

Factor	No. (%)
Forgetting to administer given concurrent tasks	42 (57)
Lack of verbal communication among staff	40 (54)
Disagreement/lack clarity on who is responsible	28 (40)
Unanticipated change of cases	20 (27)
Inconvenience of mixing antibiotic or connecting IV	7 (10)

IV = intravenous.

*Responses to the question: "How important do you believe the following factors are in influencing timing of initiation and duration of antibiotic prophylaxis?" Scale: 1 = very little and 5 = very much.

DISCUSSION

Although strong evidence and guidelines exist that recommend a variety of SSI prevention strategies, compliance with this evidence has generally been described as poor.¹⁴⁻¹⁷ We performed a needs assessment to understand the context within which surgeons make decisions and to identify potential barriers of evidence adoption. Our results can be used to select and tailor strategies that may improve SSI prevention.

Despite awareness of evidence supporting the effectiveness of best practices, many academic surgeons and trainees fail to implement them, especially with regards to no hair removal before surgery, omission of mechanical bowel preparation and perioperative hyperoxia. When focusing specifically on antibiotic prophylaxis, it appears that whereas most surgeons are aware that antibiotic prophylaxis is important in preventing SSIs, they are less clear about its role in preventing other adverse sequelae, including deep and organ space SSI, prolonged length of stay in hospital, readmissions and death.

The knowledge translation literature has shown that uptake and compliance with passively disseminated guidelines is poor.¹⁸ In contrast, our survey respondents believed that it is important to consult practice guidelines when making decisions regarding antibiotic prophylaxis. Although guidelines exist in areas such as antibiotic prophylaxis, surgeons may not be aware of their existence. Fewer surgeons indicated that computerized decision aids or standard pharmacy sets were important in their decision-making. This may, however, be a reflection of the resources available to surgeons in our setting. For example, only 2 of 7 participating hospitals have computerized order entry and support. Therefore, it is not surprising that many respondents did not believe that this is an important resource as they have not had an opportunity to experience the potential benefits.¹⁹

Table 5. Proportion of respondents who believe the following strategies are in place or should be implemented at the hospital level to reduce SSI rates*

Strategy	Currently in place, no. (%)	Should be implemented, no. (%)
Checklist/chart in operating room	35 (49)	56 (90)
Standardized written orders	35 (49)	43 (75)
Departmental protocol or clinical pathway	35 (48)	55 (87)
Formal surveillance program	31 (43)	51 (85)
Hospital policy	23 (33)	35 (57)
Designated SSI coordinator	19 (27)	43 (71)
Controlled antibiotic dispensing	19 (26)	27 (45)
Provider-specific feedback	7 (10)	42 (67)
Computerized decision program	2 (3)	27 (41)

SSI = surgical site infection.

*Responses to the questions: "Which of the following strategies are currently in place in your hospital? Which do you think should be in place to reduce surgical site infection rates at your hospital?"

Furthermore, the results of our study demonstrated that barriers to appropriate timely administration of antibiotic prophylaxis are multifactorial. About 50% of respondents believe that the competing priorities in the operating room, lack of communication and lack of responsibility are all important barriers for appropriately administered antibiotic prophylaxis. These factors can all be classified as barriers at the hospital or system level. Therefore, proposed implementation strategies will require tremendous institutional commitment for coordinated quality improvement. We used a workshop to unite stakeholders from various specialties, such as anesthesiology, nursing, pharmacy, surgery and infectious disease, at each hospital. They reviewed our study data, and discussed the merits and challenges associated with various knowledge translation strategies. Subsequently these health professionals have focused on specific implementation strategies that may be most beneficial at their hospital. These include the use of operative checklists, standardized written orders and departmental protocols, increased resources toward surveillance and audit and feedback programs to monitor SSI rates.

Limitations

This study has several limitations. First, our response rate was only 60%. It is likely that respondents differed from nonrespondents in their knowledge and understanding of SSI prevention strategies. Thus, if anything, our results overestimate knowledge. Second, the responses were self-reported and might not be consistent with practice. Self-reporting has been shown to overestimate performance considerably, suggesting that compliance with guidelines is poorer than reported. The disparity is potentially significant. Adams and colleagues²⁰ conducted a review of the literature to determine the utility of self-reports as a measure of guideline adherence and identify the effect of response bias on the validity of self-reports. In 87% of 37 comparisons, self-reported compliance measures consistently exceeded objective measures, with a median difference of 27%. As an example, an audit of more than 700 patients at the University of Toronto during this same time period revealed that only 80% of patients undergoing elective colorectal surgery received preoperative antibiotics in a timely fashion. Furthermore, this audit demonstrated that up to 50% of these same patients were leaving the operating room with core temperatures less than 36°C (D.S.F., unpublished data, 2008). These results are in contrast to our survey responses, which indicate that 99% and 96% of surgeons use antibiotic prophylaxis and perioperative normothermia, respectively. Despite this discordance, our survey results provide important insights into knowledge and beliefs, which might guide better implementation strategies. Finally, the generalizability of our results may be limited, as they represent findings from institutions associated with only 1 academic centre. How-

ever, there is strong evidence from other studies illustrating a lag in adoption of evidence into practice.⁴

CONCLUSION

Taken together, our data suggest that gaps in the translation of evidence into practice are pervasive, even within academic environments. To demonstrate change, implementation strategies must focus not only on the care providers, but also on the environments in which they practise. Finally, our study emphasizes the value of a structured knowledge translation framework before attempting changes in practice.

Competing interests: S. Forbes declares having received speaker fees from Merck on the topic of the surgical management of intra-abdominal sepsis. None declared for the other authors.

Contributors: C. Eskicioglu, A. Gagliardi, D. Fenech, S. Forbes, R. McLeod and A. Nathans designed the study. C. Eskicioglu, M. McKenzie and R. McLeod acquired the data, which C. Eskicioglu, A. Gagliardi and A. Nathans analyzed. C. Eskicioglu wrote the article, which all authors reviewed and approved for publication.

References

1. National Nosocomial Infections Surveillance System. National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004, issued October 2004. *Am J Infect Control* 2004;32:470-85.
2. Kirkland KB, Briggs JP, Trivette SL, et al. The impact of surgical site infections in the 1990s. *Infect Control Hosp Epidemiol* 1999;20:725-30.
3. Hedrick TL, Heckman JA, Smith RL, et al. Efficacy of protocol implementation on incidence of wound infection colorectal operations. *J Am Coll Surg* 2007;205:432-8.
4. Davis D, Evans M, Jadad A, et al. The case for knowledge translation: shortening the journey from evidence to effect. *BMJ* 2003;327:33-5.
5. Forbes SS, Stephen WJ, Harper WL, et al. Implementation of evidence-based practices for surgical site infection prophylaxis: results of a pre- and post-intervention study. *J Am Coll Surg* 2008;207:336-41.
6. van Kasteren MEE, Kullberg BJ, deBoer AS, et al. Adherence to local hospital guidelines for surgical antimicrobial prophylaxis: a multicentre audit in Dutch hospitals. *J Antimicrob Chemother* 2003;51:1389-96.
7. Canadian Institute of Health Research. *About knowledge translation at CIHR*. Available: <http://www.cihr-irsc.gc.ca/e/39158.html#3> (accessed 2012 May 3).
8. Doumit G, Gattellari M, Grimshaw J, et al. Local opinion leaders: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* 2007;(1):CD000125.
9. Pathman DE, Konrad TR, Freed GL, et al. The awareness-to-adherence model of the steps to guideline compliance: the case of pediatric vaccine recommendations. *Med Care* 1996;34:873-89.
10. NHS Centre for Reviews and Dissemination. Getting evidence into practice. *Effective Health Care* 1999;5:1-16.

11. Jacobson N, Butterill D, Goering P. Development of a framework for knowledge translation: understanding user context. *J Health Serv Res Policy* 2003;8:94-9.
12. Gagliardi AR, Eskicioglu C, McKenzie M, et al. Identifying opportunities for quality improvement in surgical site infection prevention. *Am J Infect Control*. In press.
13. Gagliardi AR, Fenech D, Eskicioglu C, et al. Factors influencing antibiotic prophylaxis for surgical site infection prevention in general surgery: a review of the literature. *Can J Surg* 2009;52:481-9.
14. Fennessy BG, O'Sullivan MJ, Fulton GJ, et al. Prospective study of use of perioperative antimicrobial therapy in general surgery. *Surg Infect (Larchmt)* 2006;7:355-60.
15. Gul YA, Hong LC, Prasannan S. Appropriate antibiotic administration in elective surgical procedures. *Asian J Surg* 2005;28:104-8.
16. Castella A, Charrier L, Di Legami V, et al. Surgical site infection surveillance: analysis of adherence to recommendations for routine infection control practices. *Infect Control Hosp Epidemiol* 2006;27:835-40.
17. Gagliotti C, Ravaglia F, Resi D, et al. Quality of local guidelines for surgical antimicrobial prophylaxis. *J Hosp Infect* 2004;56:67-70.
18. Grimshaw JM, Shirran L, Thomas RE, et al. Changing provider behavior: an overview of systematic reviews of interventions. *Med Care* 2001;39(Suppl 2):II-2-45.
19. Garg AX, Adhikari NK, McDonald H, et al. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes. *JAMA* 2005;293:1223-38.
20. Adams AS, Soumerai SB, Lomas J, et al. Evidence of self-report bias in assessing adherence to guidelines. *Int J Qual Health Care* 1999;11:187-92.

How you can get involved in the CMA!

The CMA is committed to providing leadership for physicians and promoting the highest standard of health and health care for Canadians. To strengthen the association and be truly representative of all Canadian physicians the CMA needs to hear from members interested in serving in elected positions and on appointed committees and advisory groups. The CMA structure comprises both governing bodies and advisory bodies either elected by General Council or appointed by the CMA Board of Directors. The Board of Directors — elected by General Council — has provincial/territorial, resident and student representation, is responsible for the overall operation of the CMA and reports to General Council on issues of governance.

CMA committees advise the Board of Directors and make recommendations on specific issues of concern to physicians and the public. Five core committees mainly consist of regional, resident and student representation while other statutory and special committees and task forces consist of individuals with interest and expertise in subject-specific fields. Positions on one or more of these committees may become available in the coming year.

For further information on how you can get involved, please contact:

Jacqueline Ethier, Corporate and Governance Services
Canadian Medical Association
1867 Alta Vista Drive, Ottawa ON K1G 5W8
Fax 613 526-7570, Tel 800 663-7336 x2249
involved@cma.ca

By getting involved, you will have an opportunity to make a difference.

We hope to hear from you!

