2014

UWOMJ Volume 83, No 1, Winter 2014

Western University

TABLE OF CONTENTS

UWOMJ

THE UNIVERSITY OF WESTERN ONTARIO MEDICAL JOURNAL

Volume 83, Issue 1, Spring 2014

www.uwomj.com

EDITORIAL

FEATURE ARTICLES

RURAL & REMOTE MEDICINE ARTICLES

TABLE OF CONTENTS

UWOMJ

THE UNIVERSITY OF WESTERN ONTARIO MEDICAL JOURNAL

Volume 83, Issue 1, Spring 2014
www.uwomj.com

RURAL & REMOTE MEDICINE ARTICLES (CONT.)

EDITORIAL TEAM

EXECUTIVE TEAM

EDITOR IN CHIEF	Melissa J. MacPherson (Meds 2014)
SENIOR ASSOCIATE EDITOR	Jason Chan (MD/PhD 2017)
JUNIOR ASSOCIATE EDITOR	Anthony Chow (Meds 2016)
SENIOR BLOG EDITOR	Yin Hui (Meds 2015)
JUNIOR BLOG EDITOR	Eric Roszell (Meds 2016)
SENIOR FINANCIAL OFFICER	Laura Callan (Meds 2015)
JUNIOR FINANCIAL OFFICER	Omer Dost (Meds 2017)
LAYOUT EDITOR	Kevan Lu (Meds 2017)
IT MANAGER	Kevan Lu (Meds 2017)

DEPARTMENTAL EDITORS

CLINICAL PROCEDURES	Denise Darmawikarta (Meds 2016) Alexander Levit (Meds 2017)
DIAGNOSTIC REVIEW	Lauren Prufer (Meds 2016) Pei Jun Zhao (Meds 2017)
ETHICS & LAW	Saad Ahmed (Meds 2016) Arthur Shuster (Meds 2017)
HEALTH POLICY & ECONOMICS	Kyle Luong (Meds 2016) Michael Hewak (Meds 2016)
HEALTH PROMOTION	Gabriela Meglei (Meds 2016) Keegan Guidolin (Meds 2017)
HISTORY OF MEDICINE	Wendy Cui (Meds 2016) Hao Li (Meds 2016)
INTERDISCIPLINARY	Kyle Pangka (Meds 2016) Jeffrey Law (Meds 2016)
MEDICINE & TECHNOLOGY	Nancy Chen (Meds 2016) Abdullah Nasser (Meds 2017)
PROFILES	Sissi Cao (Meds 2016) Han Yan (Meds 2017)
THINKING ON YOUR FEET	Anthony Chow (Meds 2016) Bashiar Thajeel (Meds 2016)
ZEBRA FILES	Eric Roszell (Meds 2016) Craig Olmstead (Meds 2017)

UWOMJ

THE UNIVERSITY OF WESTERN ONTARIO MEDICAL JOURNAL

EDITORIAL BOARD

1. Dr. Lois Champion
2. Dr. Michael Rieder
3. Dr. Jeffrey Nisker
4. Dr. Faisal Rehman
5. Dr. Jim Silcox
6. Dr. Douglas Quan

Cover Art: Han Yan

Description: This is a photoshopped image of "American Gothic," a painting by Grant Wood which depicts a farmer and his daughter. Interestingly, the woman in the painting was modeled by Wood's sister and their dentist.

EDITORIAL

Rural and remote medicine

In the last proper Canadian census conducted in 2006, it was determined that 20% of Canada's population resided in rural locations. This percentage translates into 6.2 million people residing outside of urban centres! Given Canada's enormous geographical size, this creates huge challenges in the provision of medical care for the 20% of the population scattered in rural and remote regions. As those of us training at the Schulich School of Medicine and Dentistry are aware, many of our fellow classmates are from rural areas throughout Southwestern Ontario. For those of us raised in urban centres, we have had a myriad of opportunities during our preclerkship and clerkship training to explore these rural locations outside of London and experience the life of a rural physician for ourselves. Some of the fondest memories of my clerkship experience occurred outside of urban centres and in smaller communities. As for my own class, many students seized the opportunity to not only explore smaller communities in southwestern Ontario during our clerkship training, but went even further afield to remote locations in northern Ontario, northern British Columbia and rural Alberta. If the beautiful photographs of these adventures posted on social media are any indication, these classmates were all rewarded for their adventurous spirit with fantastic experiences and memories that will last a lifetime. It was no surprise during this year's CaRMS match that many of my classmates matched to family medicine residency training programmes in rural locations. In fact, many of these positions are becoming highly sought-after training opportunities.

This issue of the UWOMJ is dedicated to the theme of rural and remote medicine. Many of us will become rural physicians and will be faced with many challenges providing healthcare for our patients in resource-limited areas. Others of us will practice in urban centres. However, we should not forget the plight of our colleagues in rural areas as sound public policy surrounding the delivery of healthcare to rural areas should be important to us all. I hope that you enjoy reading the articles detailing the various challenges and strategies at play in the delivery of rural and remote medicine from a medical student perspective.

As for myself, I have spent a wonderful four years at the Schulich School of Medicine and Dentistry. It has been an honour and a privilege to serve as this year's editor-in-chief of the UWOMJ, now in its 84th year of publication. I hope that the journal continues to serve as a forum in which medical students can publish scholarly work for many years to come. This publication would not be possible without a large team of dedicated students making it happen. I wish to thank the wonderful colleagues with whom I have had the pleasure of working this past academic year. I now hand over the reins to our next editor-in-chief Jason Chan.

Melissa J MacPherson, PhD (Meds 2014)
Editor in Chief

FEATURE ARTICLE

CPR and YOU

What every medical student needs to know about performing CPR

Lauren Prufer (Meds 2016)
Faculty Reviewer: Dr Dan Howes, MD, FRCPC (Departments of Emergency Medicine and Critical Care)

BACKGROUND

Due to the difficulties associated with recording and analyzing low-frequency emergency events, in-hospital cardiac arrest (IHCA) intervention has historically been less rigorously studied than out-of-hospital cardiac arrest (OHCA). Survival of IHCA is low: reported survival to hospital discharge (SHD) rates range from 6.6% to 18%, with 5.2% of patients surviving to one year.[1-4] Survival rates have not significantly improved in decades,[5] and studies of in-hospital cardiopulmonary resuscitation (CPR) quality have found that CPR provided by trained in-hospital staff often does not conform to published American Heart Association (AHA) guidelines.[6] Hesitancy of first responders, typically nurses and residents, to initiate CPR in the absence of an attending physician,[7] despite measurable survival benefits associated with rapid initiation of CPR and other resuscitation system errors,[8-13] such as delayed or incorrect medication administration,14 may also contribute to reduced survival rates for IHCA. Studies of skill acquisition and retention in medical students have demonstrated that CPR proficiency deteriorates rapidly over time, resulting in suboptimal CPR quality upon entry into a clinical setting.[15] This paper aims to familiarize medical learners with basic indicators of CPR quality.

INDICATORS OF CPR QUALITY FOR MEDICAL LEARNERS

Indicators of CPR quality have been linked to increased likelihood of return of spontaneous circulation (ROSC) and improved SHD and include time to respond, chest compression fraction (CCF), rate of compression, chest compression depth and leaning and ventilation.

1. Time to Respond

Time to respond is the time from cardiovascular collapse to the initiation of chest compressions or defibrillation. Rapid initiation of CPR is important for the maintenance of organ and tissue perfusion during cardiac arrest (CA).[9] Two groups have found that odds of SHD were approximately halved when CPR and defibrillation was initiated more than 60 seconds postcollapse,[11,12] and several groups have observed significant correlations between decreased survival rate and increased response time.[13,16]

Current AHA recommendations state that teams should initiate compressions and defibrillation less than 120 seconds following collapse.[8] Studies on IHCA response times found an average of 180 seconds elapsed before response team arrival.[7] As well, once the team had arrived, a further 35 seconds elapsed before initiation of CPR.[17] First responders, typically residents or nurses, were hesitant to check pulse, analyze rhythm and initiate CPR or defibrillation in the absence of an attending physician.[7] Trained and qualified first responders failed to initiate CPR and defibrillation 12% and 44% of the time, respectively.[7] The rate of SHD following IHCA at this institution did not differ significantly from national averages, suggesting that reluctance of trained ward staff to initiate treatment prior to arrival of the emergency response team could be contributing to the low survival rates observed across institutions.[7]

2. Chest Compression Fraction (CCF)

CCF is the proportion of total time from CA to ROSC or death spent performing chest compressions. Clinical studies have shown that a higher CCF increases the likelihood of ROSC and SHD.[19-22] A prospective observational study of ventricular tachycardia (VT) and ventricular fibrillation (VF) found that every 10% increase in CCF resulted in a 1.11-fold increased odds ratio (OR) of SHD.[19] Minimal-pause CPR protocols have also been widely studied; reduced pre-, peri- and post-shock pause and increased CCF have been associated with improved SHD.[20-22] A trial using mechanical chest compressions found decreased likelihood of cerebrovascular incidents and increased likelihood of ROSC and SHD with use of a minimal-pause CPR protocol.[23] AHA guidelines suggest that CA response teams use a minimal-pause protocol and aim for a CCF of greater than 0.8.[8]

3. Rate of Compression

2010 AHA guidelines recommend a rate of greater than 100 compressions per minute.[24] Data from the Resuscitation Outcomes Consortium (ROC) Cardiac Arrest Epistry suggest that compression rates follow a dose-dependent curve, finding that rates between 100 and 125 compressions per minute have been associated with the highest likelihood of ROSC.[25] Rates lower than 100 may reduce tissue oxygenation and rates greater than 120 may compromise compression depth and coronary artery perfusion (CAP).[27,28] Compressions are often performed too slowly, with one study finding average rates of less than 80 in 36.9% of resuscitation episodes.[29] Receiving less than 80 compressions per minute was associated with a 30% reduction in likelihood of attaining ROSC.[29]

4. Chest Compression Depth and Residual Leaning

Chest compression depth measures the sternal displacement during compressions while residual leaning refers to continued pressure on the chest between compressions. The AHA recommends a compression depth of at least 50 mm in adults and minimal residual leaning.[9]

Compression depth greater than 50 mm during the 30 seconds before defibrillation has been associated with increased likelihood of successful defibrillation, ROSC and SHD.[10,25] Despite the importance of compression depth in maintaining adequate perfusion, studies of out-of-hospital CPR have found that suboptimal compressions during CPR are common. One observational study of Canadian and American hospitals found that compressions performed by trained emergency medical responders did not meet the 2010 AHA guidelines 91% of the time.[10]

Residual leaning between compressions may result in reduced cardiac output due to inhibition of venous return.[30-32] Studies in porcine models have demonstrated that residual pressure between compressions may be associated with increased right atrial pressure, decreased coronary and cerebral artery perfusion and poor neurological outcome.[30-32] Studies of human rescuers have found that leaning was present during half of recorded compressions.[33] Rescuers may be more prone to leaning if they are very tall or perform compressions using a stool.[34]

5. Ventilation

Rate and magnitude of ventilation are important indicators of CPR quality.[19,35,36] AHA guidelines recommend a ventilation rate of less than 12 breaths per minute and that rescuers refrain from overinflating lungs.[10] Physiologic studies using the porcine model found that overventilation resulted in decreased CAP and venous return to the heart as well as decreased survival.[19,35] End tidal CO_2 ($ETCO_2$) concentrations may also be used as an indicator of CPR quality and tissue perfusion during IHCA.[37,38] The AHA expert panel has recommended that $ETCO_2$ not fall below 10 mmHg during CPR and that abrupt increase in $ETCO_2$ to greater than 35 to 40 mmHg be considered an indicator of ROSC.[8]

KEY POINTS FOR MEDICAL LEARNERS DURING ICHA

Resuscitation errors in the hospital setting are common, with one study of 118,387 IHCAs reporting that 40.4% of in-hospital VF/pulseless VTs were associated with a resuscitation system error.[38] Delayed defibrillation and chest compression were among the most common errors recorded in the in-hospital setting.[38] Based on hazard ratio analysis, the presence of a documented error was associated with a 34.2% (95% confidence interval, 29.5-39.1) increase in relative risk of death prior to hospital discharge.[38] Medical students can contribute to improved patient outcome by educating themselves about signs and symptoms of impending CA (Figure),[39,40] activation of in-hospital emergency call systems, location of AED devices and necessary equipment on each hospital floor and through prompt initiation of high-quality CPR. CPR providers should "push fast, push hard", aiming for rates greater then 100 compressions per minute and compression depth greater then 50 mm.[8,24] Compression quality may be improved by practicing with a metronome or automated feedback device; these have been shown to improve both pace and depth of chest compressions in medical learners.[41-44] Compression depth can be improved through placement of a backboard or use of a hard surface during CPR.[8] Performing chest compressions using a stool or while kneeling has also been shown to reduce rescuer fatigue by increasing mechanical advantage;[34,45] however, care should be taken to avoid leaning. Frequent rotation of rescuers at prespecified intervals may also help to reduce fatigue and improve compression quality.

Pauses in CPR can be minimized by setting specific time goals for task completion (Table). Witnesses to the arrest should communicate all pertinent information succinctly upon team leader arrival. Students who have access to a dummy and wish to practice with feedback may be interested in downloading an automated feedback device to their smartphone, such as the ZOLL pocket CPR device. Though not recommended for use during real-life situations, the program is capable of giving automated feedback about compression rate and depth and may give students valuable practice by helping to improve CPR quality during simulation.

National Early Warning Score (NEWS)*

PHYSIOLOGICAL PARAMETERS	3	2	1	0	1	2	3
Respiration Rate	≤8		9 - 11	12 - 20		21 - 24	≥25
Oxygen Saturations	≤91	92 - 93	94 - 95	≥96			
Any Supplemental Oxygen		Yes		No			
Temperature	≤35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥39.1	
Systolic BP	≤90	91 - 100	101 - 110	111 - 219			≥220
Heart Rate	≤40		41 - 50	51 - 90	91 - 110	111 - 130	≥131
Level of Consciousness				A			V, P, or U

*The NEWS initiative flowed from the Royal College of Physicians' NEWS Development and Implementation Group (NEWSDIG) report, and was jointly developed and funded in collaboration with the Royal College of Physicians, Royal College of Nursing, National Outreach Forum and NHS Training for Innovation

The National Early Warning Score (NEWS) thresholds and triggers

NEW scores	Clinical risk
0 Aggregate 1 – 4	Low
RED score* (Individual parameter scoring 3) Aggregate 5 – 6	Medium
Aggregate 7 or more	High

Please see next page for explanatory text about this chart.

Royal College of Physicians

NHS Training for Innovation

Figure: Sample of scoring system for physiological deterioration in-hospital. Increasing national early warning score (NEWS) is indicative of increasing risk of death, ICU admission or CA within next 24hrs.40 A level of conciousness score of A is assigned if the patient is alert. A score of V, P or U is assigned if a patient responds only to voice or pain or is unresponsive. Patients may be stratified into clinical risk categories using NEWS. Patients with an aggregate NEWS of greater then 7 or any individual parameter scoring greater then 3 are considered to be at high risk and require urgent clinical evaluation. Clinical tools like the NEWS system can help to identify high risk patients, allowing for early intervention and thus prevention of adverse events. The NEWS can be found at http://www.rcplondon.ac.uk/resources/national-early-warning-score-news.

Table: Summary of Components of High-Quality CPR for Medical Learners

QUALITY INDICATOR	DESCRIPTION
1. **General**	• Be aware of and monitor patients for signs and symptoms of physiological deterioration which may precede cardiac arrest (see Table 1). • Know how to activate emergency response if an unconscious patient is discovered. • Know location of AEDs and other required medical equipment.
2. **Time to respond**	• Rapid initiation of chest compressions.

3. **Chest Compression Fraction**	• Keep pauses during CPR to a minimum:
	  • Less than 10s for rhythm analysis and defibrillation.
	  • Less than 3s to rotate compressors.
	  • Rotate compressors regularly during necessary pauses for ventilation.

4. **Chest Compression Rate**	• 100-120 per minute.
5. **Chest Compression Depth**	• > 50 mm. • Use a backboard or hard surface. • Use a stool or kneel while performing compressions. • Avoid leaning between compressions. • Rotate compressors frequently to avoid fatigue.
6. **Ventilation**	• Rate of < 12 breaths per minute. • Avoid overinflating lungs.

REFERENCES

1. Hodgetts TJ, et al. Incidence, location and reasons for avoidable in-hospital cardiac arrest in a district general hospital. Resuscitation. 2005(2);120:158-64.
2. Jones-Crawford JL, Parish DC, Smith BE, Dane FC. Resuscitation in the hospital: circadian variation of cardiopulmonary arrest. Am J Med. 2010;170(2):18-26.
3. Nadkarni VM, et al; National Registry of Cardiopulmonary Resuscitation Investigators. First documented rhythm and clinical outcome from in-hospital cardiac arrest among children and adults. JAMA. 2006;295(1):50-7.
4. Bloom HL, et al. Long-term survival after successful in-hospital cardiac arrest resuscitation. AM Heart J. 2007;153(5):831-6.
5. Peberdy MA, et al. Cardiopulmonary resuscitation of adults in the hospital: a report of 14270 cardiac arrests from the National registry of cardiopulmonary resuscitation. Resuscitation. 2003;58(3):297-308.
6. Abella BS, et al. Chest compression rates during cardiopulmonary resuscitation are suboptimal a prospective study during in-hospital cardiac arrest. Circulation. 2005;111(4):428-34.
7. Einav S, et al. Performance of department staff in the window between discovery of collapse to cardiac arrest team arrival. Resuscitation. 2006;69(2):213-20.
8. Meaney PA, et al. CPR Quality: Improving cardiac resuscitation outcomes both inside and outside the hospital a consensus statement from the American Heart Association. Circulation. 2013;128(4):417-35.
9. Stiell IG, et al; Resuscitation Outcomes Consortium (ROC) Investigators. What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation? Crit Care Med. 2012;40(4):1192-8.
10. De Maio VJ, et al. Optimal defibrillation response intervals for maximum out-of-hospital cardiac arrest survival rates. Annals of emergency medicine. 2003;42(2): 242-50.
11. Chan PS, et al. Delayed time to defibrillation after in-hospital cardiac arrest. New Engl J Med. 2008;358(1): 9-17.
12. Herlitz J, et al. Characteristics and outcome among patients suffering from in hospital cardiac arrest in relation to the interval between collapse and start of CPR. Resuscitation. 2002;53(1): 21-7.
13. Herlitz J, et al. Very high survival among patients defibrillated at an early stage after in-hospital ventricular fibrillation on wards with and without monitoring facilities. Resuscitation. 2005;66(2):159-66.
14. Ornato JP, et al. Impact of resuscitation system errors on survival from in-hospital cardiac arrest. Resuscitation. 2012;83(1):63-9.
15. Behrend T, et al. Retention of cardiopulmonary resuscitation skills in medical students utilizing a high-fidelity patient simulator. Medical Student Research Journal. 2011;1(1):1-4.
16. De Maio VJ, et al. Optimal defibrillation response intervals for maximum out-of-hospital cardiac arrest survival rates. Ann Emerg. 2003;42(2):242-50.
17. Marsch SCU, et al. Performance of first responders in simulated cardiac arrests. Crit Care Med. 2005;33(5):963-7.
18. Berg RA, Sanders AB, Kern KB, et al. Adverse hemodynamic effects of interrupting chest compressions for rescue breathing during cardiopulmonary resuscitation for ventricular fibrillation cardiac arrest. Circulation. 2001;104(20):2465-70.
19. Christenson J, et al. Resuscitation Outcomes Consortium Investigators. Chest compression fraction determines survival in patients with out-of-hospital ventricular fibrillation. Circulation. 2009;120(13):1241-7.
20. Cheskes S, et al. The impact of peri-shock pause on survival from out-of-hospital shockable cardiac arrest during the resuscitation outcomes consortium PRIMED trial. Resuscitation

[Internet]. 2013 Oct 28 [cited Nov 15]. Available from: http://www.resuscitationjournal.com/article/S0300-9572(13)00814-9/abstract.
21. Rea TD, Helbock M, Perry S, et al. Increasing use of cardiopulmonary resuscitation during out-of-hospital ventricular fibrillation arrest: survival implications of guideline changes. Circulation. 2006;114(25):2760-5.
22. Eftestøl T, Kjetil S, Steen PA. Effects of interrupting precordial compressions on the calculated probability of defibrillation success during out-of-hospital cardiac arrest. Circulation. 2002;105(19): 2270-3.
23. Lee I, et al. Improved survival outcome with continuous chest compressions with ventilation compared to 5: 1 compressions-to-ventilations mechanical cardiopulmonary resuscitation in out-of-hospital cardiac arrest. J Chin Med Assoc. 2013;76(3):158-63.
24. Edelson DP, Abella BS, Kramer-Johansen J, et al. Effects of compression depth and pre-shock pauses predict defibrillation failure during cardiac arrest. Resuscitation 2006;71(2):137-45.
25. Idris AH, et al. Relationship between chest compression rates and outcomes from cardiac arrest clinical perspective. Circulation. 2012;125(24):3004-12.
26. Monsieurs KG, et al. Excessive chest compression rate is associated with insufficient compression depth in prehospital cardiac arrest. Resuscitation. 2012;83(11):1319-23.
27. Wolfe JA, Maier GW, Newton JR et al. Physiologic determinants of coronary blood flow during external cardiac massage. J Thorac Cardiovasc Surg. 1988;95(3):523-32.
28. Abella BS, et al. Chest compression rates during cardiopulmonary resuscitation are suboptimal: a prospective study during in-hospital cardiac arrest. Circulation. 2005;111(4):428-34.
29. Zuercher M, et al. Leaning during chest compressions impairs cardiac output and left ventricular myocardial blood flow in piglet cardiac arrest. Crit Care Med. 2010;38(4):1141.
30. Udassi JP, et al. Novel adhesive glove device (AGD) for active compression–decompression (ACD) CPR results in improved carotid blood flow and coronary perfusion pressure in piglet model of cardiac arrest. Resuscitation. 2012;83(6):750-4.
31. Metzger AJ, et al. Improved cerebral perfusion pressures and 24-hr neurological survival in a porcine model of cardiac arrest with active compression-decompression cardiopulmonary resuscitation and augmentation of negative intrathoracic pressure. Crit Care Med. 2012;40(6): 1851-6.
32. Niles D, et al. Leaning is common during in-hospital pediatric CPR, and decreased with automated corrective feedback. Resuscitation. 2009;80(5):553-7.
33. Edelson DP, et al. The impact of a step stool on cardiopulmonary resuscitation: a cross-over manikin study. Resuscitation. 2012;83(7):874-8.
34. Aufderheide TP, Sigurdsson G, Pirrallo RG, et al. Hyperventilation-induced hypotension during cardiopulmonary resuscitation. Circulation. 2004;109(16):1960-5.
35. Langhelle A, Sunde K, Wik L, Steen PA. Arterial blood-gases with 500- versus 1000-ml tidal volumes during out-of-hospital CPR. Resuscitation. 2000;45(1):27-33.
36. Villanueva-Reiakvam, S; ZOLL Medical Corporation. The ART of Resuscitation. Code Communications Newsletter [Internet]. 2013 [cited Jul]. Available from: http://www.zoll.com/uploadedFiles/Public_Site/Core_Technologies/Real_CPR_Help/ArtofResuscitation.pdf
37. Myatra SN, Todi AT, Jigeeshu VD. ICU Protocols. XXVI. India: Springer India; 2012. 879 p.
38. Ornato JP, et al. Impact of resuscitation system errors on survival from in-hospital cardiac arrest. Resuscitation. 2012;83(1);63-9.
39. Bellomo R, Goldsmith D, Uchino S, et al. A prospective before-and-after trial of a medical emergency team. Med J of Aust. 2003;179(6):283-7.
40. Smith GB, et al. The ability of the National Early Warning Score (NEWS) to discriminate patients at risk of early cardiac arrest, unanticipated intensive care unit admission, and death. Resuscitation. 2013;84(4):465-70.
41. Allan KS, Wong N, Aves T, Dorian P. The benefits of a simplified method for CPR training of medical professionals: A randomized controlled study. Resuscitation. 2010;84(8):1119-24.
42. Chung TN, et al. The specific effect of metronome guidance on the quality of one-person cardiopulmonary resuscitation and rescuer fatigue. J Emerg Med. 2012;43(6):1049-54.
43. Martin P, et al. Real-time feedback can improve infant manikin cardiopulmonary resuscitation by up to 79%-a randomized controlled trial. Resuscitation. 2013 84(8):1125-30.
44. Kim SC, et al. A simple audio-visual prompt device can improve CPR performance. J Emerg Med. 2013;44(1):128-34.
45. Foo NP, Chang JH, Lin HJ, Guo HR. Rescuer fatigue and cardiopulmonary resuscitation positions: a randomized controlled cross-over trial. Resuscitation. 2010;81(5):579-84.

FEATURE ARTICLE

Neurofibromatosis

An ideal model for multidisciplinary care

Caitlin VanDeCappelle (Meds 2014)
Faculty Reviewer: Dr Sharan Goobie, MSc, MD, FRCPC (Department of Genetics)

ABSTRACT

Neurofibromatosis type 1 (NF1) is an inherited tumor predisposition syndrome with multiple manifestations in children and adults. Due to the multisystemic nature of this syndrome there are multidisciplinary NF1 clinics in many major centres in the United States; however, this is not yet the trend in Canada. Our study seeks to gain understanding of the current state of health surveillance in children with NF1 in Southwestern Ontario, which medical disciplines are involved in their care and parental interest in a future multidisciplinary clinic at London Health Sciences Centre (LHSC).

Methods: 50 parents or guardians of pediatric NF1 patients completed a 39-question telephone interview pertaining to diagnosis, aspects of yearly screening and willingness to attend a multidisciplinary clinic. Responses were then compared to the current screening guidelines for the pediatric NF1 population as suggested by the American Academy of Pediatrics.

Results: Only 56% of patients receive an annual neurological exam, while over 87% are having yearly blood pressure screens. 40% of patients cite their medical geneticist as the main coordinator of their care, while 12% cite no coordination of care. 48% of families travel more than 50 km to LHSC, with the majority visiting >3 times per year. 96% of participants are interested in participating in a multidisciplinary clinic.

Conclusions: The results obtained from this study support the development of a multidisciplinary NF1 clinic at LHSC.

INTRODUCTION

Neurofibromatosis 1 (NF1) is an autosomal dominant condition with a birth incidence of 1 in 2500 to 3300.[1] It affects all racial groups and genders equally, and can affect neurological, cognitive, social and physical development. The NF1 gene, located on chromosome 17q11.2, functions as a tumour suppressor gene. Clinical criteria exist for establishing a diagnosis of NF1, and therefore genetic testing is not often required.[4] Mutations in the NF1 gene result in features such as neurofibromas, multiple café au lait spots (hyperpigmented macules), skinfold freckling, iris Lisch nodules and optic gliomas.[2] Neurofibromas are heterogenous benign peripheral nerve sheath tumours, which most often appear as discrete subcutaneous or cutaneous growths. Some individuals may only have mild skin lesions, whereas others may develop disfiguring tumours and life-threatening complications. Complications of NF1 can include optic gliomas, spinal nerve tumors, hypertension, scoliosis and other bone abnormalities. There is also a 5 to 10% increased risk for malignant peripheral nerve sheath tumors. Other serious complications can include brain tumors, seizures, rhabdomyosarcomas and pheochromocytomas.[1] Along with physical manifestations, NF1 is also associated with an increased prevalence of cognitive impairment. Prevalence of learning disabilities among children with NF1 has been estimated to range from 25 to 61%.[3]

The current mainstay of management for NF1 is age-specific monitoring of disease manifestation and patient education.[4] Health surveillance guidelines proposed by the American Academy of Pediatrics suggest an annual physical exam including blood pressure monitoring, skin examination, screening for scoliosis and a full neurological assessment.[5] An annual ophthalmologic exam in childhood (less frequently in older children and adults) is recommended to screen for optic glioma.[5] Other studies and investigations, such as MRI imaging, are currently only recommended on the basis of clinical signs and symptoms, i.e. suspected intracranial or internal tumours.[5]

Care for NF1 patients typically involve various specialists and support services. Multidisciplinary NF clinics have been established in various locations within the United States to provide a setting in which a diagnosis and follow up of patients with NF1 can be coordinated. At the Neurofibromatosis Clinic of the Children's Hospital Medical Center in Cincinnati, Ohio, patients are referred for diagnosis, genetic counseling and various medical and surgical consultations. Patients are then followed annually where history is updated and full exam is completed, and family members at risk for NF also undergo full skin examination and slit-lamp examination of the irides. Current literature suggests that close collaboration such as this will facilitate a uniform approach to the diagnosis and management of NF1 and its complications.[4]

Our study seeks to gain more understanding of follow up management of our NF1 patient population at LHSC — which disciplines are involved, who is coordinating such care, the extent to which guidelines are being followed without such clinic involvement — and to define necessary services as identified by our patients in order to improve the current management and surveillance of our NF1 patients and their families.

METHODS

Parents of 122 children (under age 18) who were seen in the department of genetics at LHSC for a possible diagnosis of NF1 were invited to participate in a telephone questionnaire. To be included in this study, families must have a child under 18 years, a diagnosis (confirmed by genetic test or clinically) of NF1 and a previous visit

with the department of genetics at LHSC. The questionnaire consisted of 39 questions related to their children's features of NF1, the types of health care professionals involved in their care, aspects of their child's yearly medical screening and their willingness to attend a multidisciplinary NF1 clinic. The study was approved by the research ethics board at UWO (REB#102904).

Questionnaire responses were then compared to the current screening guidelines for the pediatric NF1 population as suggested by the American Academy of Pediatrics. Proportions of patients whose NF1 medical screening met current guidelines were calculated. Trends in deficits of patient care were identified. Types of medical specialties involved in the NF1 patients' care were assessed. This information was used to assess potential components of a multidisciplinary NF1 clinic. Overall interest in a multidisciplinary NF1 clinic was determined using the proportion of positive responses (compared to negative responses) to a yes/no question. Given the small patient sample, formal statistical analysis was not required.

RESULTS

Of 122 families sent a letter of participation, 52 families were successfully contacted for a telephone interview. Two families from this group did not meet survey requirements as they did not have confirmed diagnoses of NF1. Mean age for diagnosis was 4 years (range 2 months to 13 years), where mean current age was 11 (range 1-17 years). Table 1 shows the distribution of features of participants in the study. These percentages are fairly consistent with the general trends in the NF1 literature.

Table 1: Reported Clinical Characteristics of Children With NF1 in Study Group

FEATURE	NUMBER (%) (*n* = 50)
6 or more café au lait spots	49 (100%)
Inguinal/axillary freckling	46 (92%)
Learning delay	25 (50%)
Parent/sibling/child with NF1	20 (40%)
2 or more cutaneous neurofibromas	17 (34%)
Macrocephaly	17 (34%)
ADHD	14 (28%)
2 or more Lisch nodules	14 (28%)
Optic gliomas	10 (20%)
Brain tumour	7 (14%)
Scoliosis	6 (12%)
Bone deformity (other than scoliosis)	5 (10%)
Seizures	4 (8%)
Early puberty	4 (8%)
Autism	3 (6%)
Plexiform neurofibroma	2 (4%)
High blood pressure	2 (4%)
Other tumour	2 (4%)
Late puberty	1 (2%)

Table 2 shows that 40% of study participants believe their medical geneticist to be the main coordinator of their care, while 24% listed their pediatrician and 6% their family doctor. 12% of respondents felt that no healthcare professional was their main coordinator.

Table 2: Healthcare Professional Acting as Main Coordinator of Care

HEALTHCARE PROFESSIONAL	NUMBER (%) (*n* = 50)
Medical Geneticist	20 (40%)
Pediatrician	12 (24%)
None	6 (12%)
Family doctor	3 (6%)
Dermatologist	2 (4%)
Neurosurgeon	2 (4%)
Neurologist	1 (2%)
Oncologist	1 (2%)
Other	3 (6%) Mother, Plastic surgeon

Table 3 shows the percentage of participants adhering to the recommendations of a yearly skin, eye, neurological and blood pressure exam. Only 56% of participants are receiving a yearly neurological exam, while over 87% of participants are getting their blood pressure check each year. Note that 2 participants were not included as their current guardians were unaware of their most recent screenings.

Table 3: Reported Adherence to Annual Examinations

EXAM	NUMBER (%) (*n* = 48)
BP check	42 (87.5%)
Eye exam	41 (85.4%)
Skin exam	31 (64.6%)
Neurological exam	27 (56.3%)

Table 4 shows the number of visits to LHSC made per year for NF1-related reasons. The majority of respondents make the trip 3 to 4 times each year for NF1-related appointments. Notably, 48% of study participants travel further than 50 km to the LHSC Children's Hospital for each visit.

Table 4: Reported Number of Visits to LHSC per Year

NUMBER OF VISITS	NUMBER (%) (*n* = 50)
0	1 (2%)
1-2	9 (18%)
3-4	28 (56%)
5-10	9 (18%)
> 10	3 (6%)

DISCUSSION

The American Academy of Pediatrics recommends that pediatric patients with NF1 receive blood pressure monitoring and neurological, eye and skin examinations annually.[7] As per our results, between 22 and 44% of our NF1 pediatric population are not meeting all of the surveillance recommendations. Particular deficits appear to be with the neurological and skin examinations, which are also the examinations that take more time during an office visit. This may be due to lack of clear physician roles, time constraints and lack of physician awareness of guidelines.

While medical geneticists and pediatricians were frequently named as the primary coordinators for our patients, this may be a recruitment bias as the list of participants was generated from those referred to medical genetics for a possible diagnosis of NF. Many other health care professionals were also listed as having a role in the care of these patients (Table 2). Based on these results and the comments from parents during the interviews, we propose that a multidisciplinary NF1 clinic should involve a medical geneticist, pediatrician, oncologist, neurologist, ophthalmologist, neurosurgeon, developmental pediatrician and social worker.

Of the families surveyed, 96% were interested in attending a multidisciplinary NF clinic. Benefits reported by families included convenience, less time away from school or work, social connection to others with NF and improved communication between specialists. As approximately half of our patients live more than 50 km away from LHSC, many families felt that a one-stop visit to see all the healthcare professionals involved in their child's care would be beneficial. Furthermore, this may ensure that guidelines are more frequently met, as patients would receive all screenings at one visit.

This study supports the development of a multidisciplinary NF1 clinic at LHSC and a clinic proposal has been developed. This clinic has the potential to improve the medical management of children with NF1, decrease the travel burden on parents who may need to come to London for multiple different specialist appointments related to their child's diagnosis and provide the opportunity for education and research related to this condition.

REFERENCES

1. Wolkenstein P, Durand-Zaleski I, Moreno J, Zeller J, Hemery F, Revuz J. Cost evaluation of the medical management of neurofibromatosis 1: a prospective study of 201 patients. Br J Dermatol 2000 Jun;142(6):1166-70.
2. Ferner R, Gutmann D. International consensus statement on malignant peripheral nerve sheath tumours in neurofibromatosis. Cancer Res 2002 Mar;62(5):1573-7.
3. Haynes N, Kirwan J, Mccrohan K. Effects of neurofibromatosis type 1 on children's development. Soc Work Public Health 2011;26(4):444-53.
4. Ferner R, Huson S, Thomas N, Moss C, Willshaw H, Evans G, Upadhyaya M, Towers R, Gleeson M, Steiger C, Kirby A. Guidelines for the diagnosis and management of individuals with neurofibromatosis 1. J Med Genet 2007 Feb;44(2):81-8.
5. Friedman JM. GeneReviews: Neurofibromatosis1 [Internet]. Seattle (WA): University of Washington; 1998 [updated 2012 May 3; cited 2013 Jun 29]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK1109.
6. Schorry E, Stowens D, Crawford A, Stowens P, Schwartz E, Dignan P. Summary of patient data from a multidisciplinary neurofibromatosis clinic. Neurofibromatosis. 1989;2(2):129-34.
7. Hersh J, Committee on Genetics. Health supervision for children with neurofibromatosis. Pediatrics. 2008 Mar;121(3):633-42.

FEATURE ARTICLE

What you need to know about imaging the liver

A practical review of current literature

Gaurav Bhattacharya (MD), Michael Kabiri (MD), Laura Callan (Meds 2015)
Faculty Reviewer: Dr Michael Lock, MD, CCFP, FCFP, FRCPC Chair (Department of Oncology, Division of Radiation Oncology)

ABSTRACT

Hepatic cancers are an increasing source of morbidity and mortality in the developing and the developed world. In this paper, we highlight the current imaging modalities used for various cystic and solid hepatic lesions. The rationale behind selection of these modalities and an efficient evidence-based step-by-step diagnostic algorithm are presented. Emphasis is placed on both identifying as well as differentiating between a benign, primary malignant and metastatic lesion.

BACKGROUND

Cancer of the liver remains one of the most common causes of cancer as well as cancer deaths worldwide[1] and is responsible for about three quarters of a million deaths each year. While primarily concentrated in the developing world, the incidence is rising rapidly in developed countries. This includes Canada, where it has more than doubled over the last forty years.[2] In North America, this ongoing rising incidence is due to increased prevalence of known underlying risk factors for liver cancer including the silent obesity-related disease called non-alcoholic steatohepatitis (NASH), hepatitis B and C, cirrhosis, as well as an aging population now entering a period of disease manifestation. Patients will present to physicians in many different specialties due to the often non-specific or incidental presentations of this group of malignancies. Early identification is critical to improved outcome and health care providers in various specialties need to become knowledgeable of the recent advances in imaging, adjuvant therapies as well as stricter follow-up protocols in a multidisciplinary environment that lead to an earlier identification of metastases to the liver.[3,4] The table[5,6] highlights the potential differentials for malignant hepatic lesions which need to be identified and differentiated from their benign counterparts.

Table: Malignant Hepatic Lesions

CYSTIC	Cystadenocarcinoma
	Squamous cell carcinoma
	Carcinoma of ovaries/pancreas/colon/kidneys
	Neuroendocrine
SOLID	Hepatocellular carcinoma
	Fibrolamellar carcinoma
	Hepatoblastoma
	Cholangiosarcoma
	Angiosarcoma
	Primary Lymphoma
	Metastases

Noninvasive differentiation of the underlying etiology, including detection, characterization, staging and therapy monitoring, is the main task of modern imaging. Among the three major available diagnostic options (ultrasound [US], computed tomography [CT] and magnetic resonance imaging [MRI]), there exist several variations in technique that permit improvements in the ability to visualize lesions. For example, requisition for contrast-enhanced imaging during certain phases, dynamic contrast-enhanced imaging and respiratory gating can be instrumental for allowing clinicians to identify a lesion correctly. While detailed histories, physical examinations and biochemical markers remain vital in framing a complete picture, cross-sectional imaging of lesions often plays the central role in determining the identity and management options of a lesion. Therefore, a clear, evidence-based and organized approach to ordering and interpreting imaging of the liver, as presented below and summarized in Figure 1,[7] is essential to clinical practice.

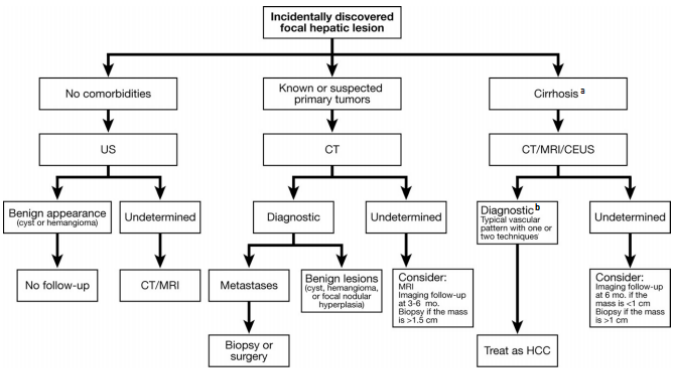

Figure 1:[7] Suggested algorithm for the investigation of patients with incidental focal liver lesions. HCC, hepatocellular carcinoma.
[a] Diagnostic work-up of incidentally discovered hepatic lesions in patients with cirrhosis is based on the data-supported recommendations endorsed by the American Association for the Study of the Liver Diseases.
[b] Lesion enhancement during the hepatic arterial dominant phase, followed by washout during the hepatic venous phase and/or delayed phase as shown by a single (lesions >2 cm) or 2 (lesions 1-2 cm) different imaging modalities.

CYSTIC LESIONS

Cysts are usually water-density, sharply demarcated lesions. The differential includes hemangiomas and malignant lesions. Figure 2 describes a standard imaging workup for identified cystic hepatic lesions. Traditionally, US has been the most economical modality for imaging the cancerous liver.[8] While sensitivity and specificity with conventional sonography had lagged behind CT and MRI, with the advent of contrast-enhanced ultrasound (CEUS), these gaps, as detailed below, have shrunk greatly. CEUS also plays an important role in distinguishing premalignant cystadenoma and

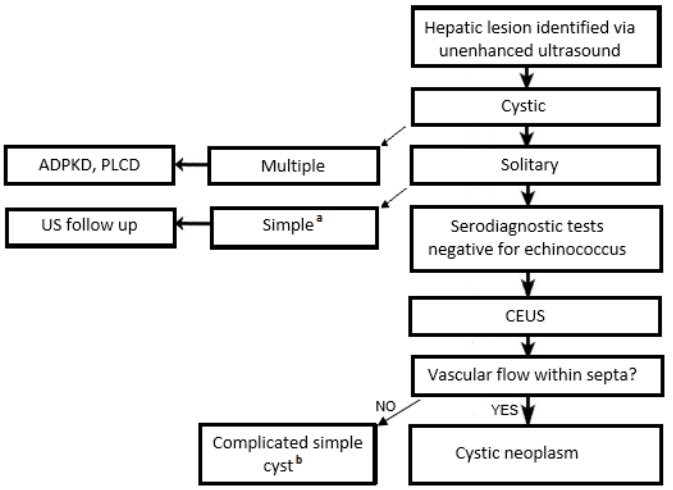

Figure 2: Algorithm highlighting cystic hepatic lesion imaging work up. PCLD: Polycystic liver disease; ADPKD: Autosomal dominant polycystic kidney disease.
[a] Simple cyst US criteria: anechoic, aseptate, smooth sharp borders, strong posterior wall echoes, relative accentuation of echoes beyond the cyst.[35]
[b] Complicated cyst as defined by compression, hemorrhage, or infection into a simple cyst.[36]

malignant cystadenocarcinoma from other complex cysts which feature similar characteristics. The former are characterized by vascular flow within the septa, which is absent in the latter. This technique is also useful in differentiating normal and common benign cystic lesions from malignant lesions. Cystic-appearing metastases, which may be manifestations of necrotic or cystic degenerations of rapidly growing tumours, and mucinous colonic or ovarian adenocarcinomas can be identified.[9]

A meta-analysis involving 45 studies and over 8000 focal lesions validates CEUS use for diagnostic workup with an overall 93% (95% confidence interval [CI], 91–95%) sensitivity and 90% (95% CI, 88–92%) specificity for diagnosis of malignant liver lesions.[10] Furthermore, the same study shows significantly better sensitivity for CEUS as compared to CT/ MRI with contrast and no significant difference in specificity between either modality.[11] As CEUS remains the most economical solution,[12-15] avoids radiation exposure, is available for bedside evaluation and usually involves much shorter wait times, US forms an ideal modality for the initial hepatic cancer diagnosis.

SOLID LESIONS

A standardized approach to image solid lesions has been developed (Figure 3) that relies on the different vascular anatomy of tumours and lesions. Solid hepatic lesions are imaged initially via triphasic abdominal CT with contrast. Imagers rely on the distinct pattern of contrast accumulation in three separate phases as the contrast enters the arterial system (Figure 4: arterial phase), then the venous system (early portal venous phase) and finally is excreted (late portal venous phase or washout phase). Briefly, tumours develop new abnormal arteries via a process called angiogenesis. Hepatic tumours derive the majority of their blood supply from the hepatic artery, while secondary lesions and the normal liver derive their blood supply mainly from the portal vein. Therefore, primary lesions "light up" in the arterial phase and maximally enhance the tumour. Respiratory motions can cause artifactual errors, but imaging of this phase can usually be achieved in a single breath-hold via multi detector CT (MDCT)[16,17] after a bolus injection of contrast.[18] Secondary lesions such as colorectal and other metastases tend to be isodense during the arterial phase and dark during the portal venous phase. The subsequent contrast washout in delayed phases provides further information useful for detection of smaller hepatocellular carcinoma (HCC) lesions.[19,20]

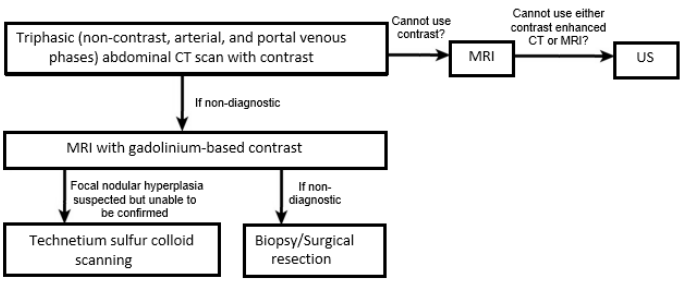

Figure 3: Algorithm highlighting solid hepatic lesion imaging work up. Note that unlike transabdominal US, intraoperative US involving direct placement of transducer up on liver parenchyma remains the most sensitive modality in identifying metastatic disease.[37]

HEPATOCELLULAR CARCINOMA AND INTRAHEPATIC CHOLANGIOCARCINOMA: A SPECIAL EMPHASIS

As the most common type of liver cancer, HCC figures prominently in parts of the world where hepatitis remains endemic. Contrary to many other cancers, HCC does not mandate histologic confirmation for patients at high risk owing to the great accuracy of modern imaging modalities as well as the risks and side effects involved with liver biopsy. Indeed, pathologic diagnosis adds little to the diagnostic accuracy of imaging plus a blood test for alphafetoprotein, a liver tumour marker. In fact, a systemic review identified MRI and CT as the ideal diagnostic tests, particularly in cirrhotic patients.[21] For now, use of positron emission tomography (PET) remains restricted to the detection of extrahepatic metastases and extrahepatic recurrence after liver transplantation, diagnosis or resection[22] and therefore will not be discussed further in this paper.

If a triphasic CT result is nondiagnostic, a gadolinium-enhanced MRI is recommended.[23] The use of hepatobiliary-contrast-enhanced MRI not only allows for a better sensitivity and specificity in identification of the various lesions involved,[24,25] but also provides additional information regarding liver function and the degree of cirrhosis. This allows for stratification of patients into early, intermediate and advanced tumour stages and can help facilitate choosing between aggressive and potentially curative versus life-extending, palliative and symptomatic treatments.

Aside from HCC, intraheptic cholangiocarcinoma (iCCA), with an increasing incidence worldwide,[26] is the most important malignant primary liver tumour differential due to its aggressive nature and dismal natural history. These tumours often present at an advanced stage and carry one of the highest mortality rates in oncology. Earlier detection is vital if patients are to be eligible

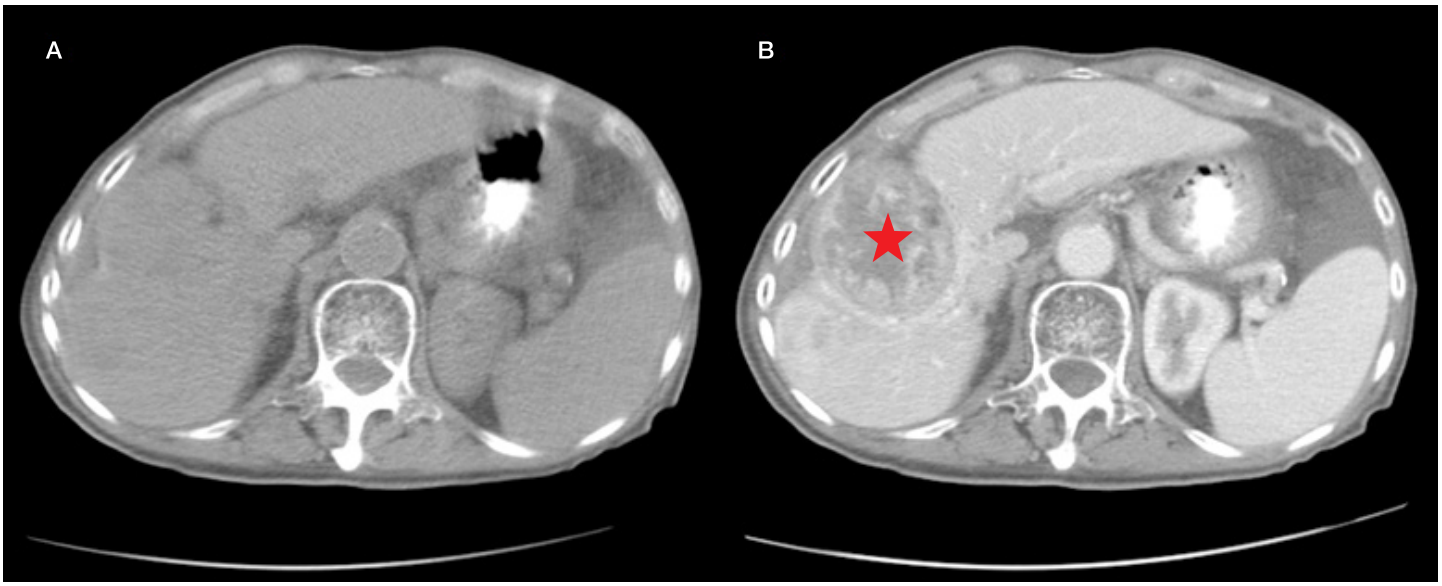

Figure 4: The impact of contrast in delineating a tumour. A, scout film. B, arterial phase axial CT image with tumour highlighted via a red star.

for aggressive treatments. Unlike HCC, which has a rapid uptake of contrast during the arterial phase and quick washout during the venous phase, iCCA has a progressive change in contrast during both phases.[27] Other unique iCCA characteristic features include active inflammation at the tumour- parenchymal interface leading to a rim pattern of peripheral enhancement and a slower contrast uptake due to extensive desmoplasia, caused by the proliferation of fibroblasts and fibroblastic tissue.[28] However, biopsy still remains essential in most iCCA patients to confirm diagnosis.

METASTASES

For metastatic liver disease, the primary objective in oncology remains assessment of the resectability of the cancer. Such resection may be carried out either via surgery or through non- surgical ablative therapies such as stereotactic body radiation therapy (SBRT) or radiofrequency ablation (RFA). Staging and successful planning is also critically affected by identification and subsequent removal of any potential extrahepatic disease as metastases to the chest and abdomen indicate poor prognosis and are contraindications to surgical resection.[29]

Repeated studies have shown the inferiority of transabdominal US to CT and MRI.[30,31] CT imaging remains the mainstay of staging and follow-up owing to several points. Firstly, CT permits excellent coverage of the entire abdomen and chest in a single session. Contrast-enhanced imaging allows for identification of both hypervascular metastases, such as those from renal cell, endocrine and some breast carcinomas (arterial phase), as well as hypovascular (portal venous phase) metastases, such as in colonic adenocarcinoma.[32] CT also permits submillimeter-thickness slicing, allowing for the same spatial (isotropic) resolution in all directions. This provides the option of selecting an optimal image plane retrospectively regardless of initial angle of scanning and thereby enhances detection of smaller lesions. Speed and a lower cumulative period of radiation exposure remain important advantages. Newer 320 detector row CT (320- MDCT) can accomplish a whole liver scan in 0.35 seconds versus 25 to 30 seconds for single-slice helical CT.[33]

Finally, volumetric 3-dimensional rendering allows accurate segmental localization and delineation (unlike the aforementioned CEUS) and digital vascular reconstruction, leading to the creation of a 3D CT hepatic-mesenteric angiogram, thus obviating the need for extraneous angiography in presurgical planning.[34]

SUMMARY

The incidence of liver lesions has risen dramatically due to a plethora of underlying factors especially common in an aging population, such as cirrhosis, fatty liver and hepatitis. Since many patients present asymptomatically with liver incidentalomas, an early diagnosis, which is potentially crucial for therapy, may be dependent upon the assessment of the specialist outside of gastroenterology, hepatology or radiology. To facilitate an ideal guideline-based therapy, an evidence-based algorithmic approach is presented and the most common imaging modalities and the variations available to the clinician are described. The approach first begins with the identification of a lesion's cystic or solid nature. Then, ultrasound may be utilized for cystic lesions as it can differentiate benign "no touch" lesions (lesions where biopsy may cause significant complications and/or where imaging alone can make the diagnosis) such as hemangiomas, focal nodular hyperplasia, adenomas, aneurysms and aortoportal shunts from their biopsiable malignant counterparts such as neuroendocrine, ovarian and pancreatic carcinomas. For solid lesions, a separate algorithm is presented, beginning primarily with contrast-enhanced CT imaging, which helps identify the unique vascular signatures of lesions and thus distinguishes between primary malignancies (such as hepatocellular carcinoma), cholangiocarcinomas and liver metastases.

REFERENCES

1. GLOBOCAN. Cancer Fact Sheet [Internet]. Geneva: World Health Organization; 2012 [cited 2014 Jan 7]. Available from: http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx
2. Roussy K. Liver cancer on the rise in Canada [Internet]. Toronto: CBC News; 2013 May 29 [cited 2013 Jul 17]. Available from: http://www.cbc.ca/news/health/liver-cancer-on-the-rise-in-canada-1.1315831
3. Manfredi S, Lepage C, Hatem C, Coatmeur O, Faivre J, Bouvier A- M. Epidemiology and management of liver metastases from colorectal cancer. Ann Surg. August 2006;244(2):254-9.
4. Pentheroudakis G, Fountzilas G, Bafaloukos D, Koutsoukou V, Pectasides D, Skarlos D, et al. Metastatic breast cancer with liver metastases: a registry analysis of clinicopathologic, management and outcome characteristics of 500 women. Breast Cancer Res Treat. 2006 Jun 1;97(3):237-44.
5. Lantinga MA, Gevers TJ, Drenth JP. Evaluation of hepatic cystic lesions. World J Gastroenterol. 2013 Jun 21;19(23):3543-54.
6. Bonder A, Afdhal N. Evaluation of liver lesions. Clin Liver Dis. 2012 May;16(2):271-83.
7. Marin D, Furlan A, Federle MP, Midiri M, Brancatelli G. Imaging approach for evaluation of focal liver lesions. Clin Gastroenterol Hepatol. 2009 Jun;7(6):624-34.
8. Song DS, Bae SH. Changes of guidelines diagnosing hepatocellular carcinoma during the last ten- year period. Clin Mol Hepatol. 2012 Sep;18(3):258-67.
9. Torzilli G, Minagawa M, Takayama T, Inoue K, Hui AM, Kubota K, et al. Accurate preoperative evaluation of liver mass lesions without fine- needle biopsy. Hepatology. 1999 Oct;30(4):889-93.
10. National Institute for Health and Care Excellence. NICE publishes guidance for ultrasound testing to diagnose liver cancer [Internet]. London: Nice Diagnostics Assessment Programme. 2012 [cited 2013 Jul 16]. Available from: http://www.nice.org.uk/newsroom/pressreleases/NICEPublishesGuidanceForUltrasoundTestingToDiagnoseLiverCancer.jsp
11. Friedrich- Rust M, Klopffleisch T, Nierhoff J, Herrmann E, Vermehren J, Schneider MD, et al. Contrast-enhanced ultrasound for the differentiation of benign and malignant focal liver lesions: a meta- analysis. Liver Int. 2013 May;33(5):739-55.
12. Westwood M, Joore M, Grutters J, Redekop K, Armstrong N, Lee K, et al. Contrast-enhanced ultrasound using SonoVue® (sulphur hexafluoride microbubbles) compared with contrast-enhanced computed tomography and contrast-enhanced magnetic resonance imaging for the characterisation of focal liver lesions and detection of liver metastases: a systematic review and cost-effectiveness analysis. Health Technol Assess. 2013 Apr;17(16):1-243.
13. Tranquart F, Correas JM, Ladam Marcus V, Manzoni P, Vilgrain V, Aube C, et al. Real-time contrast-enhanced ultrasound in the evaluation of focal liver lesions: diagnostic efficacy and economical issues from a French multicentric study. J Radiol. 2009 Jan;90(1 Pt 2):109-22.
14. Giesel FL, Delorme S, Sibbel R, Kauczor HU, Krix M. Contrast-enhanced ultrasound for the characterization of incidental liver lesions – an economical evaluation in comparison with multi-phase computed tomography. Ultraschall Med. 2009 Jun;30(3):259-68.
15. Romanini L, Passamonti M, Aiani L, Cabassa P, Raieli G, Montermini I, et al. Economic assessment of contrast- enhanced ultrasonography for evaluation of focal liver lesions: a multicentre Italian experience. Eur Radiol. 2007 Dec;17 Suppl 6:F99-106.
16. Xu LH, Cai SJ, Cai GX, Peng WJ. Imaging diagnosis of colorectal liver metastases. World J Gastroenterol. 2011 Nov 14;17(42):4654-9.
17. 1Hwang GJ, Kim MJ, Yoo HS, Lee JT. Nodular hepatocellular carcinomas: detection with arterial-, portal-, and delayed-phase images at spiral CT. Radiology. 1997 Feb;202(2):383-8.
18. Foley WD, Mallisee TA, Hohenwalter MD, Wilson CR, Quiroz FA, Taylor AJ. Multiphase hepatic CT with a multirow detector CT scanner. Ajr Am J Roentgenol. 2000 Sep;175(3):679-85.
19. Iannaccone R, Laghi A, Catalano C, Rossi P, Mangiapane F, Murakami T, et al. Hepatocellular carcinoma: role of unenhanced and delayed phase multi- detector row helical CT in patients with cirrhosis. Radiology. 2005 Feb;234(2):460-7.
20. Moritz T, Prosch H, Schuster H, Ba- Ssalamah A. Malignant focal liver lesions. Radiologe. 2011 Aug;51(8):697-703.
21. Bruix J, Sherman M, American Association for the Study of Liver Diseases. Management of hepatocellular carcinoma: an update. Hepatology. 2011 Mar;53(3):1020-2.
22. Colli A, Fraquelli M, Casazza G, Massironi S, Colucci A, Conte D, et al. Accuracy of ultrasonography, spiral CT, magnetic resonance, and alpha- fetoprotein in diagnosing hepatocellular carcinoma: a systematic review. Am J Gastroenterol. 2006 Mar;101(3):513-23.
23. Campos JT, Sirlin CB, Choi JY. Focal hepatic lesions in Gd-EOB- DTPA enhanced MRI: the atlas. Insights Imaging. 2012 Oct;3(5):451-74.
24. Song MJ, Bae SH, Yoo IR, Park CH, Jang JW, Chun HJ, et al. Predictive value of 18F- fluorodeoxyglucose PET/CT for transarterial chemolipiodolization of hepatocellular carcinoma. World J Gastroenterol. 2012 Jul 7;18(25):3215-22.
25. Bruix J, Sherman M, Llovet JM, Beaugrand M, Lencioni R, Burroughs AK, et al. Clinical management of hepatocellular carcinoma. Conclusions of the Barcelona- 2000 EASL conference. European Association for the Study of the Liver. J Hepatol. 2001 Sep;35(3):421-30.
26. European Association for Study of Liver, European Organisation for Research and Treatment of Cancer. EASL- EORTC clinical practice guidelines: management of hepatocellular carcinoma. Eur J Cancer. 2012 Mar;48(5):599-641.
27. Bastati- Huber N, Prosch H, Baroud S, Magnaldi S, Schima W, Ba- Ssalamah A. New developments in MRI of the liver. Radiol. 2011 Aug;51(8):680-7.
28. Patel T. Worldwide trends in mortality from biliary tract malignancies. BMC Cancer. 2002 May 3;2:10.
29. Vilgrain V. Staging cholangiocarcinoma by imaging studies. HPB. 2008;10(2):106-9.

30. Rimola J, Forner A, Reig M, Vilana R, de Lope CR, Ayuso C, et al. Cholangiocarcinoma in cirrhosis: absence of contrast washout in delayed phases by magnetic resonance imaging avoids misdiagnosis of hepatocellular carcinoma. Hepatology. 2009 Sep;50(3):791-8.
31. Razumilava N, Gores GJ. Classification, diagnosis, and management of cholangiocarcinoma. Clin Gastroenterol Hepatol. 2013 Jan;11(1):13-21.e1; quiz e3-4.
32. Anderson CD, Rice MH, Pinson CW, Chapman WC, Chari RS, Delbeke D. Fluorodeoxyglucose PET imaging in the evaluation of gallbladder carcinoma and cholangiocarcinoma. J Gastrointest Surg. 2004 Jan;8(1):90-7.
33. Petrowsky H, Wildbrett P, Husarik DB, Hany TF, Tam S, Jochum W, et al. Impact of integrated positron emission tomography and computed tomography on staging and management of gallbladder cancer and cholangiocarcinoma. J Hepatol. 2006 Jul;45(1):43-50.
34. Yang J, Yan LN. Current status of intrahepatic cholangiocarcinoma. World J Gastroenterol Wjg. 2008 Nov 7;14(41):6289-97.
35. Fong Y. Surgical therapy of hepatic colorectal metastasis. CA Cancer J Clin. 1999 Aug;49(4):231-55.
36. Hagspiel KD, Neidl KF, Eichenberger AC, Weder W, Marincek B. Detection of liver metastases: comparison of superparamagnetic iron oxide- enhanced and unenhanced MR imaging at 1.5 T with dynamic CT, intraoperative US, and percutaneous US. Radiology. 1995 Aug;196(2):471-8.
37. Robinson PJ. Imaging liver metastases: current limitations and future prospects. Br J Radiol. 2000 Mar;73(867):234-41.
38. Bernatik T, Strobel D, Hahn EG, Becker D. Detection of liver metastases: comparison of contrast- enhanced wide- band harmonic imaging with conventional ultrasonography. J Ultrasound Med. 2001 May;20(5):509-15.
39. Miller FH, Butler RS, Hoff FL, Fitzgerald SW, Nemcek AA Jr, Gore RM. Using triphasic helical CT to detect focal hepatic lesions in patients with neoplasms. Ajr Am J Roentgenol. 1998 Sep;171(3):643-9.
40. Sonoda A, Nitta N, Ushio N, Nitta- Seko A, Tomozawa Y, Watanabe S, et al. 320- detector- row computed tomography arteriography using CO2 gas to detect malignant liver tumors. Minim Invasive Ther Allied Technol. 2013 Apr;22(2):89-96.
41. Floriani I, Torri V, Rulli E, Garavaglia D, Compagnoni A, Salvolini L, et al. Performance of imaging modalities in diagnosis of liver metastases from colorectal cancer: a systematic review and meta- analysis. J Magn Reson Imaging Jmri. 2010 Jan;31(1):19-31.
42. Wiering B, Krabbe PFM, Jager GJ, Oyen WJG, Ruers TJM. The impact of fluor- 18- deoxyglucose- positron emission tomography in the management of colorectal liver metastases. Cancer. 2005 Dec 15;104(12):2658-70.
43. Ke S, Zhang F, Wang W, Qiu X, Lin J, Cameron AG, et al. Multiple target- specific molecular imaging agents detect liver cancer in a preclinical model. Curr Mol Med. 2012 Sep;12(8):944-51.
44. Müller T, Mehrle S, Schieck A, Haberkorn U, Urban S, Mier W. Liver Imaging with a Novel Hepatitis B Surface Protein Derived SPECT- Tracer. Mol Pharm. 2013 Jun 3;10(6):2230-6.
45. Doherty JR, Trahey GE, Nightingale KR, Palmeri ML. Acoustic radiation force elasticity imaging in diagnostic ultrasound. Ieee Trans Ultrason Ferroelectr Freq Control. 2013 Apr;60(4):685-701.
46. Lee DH, Lee JM, Klotz E, Kim SJ, Kim KW, Han JK, et al. Detection of recurrent hepatocellular carcinoma in cirrhotic liver after transcatheter arterial chemoembolization: value of quantitative color mapping of the arterial enhancement fraction of the liver. Korean J Radiol Off J Korean Radiol Soc. 2013 Feb;14(1):51-60.
47. Pokharel SS, Macura KJ, Kamel IR, Zaheer A. Current MR imaging lipid detection techniques for diagnosis of lesions in the abdomen and pelvis. Radiogr Rev Publ Radiol Soc North Am Inc. 2013 May;33(3):681-702.
48. Spiegel RM, King DL, Green WM. Ultrasonography of primary cysts of the liver. Ajr Am J Roentgenol. 1978 Aug;131(2):235-8.
49. Plard L, Guedin P, Le Pennec V, Chiche L. Hepatic cysts: diagnosis and management. J Chir (Paris). 2008 Jun;145(3):217-25.

FEATURE ARTICLE

Radiation in the treatment of liver cancer

A review of the literature

Laura Callan (Meds 2015), Benjamin Beech (Meds 2016), Eugene Wong (PhD, FCCPM)
Faculty Reviewer: Dr Michael Lock, MD, CCFP, FRCP, FRCPC, Chair (Department of Oncology, Division of Radiation Oncology)

Radiation therapy (RT) is a newly evolving option in the treatment of both primary and metastatic liver cancer. To understand how RT can be applied to liver cancer and potential future directions of treatments, a review of the literature was performed.

INTRODUCTION & GENERAL TREATMENT OVERVIEW

PRIMARY LIVER CANCER

Primary liver cancer is the fastest growing cancer in Canada, with the incidence rate increasing by almost 4% per year in males and 3% per year in females since 1970, and is the third most common cause of cancer death worldwide.[1] The most common type of primary liver cancer is hepatocellular carcinoma (HCC), accounting for approximately 72% of cases.[1] Hepatitis B and C viruses (HBV and HCV) are known to be oncogenic[1] and it is possible that some of the increase in the rates of liver cancer in North America is a result of increased immigration from countries where HBV is endemic;[2] however, half of all cases of HCC in North America are not related to HBV or HCV.[3] Other risk factors include alcohol,[4] obesity,[5] diabetes,[6] smoking[7] and genetic risk factors such as hemochromatosis and alpha1-antitrypsin deficiency.[8] Primary liver cancer is one of the deadliest cancers, with a 20% five-year survival.[1]

The only treatments of liver cancer currently considered potentially curative are resection, transplantation,[9] transarterial chemoembolization (TACE)[10] and radiofrequency ablation (RFA).[1,11] In 2008, a chemotherapeutic agent, sorafenib, was shown to be tolerable and effective in a select group of patients.[12] Patients with very early-stage primary liver cancer are typically treated with surgical resection, resulting in a 90% five-year survival rate.[14] Resection can also be used in patients with early-stage disease and good liver function (Child-Pugh A),[1] resulting in a 50% five-year survival rate; however, these patients still have a 70% recurrence rate.[15] Resection is not an option for patients with early-stage disease and poor liver function, so they are often treated with liver transplantation,[1] resulting in a 70% five-year survival rate and a recurrence rate of less than 15%;[15] unfortunately, the wait time for such a surgery is typically very long. Other patients with early-stage disease for whom surgery is not possible due to the location of the tumour can be treated with RFA,[1] which has similar survival rates to resection.[16] TACE is often used to treat intermediate-stage liver cancer and has been shown to improve survival by 20 to 25%,[14] with the best results occurring when there is no macrovascular involvement[10,17] and a tumour size less than 10 cm.[18] Those with advanced disease are typically not treated actively,[1] the exception being the relatively uncommon case where the patient retains good liver function and sorafenib may be used.[14] Two randomized controlled trials with sorafenib have shown that median survival is improved by two to three months.[12]

LIVER METASTASES

The most common causes of secondary hepatic malignancy are colorectal carcinoma, breast carcinoma, melanoma and neuroendocrine tumours.[15] The 5-year overall survival with unresectable liver metastases from colorectal cancer is less than 2% when treated with chemotherapy.[15] If local therapy, such as surgical resection or RFA, is possible, survival increases to between 33 to 58%[19-21] and 17 to 55%[15] respectively. Therefore, resection and preservation of a minimal functional remnant of liver is recommended.[21] If the tumours are originally unresectable, it is sometimes possible to use chemotherapy to shrink the tumours to a resectable size or away from critical structures such as blood vessels.[15]

NOVEL TREATMENT METHODS FOR LIVER CANCER

Many novel approaches to improving survival in both primary and secondary liver cancer have been investigated. Radioembolization, the delivery of radioactive particles to a tumour via the bloodstream, has shown limited success in causing tumour necrosis, thereby improving survival.[22] Biodegradeable microspheres full of a chemotherapeutic agent may also be used and this technique has been shown to be safer than traditional chemotherapy in patients with liver disease; however, there is no evidence to date that it improves survival compared to other traditional treatment options.[23] Another approach has been to use radiotherapy, a treatment frequently employed for cancers in other locations, but, for reasons described below, it has only recently been used with curative intent in patients with liver cancer. Radiation is appealing as it is non-invasive and has been shown to be effective in the primary cancers that commonly metastasize to the liver. Furthermore, it has been shown to improve survival in patients who cannot receive other therapies due to complications such as portal vein thrombosis.[24]

LIVER TOXICITY IN RADIOTHERAPY

Irradiating the liver can lead to radiation-induced liver disease (RILD) even at low doses. A whole-liver tolerance dose has been set at a maximum of 30 Gy in separate 2 Gy fractions, a dose which results in a 5% risk of liver failure 5 years after treatment.[25] RILD is potentially life-threatening and in the past has limited the role of radiation in liver cancer to mostly palliative.[26-29] This risk of RILD increases if the patient has established poor liver function due to cirrhosis or the cancer itself.[28,30] Malignant lesions of the liver typically require greater than 75 Gy for adequate treatment[31] and, therefore, treatment of these lesions with radiation poses a very high risk of

RILD. Since the liver has regenerative properties, it is possible to irradiate a portion of the liver, rather than the entire organ, thereby decreasing the risk of RILD;[32,33] however, until recently the technology required to locate the tumour within the liver and to apply radiation to that limited area has not been available.

TECHNICAL ADVANCES WHICH ALLOW FOR RADIOTHERAPY WITH CURATIVE INTENT

IMAGING METHODS

Recent advancements have allowed the use of radiation in liver cancer with curative intent. New imaging techniques can better localize the tumour within the liver, allowing for high doses to be applied to a small area around the focal lesion and limiting the risk of RILD to less than 5%.[34-38] These include the use of contrast-enhanced computed tomography (CT)[39] as well as combined imaging techniques such as CT with magnetic resonance imaging (MRI) or positron emission tomography (PET) to better define tumour boundaries.[40,41] Further, imaging can now be performed in the treatment room, using technology such as cone beam CT to allow for visualization of the liver immediately before or during treatment.[45]

MOTION INCORPORATING METHODS

Methods for reducing or accounting for liver motion can be applied during imaging to improve the quality of the image or during treatment to allow for more precise delivery. During breathing, the liver moves on average 15.5 mm in the craniocaudal direction, 10 mm in the anteroposterior direction and 7.5 mm in the mediolateral direction.[46] It is recommended that treatment planning account for any motion greater than 5 mm.[47] This can be done by three methods: reducing motion through abdominal compression, eliminating motion through breath holding or incorporating motion through gating or tracking of surrogate markers.[45] Abdominal compression requires the patient to voluntarily breathe shallowly while the abdomen is mechanically compressed,[45] and can reduce liver motion by approximately 7 mm.[48] Eliminating motion through breath-holding is most reproducible if patients hold their breath at the exhale position[45] and has an interfraction variability of 2.2 mm +/– 2.0 mm.[49,50] Incorporating motion into treatment is currently the focus of extensive research as it reduces the burden on the patient.[45] Relevant techniques include gating, where the radiation beam is only turned on when the tumour is in a specific position, and tracking, where the beam is moved according to the position of the tumour. Both require tracking the position of the tumour with either an external marker placed on the patient's chest, or a fiducial marker placed within the patient's liver.[51]

DOSE DELIVERY METHODS

Advances in methods of delivering radiation have also allowed for more precise dose delivery. Conformal RT (CRT), intensity-modulated RT (IMRT) and stereotactic ablative RT (SABR) have allowed for a higher dose to be delivered to a focal tumour even while a lower dose is delivered to the surrounding liver and other normal structures.[52-54] CRT utilizes multiple beams to sculpt the dose to conform to the shape of tumours. IMRT advances this technique by using computer algorithms to enable even more accurate placement of radiation dose within the tumour. SABR uses image guidance and increased dose per treatment fraction to ablate tumours. Studies have shown that the most important predictor of survival for liver cancer is radiation dose.[31] Treating a tumour with more than 75 Gy overall has been shown to increase mean survival from 14.9 months to 23.9 months in HCC;[31] however, no randomized trials have been performed to date.

COMBINATION TREATMENT METHODS

A further technique is to combine other treatment modalities with RT. The most common treatment used in such a combination is TACE.[55-59] Studies have found that it is sometimes possible to shrink the tumour using TACE, then irradiate the smaller liver volume.[31] A higher overall survival rate has been found with the combination of radiation and TACE versus TACE alone (11.7 compared to 4.7 months median overall survival).[60]

CONCLUSIONS AND FUTURE DIRECTIONS

Despite statistically significant mortality improvements in primary and secondary liver cancer as a result of the above, the overall outcome for a large proportion of patients remains poor. Major advancements in radiation technology have resulted in better motion control, tumour localization, understanding of radiobiological toxicity and radiation delivery. Case series data suggests that this has translated into improved local control and survival. These early studies have suggested particular roles for radiation that require additional investigation, including the role of radiation in patients (1) with larger lesions when combined with TACE, (2) being bridged to transplant, (3) with portal vein thrombosis and (4) undergoing palliation.

REFERENCES

1. Canadian Cancer Society's Advisory Committee on Cancer Statistics. Canadian cancer statistics 2013. Toronto, ON: Canadian Cancer Society; 2013.
2. Burak KW, Coffin CS, Myers RP. Hepatitis B awareness and education: a failing grade. Can J Gastroenterol. 2011;25(3):125-6.
3. El-Serag HB, Mason AC. Risk factors for the rising rates of primary liver cancer in the United States. Arch Intern Med. 2000;160(21):3227-30.
4. Corrao G, Bagnardi V, Zambon A, La Vecchia C. A meta-analysis of alcohol consumption and the risk of 15 diseases. Prev Med. 2004;38(5):613-9.
5. Larsson SC, Wolk A. Overweight, obesity and risk of liver cancer: a meta-analysis of cohort studies. Br J Cancer. 2007;97(7):1005-8.
6. El-Serag HB, Hampel H, Javadi F. The association between diabetes and hepatocellular carcinoma: a systematic review of epidemiologic evidence. Clin Gastroenterol Hepatol. 2006;4(3):369-80.
7. Gandini S, Botteri E, Iodice S, et al. Tobacco smoking and cancer: a meta-analysis. Int J Cancer. 2008;122(1):155-64

8. Blonski W, Kotlyar DS, Forde KA. Non-viral causes of hepatocellular carcinoma. World J Gastroenterol. 2010;16(29):3603-15.
9. Mazzaferro V, Regalia E, Doci R, et al. Liver transplantation for the treatment of small hepatocellular carcinomas in patients with cirrhosis. N Engl J Med. 1996;334(11):693-9.
10. Llovet JM, Real MI, Montana X, et al. Arterial embolisation or chemoembolisation versus symptomatic treatment in patients with unresectable hepatocellular carcinoma: a randomised controlled trial. Lancet. 2002;359(9319):1734-9.
11. Sherman M, Burak K, Maroun J, et al. Multidisciplinary Canadian consensus recommendations for the management and treatment of hepatocellular carcinoma. Curr Oncol. 2011;18(5):228-40.
12. Llovet JM, Ricci S, Mazzaferro V, et al. Sorafenib in advanced hepatocellular carcinoma. N Engl J Med. 2008;359(4):378-90.
13. Livraghi T, Meloni F, Di Stasi M, et al. Sustained complete response and complications rates after radiofrequency ablation of very early hepatocellular carcinoma in cirrhosis: is resection still the treatment of choice? Hepatology. 2008;47(1):82-9.
14. El-Serag HB. Hepatocellular carcinoma. N Engl J Med. 2011;365(12):1118-1127.
15. Dawson LA. Overview: where does radiation therapy fit in the spectrum of liver cancer local-regional therapies? Semin Radiat Oncol. 2011;21(4):241-6.
16. Hong SN, Lee SY, Choi MS, et al. Comparing the outcomes of radiofrequency ablation and surgery in patients with a single small hepatocellular carcinoma and well-preserved hepatic function. J Clin Gastroenterol. 2005;39(3):247-52.
17. Lo CM, Ngan H, Tso WK, et al. Randomized controlled trial of transarterial lipiodol chemoembolization for unresectable hepatocellular carcinoma. Hepatology. 2002;35(5):1164-71.
18. Thornton RH, Covey A, Petre EN, et al. A comparison of outcomes from treating hepatocellular carcinoma by hepatic artery embolization in patients younger or older than 70 years. Cancer. 2009;115(21):5000-6.
19. Wei AC, Greig PD, Grant D, Taylor B, Langer B, Gallinger S. Survival after hepatic resection for colorectal metastases: a 10-year experience. Ann Surg Oncol. 2006;13(5):668-76.
20. Lo SS, Moffatt-Bruce SD, Dawson LA, et al. The role of local therapy in the management of lung and liver oligometastases. Nat Rev Clin Oncol. 2011;8(7):405-16.
21. Fong Y, Fortner J, Sun RL, Brennan MF, Blumgart LH. Clinical score for predicting recurrence after hepatic resection for metastatic colorectal cancer: analysis of 1001 consecutive cases. Ann Surg. 1999;230(3):309-18; discussion 318-21.
22. Memon K, Kulik L, Lewandowski RJ, et al. Radiographic response to locoregional therapy in hepatocellular carcinoma predicts patient survival times. Gastroenterology. 2011;141(2):526-35, 535.e1-2.
23. Lammer J, Malagari K, Vogl T, et al. Prospective randomized study of doxorubicin-eluting-bead embolization in the treatment of hepatocellular carcinoma: results of the PRECISION V study. Cardiovasc Intervent Radiol. 2010;33(1):41-52.
24. Zhang XB, Wang JH, Yan ZP, Qian S, Du SS, Zeng ZC. Hepatocellular carcinoma with main portal vein tumor thrombus: treatment with 3-dimensional conformal radiotherapy after portal vein stenting and transarterial chemoembolization. Cancer. 2009;115(6):1245-52.
25. Emami B, Lyman J, Brown A, et al. Tolerance of normal tissue to therapeutic irradiation. Int J Radiat Oncol Biol Phys. 1991;21(1):109-22.
26. Dawson LA, Ten Haken RK. Partial volume tolerance of the liver to radiation. Semin Radiat Oncol. 2005;15(4):279-83.
27. Reed GB,Jr, Cox AJ,Jr. The human liver after radiation injury, a form of veno-occlusive disease. Am J Pathol. 1966;48(4):597-611.
28. Xu ZY, Liang SX, Zhu J, et al. Prediction of radiation-induced liver disease by lyman normal-tissue complication probability model in three-dimensional conformal radiation therapy for primary liver carcinoma. Int J Radiat Oncol Biol Phys. 2006;65(1):189-95.
29. Liang SX, Zhu XD, Lu HJ, et al. Hypofractionated three-dimensional conformal radiation therapy for primary liver carcinoma. Cancer. 2005;103(10):2181-8.
30. Liang SX, Zhu XD, Xu ZY, et al. Radiation-induced liver disease in three-dimensional conformal radiation therapy for primary liver carcinoma: the risk factors and hepatic radiation tolerance. Int J Radiat Oncol Biol Phys. 2006;65(2):426-34.
31. Feng M, Ben-Josef E. Radiation therapy for hepatocellular carcinoma. Semin Radiat Oncol. 2011;21(4):271-7.
32. Son SH, Choi BO, Ryu MR, et al. Stereotactic body radiotherapy for patients with unresectable primary hepatocellular carcinoma: dose-volumetric parameters predicting the hepatic complication. Int J Radiat Oncol Biol Phys. 2010;78(4):1073-80.
33. Schefter TE, Kavanagh BD, Timmerman RD, Cardenes HR, Baron A, Gaspar LE. A phase I trial of stereotactic body radiation therapy (SBRT) for liver metastases. Int J Radiat Oncol Biol Phys. 2005;62(5):1371-8.
34. Robertson JM, McGinn CJ, Walker S, et al. A phase I trial of hepatic arterial bromodeoxyuridine and conformal radiation therapy for patients with primary hepatobiliary cancers or colorectal liver metastases. Int J Radiat Oncol Biol Phys. 1997;39(5):1087-92.
35. McGinn CJ, Ten Haken RK, Ensminger WD, Walker S, Wang S, Lawrence TS. Treatment of intrahepatic cancers with radiation doses based on a normal tissue complication probability model. J Clin Oncol. 1998;16(6):2246-52.
36. Dawson LA, McGinn CJ, Normolle D, et al. Escalated focal liver radiation and concurrent hepatic artery fluorodeoxyuridine for unresectable intrahepatic malignancies. J Clin Oncol. 2000;18(11):2210-8.
37. Ben-Josef E, Normolle D, Ensminger WD, et al. Phase II trial of high-dose conformal radiation therapy with concurrent hepatic artery floxuridine for unresectable intrahepatic malignancies. J Clin Oncol. 2005;23(34):8739-47.
38. Dawson LA, Normolle D, Balter JM, McGinn CJ, Lawrence TS, Ten Haken RK. Analysis of radiation-induced liver disease using the lyman NTCP model. Int J Radiat Oncol Biol Phys. 2002;53(4):810-21.
39. Bruix J, Sherman M. Management of hepatocellular carcinoma: An update. Hepatology. 2011;53(3):1020-2.

40. Hussain SM, Semelka RC. Hepatic imaging: comparison of modalities. Radiol Clin North Am. 2005;43(5):929-47, ix.
41. Voroney JP, Brock KK, Eccles C, Haider M, Dawson LA. Prospective comparison of computed tomography and magnetic resonance imaging for liver cancer delineation using deformable image registration. Int J Radiat Oncol Biol Phys. 2006;66(3):780-91.
42. Lujan AE, Larsen EW, Balter JM, Ten Haken RK. A method for incorporating organ motion due to breathing into 3D dose calculations. Med Phys. 1999;26(5):715-20.
43. Seppenwoolde Y, Shirato H, Kitamura K, et al. Precise and real-time measurement of 3D tumor motion in lung due to breathing and heartbeat, measured during radiotherapy. Int J Radiat Oncol Biol Phys. 2002;53(4):822-34.
44. Nehmeh SA, Erdi YE, Rosenzweig KE, et al. Reduction of respiratory motion artifacts in PET imaging of lung cancer by respiratory correlated dynamic PET: methodology and comparison with respiratory gated PET. J Nucl Med. 2003;44(10):1644-8.
45. Brock KK. Imaging and image-guided radiation therapy in liver cancer. Semin Radiat Oncol. 2011;21(4):247-55.
46. Kirilova A, Lockwood G, Choi P, et al. Three-dimensional motion of liver tumors using cine-magnetic resonance imaging. Int J Radiat Oncol Biol Phys. 2008;71(4):1189-95.
47. Keall PJ, Mageras GS, Balter JM, et al. The management of respiratory motion in radiation oncology report of AAPM task group 76. Med Phys. 2006;33(10):3874-900.
48. Herfarth KK, Debus J, Lohr F, et al. Extracranial stereotactic radiation therapy: set-up accuracy of patients treated for liver metastases. Int J Radiat Oncol Biol Phys. 2000;46(2):329-35.
49. Dawson LA, Brock KK, Kazanjian S, et al. The reproducibility of organ position using active breathing control (ABC) during liver radiotherapy. Int J Radiat Oncol Biol Phys. 2001;51(5):1410-21.
50. Eccles C, Brock KK, Bissonnette JP, Hawkins M, Dawson LA. Reproducibility of liver position using active breathing coordinator for liver cancer radiotherapy. Int J Radiat Oncol Biol Phys. 2006;64(3):751-59.
51. Shirato H, Shimizu S, Kitamura K, et al. Four-dimensional treatment planning and fluoroscopic real-time tumor tracking radiotherapy for moving tumor. Int J Radiat Oncol Biol Phys. 2000;48(2):435-42.
52. Thomas E, Chapet O, Kessler ML, Lawrence TS, Ten Haken RK. Benefit of using biologic parameters (EUD and NTCP) in IMRT optimization for treatment of intrahepatic tumors. Int J Radiat Oncol Biol Phys. 2005;62(2):571-78.
53. Kwon JH, Bae SH, Kim JY, et al. Long-term effect of stereotactic body radiation therapy for primary hepatocellular carcinoma ineligible for local ablation therapy or surgical resection. stereotactic radiotherapy for liver cancer. BMC Cancer. 2010;10:475.
54. Mendez Romero A, Wunderink W, Hussain SM, et al. Stereotactic body radiation therapy for primary and metastatic liver tumors: a single institution phase i-ii study. Acta Oncol. 2006;45(7):831-7.
55. Zhou ZH, Liu LM, Chen WW, et al. Combined therapy of transcatheter arterial chemoembolisation and three-dimensional conformal radiotherapy for hepatocellular carcinoma. Br J Radiol. 2007;80(951):194-201.
56. Seong J, Park HC, Han KH, Chon CY. Clinical results and prognostic factors in radiotherapy for unresectable hepatocellular carcinoma: a retrospective study of 158 patients. Int J Radiat Oncol Biol Phys. 2003;55(2):329-36.
57. Zeng ZC, Tang ZY, Fan J, et al. A comparison of chemoembolization combination with and without radiotherapy for unresectable hepatocellular carcinoma. Cancer J. 2004;10(5):307-16.
58. Li B, Yu J, Wang L, et al. Study of local three-dimensional conformal radiotherapy combined with transcatheter arterial chemoembolization for patients with stage III hepatocellular carcinoma. Am J Clin Oncol. 2003;26(4):e92-9.
59. Guo WJ, Yu EX, Liu LM, et al. Comparison between chemoembolization combined with radiotherapy and chemoembolization alone for large hepatocellular carcinoma. World J Gastroenterol. 2003;9(8):1697-701.
60. Koo JE, Kim JH, Lim YS, et al. Combination of transarterial chemoembolization and three-dimensional conformal radiotherapy for hepatocellular carcinoma with inferior vena cava tumor thrombus. Int J Radiat Oncol Biol Phys. 2010;78(1):180-7.

FEATURE ARTICLE

Technology in rural continuing medical education

Using the information highway to close the distance

James Yan (Meds 2015)
Faculty Reviewer: Dr Ken W Milne, MD, MSc, CCFP(EM), FCFP (Division of Emergency Medicine)

The career of medicine is often described as a career involving lifelong learning. Knowledge and skills are constantly updated and "best practices" are continually redefined based off the latest advances in medical research and guidelines.[1] Typically physicians are engaged in this continuing medical education (CME) via both formal and informal methods, and this is a career-long process.[1] However, it has been documented that access to CME opportunities is much more limited for rural practising physicians than their urban colleagues.[2,3] Rural physicians often practise and live in geographically isolated areas with fewer resources and greater distances between networks of colleagues.[2-4] The geographic distance from urban centres and the generally smaller populations of rural communities are disincentives for formal CME programs to be held in rural centres.[5] Rural physicians also experience additional difficulties in the form of higher costs of transport as well as increased opportunity costs of being away from practise, long travel times leading to less time with family, and greater difficulty in finding substitutes to cover their clinical responsibilities.[3] These obstacles can be a source of stress and professional isolation for rural physicians who must keep up their skills and strive to provide optimal care for their patients. Rural physicians, relative to their urban colleagues, report less participation in formal CME events.[5]

Similarly, rural physicians are also at a disadvantage when conducting medical research. Resource distribution for medical research is uneven and rural sites often receive far less funding than urban centres.[6] It is also an obstacle for any sort of coordinating body or organization to provide cohesion and coordination to rural medical research efforts. Collaboration and communication can be stalled by the large distances between local health networks. The difficulties of establishing rurally focused medical research add to the challenge in delivering proper medical care to these communities. In Canada, rural populations have been shown to have lower life expectancy and overall poorer health.[6,7] There are also often different prevalence and incidence of certain diseases in rural regions as compared to urban populations due to differences in industry, environment, nutritional access, and other social determinants of health.[3,6] Due to lack of access to a conveniently reachable specialist support network for referral, medical practitioners in their local populations have to have more knowledge and expertise in a broader clinical scope in order to manage the health of rural populations.[8,9] Improving research that recognizes the differences between urban and rural health care needs is needed in order to develop a best practises methods for the provision of health care to rural Canadians.

The recent rapid surge of information technology development has been a great boon to improving access for rural and remote physicians.[10-13] The growing focus on mobile and wireless capability seems to address the needs of physicians on the go or in distant locations.[13] These devices have created new roads for people to connect, and rural physicians should be power users in this regard.[13] As the capabilities to transfer and share information continue to evolve, there is incredible potential to use the information highway to shrink the geographic distance that separates rural and remote physicians from resources and colleagues.

There are a number of ways in which technology is already showing its influence. Better data compression, improved broadband speeds, and high-definition monitors have allowed remotely distributed sites to video conference, consult images, or even provide simulation teaching. Distance learning can create continual education opportunities for remote physicians who cannot spare the time to leave their community without care.[12] The open availability of online learning can also allow rural physicians to gain access to a wider variety of skills to learn. Physicians are also rapidly utilizing social media to engage each other globally.[13] Doctors who find that they cannot attend a specific conference of interest can still join the conversation by searching up that conference's hashtag (#) online.[14,15] Websites like www.symplur.com work to inform health care professionals of various conferences' and moderated online discussions' Twitter hashtags.[15] Finally, as online communities become more prominent, it is only natural that groups of physicians adopt this technology as well. While the interactions may be virtual, online communities still allow physicians to collaborate and network. The Gateway Rural Health Research Initiative is a Canadian example that connects rural communities and health centres together in order to drive rural health research capabilities.[16]

The world of rural medicine is still undergoing a process to improve the training opportunities available to its physicians. While it is a difficult undertaking to overcome the wide geographic distribution that challenges Canadian rural doctors, the use of new communications technology is helping to bridge that gap. Progressions in information technology can address the barriers faced by rural physicians pursuing CME by reducing the need to travel, lowering costs, and connecting distant networks. It is challenging to encourage physician participation in and endorsement of the novel approaches to obtain training via information technology. As we move into the future, it is reasonable to surmise that improved access to continual training for rural physicians will help deliver better quality health care to the rural and remote populations of Canada.

REFERENCES

1. Bankey R, Campbell C. Lifelong learning white paper - supporting physician lifelong learning: strategies, tools and recommendations [Internet]. Ottawa: Royal College of Physicians and Surgeons of Canada; 2008 [cited 2013 Nov 1]. 6 p. Available from: http://rcpsc.medical.org/clip/clip_research/publications/index.php
2. Sargeant JM. Medical education for rural areas: opportunities and challenges for information and communications technologies. J Postgrad Med. 2005;51(4):301-7.
3. Curran VR, Fleet L, Kirby F. Factors influencing rural health care professionals' access to continuing professional education. Aus J Rural Health. 2006 Mar; 14(2):51-5.
4. Lewkonia R. Educational implications of practice isolation. Med Educ. 2001 Dec;35(6):525-9.
5. Curran V, Hatcher L, Kirby F. CME needs of rural physicians. How do we compare with our urban counterparts? Can J Rural Med. 2000 S;5(3):131-8.
6. Pong RW. Rural Health Research in Canada: at the crossroads. Aus J Rural Health. 2001 Dec;8(5):261-5.
7. Rourke JT. Strategies to increase the enrolment of students of rural origin in medical school: recommendations from the Society of Rural Physicians of Canada. CMAJ. 2005 Dec;172(4):62-5.
8. Strasser R. Rural general practice: is it a distinct discipline? Aus Fam Physician. 1995 May;24(5):870-6.
9. Rourke JT. Postgraduate training for rural family practice. Goals and opportunities. Can Fam Physician. 1996 June;42:1133-8.
10. Curran VR, Fleet L. A review of evaluation outcomes of web- based continuing medical education. Med Ed. 2005 May;39(6):561-7.
11. Harden RM. Trends and the future of postgraduate medical education. Emerg Med J. 2006 Jan;23(10):798-802.
12. Ryan G, Lyon P, Kumar K, Bell J, Barnet S, Shaw T. Online CME: an effective alternative to face-to-face delivery. Med Teach. 2007;29(8):e251-7.
13. Greene J. Social Media and Physician Learning: is it all Twitter? Ann Emerg Med. 2013 Nov; 62(5):11A-13A.
14. McKendrick DR, Cumming GP, Lee AJ. Increased use of Twitter at a medical conference: a report and a review of the educational opportunities. J Med Internet Res. 2012 Dec;14(6):e176.
15. Neill A, Cronin JJ, Brannigan D, O'Sullivan R, Cadogan M. The impact of social media on a major international emergency medicine conference. Emerg Med J. 2013 Feb;0:1-4.
16. Gateway Rural Health Research Institute [Internet]. Seaforth (ON): Gateway Rural Health Research Institute; c2008. Gateway's frontline research advantage; 2018 Sep 26 [cited 2013 Nov 1]. Available from: http://www.gatewayresearch.ca/research.

FEATURE ARTICLE

ICU management of complicated sepsis secondary to necrotizing fasciitis

Mathias Fricot (Meds 2016)
Faculty Reviewer: Dr Lois Champion, MD, FRCPC (Department of Anesthesia)
Observed Physician: Dr Philip George, MB, MRCP(UK), FRCPC (Staff Intensivist TBRHSC)

ABSTRACT

In this report we present a case of sepsis secondary to necrotizing fasciitis and its complications.

CASE PRESENTATION

A 37-year-old woman from a Northern Ontario community presented to the nursing station with a 3-day history of gradual-onset swelling and pain in the left arm. Upon arrival the patient was alert, oriented, and had no respiratory, abdominal, or cardiovascular symptoms. She had high-grade fever, chills, and night sweats. The arm was tender and swollen with visible hemorrhagic areas. She is a long-standing IV drug abuser and admitted to missing the vein when she injected drugs 5 days ago. Since then, the patient had noticed reddening of the right arm and complained of flu-like symptoms.

Relevant past medical history included intravenous (IV) drug use, hepatitis C positive status, and narcotic abuse. She had a previous MRSA positive nasal swab during a hospital admission and has a documented penicillin allergy (rash). The patient is a tobacco smoker with a 10-pack-year history.

A provisional diagnosis of severe cellulitis in the left arm was made. The patient was admitted to the local hospital and started on IV ceftriaxone, IV normal saline, ibuprofen, and acetaminophen. Blood cultures and complete blood count (CBC) were ordered. Over the course of the next 3 days a high-grade fever persisted and swelling of the arm worsened in spite of parenteral antibiotics. She developed hypotension and was noted to have worsening renal function on blood tests indicating acute kidney injury. Intravenous fluid resuscitation was commenced, vancomycin and clindamycin were added to the antibiotic regimen, and the patient was transferred to Thunder Bay Regional Health Sciences Centre (TBRHSC) for further management.

Upon arrival at TBRHSC the patient was hemodynamically stable (blood pressure 108/59[75], heart rate [HR] 80+, oxygen saturation 95%, respiratory rate [RR] normal, temperature 35.4°C) after 6L of crystalloid resuscitation. A provisional diagnosis of necrotizing fasciitis (NF) was made and plastic surgery was consulted. The patient was taken to the operating room (OR) for emergency surgery. Postoperatively she was extubated and admitted to the intensive care unit (ICU) for ongoing care. A broad-spectrum antibiotic regimen using ceftriaxone, vancomycin, clindamycin, and metronidazole was initiated postoperatively in conjunction with morphine for pain control.

At admission to the ICU the patient was hypotensive, tachypneic (respiratory rate 20/min), and intermittently confused with poor urine output. Vital signs were blood pressure 112/72, HR 72, and oxygen saturation 94% on 4L nasal prongs. Lactate levels were elevated at 5 mmol/L. Arterial blood gases (ABG) showed uncompensated metabolic acidosis and hypoxemia. Chest x-ray showed bilateral interstitial shadowing with interspersed areas of focal consolidation. Blood cultures from the previous hospital were positive for gram-positive cocci. A diagnosis of septic shock secondary to NF and complicated by acute respiratory distress syndrome (ARDS) was made.

In the ICU, IV crystalloids and broad-spectrum antibiotics (ceftriaxone, clindamycin, vancomycin) were continued, a central line inserted and vasopressor therapy with norepinephrine initiated. Within a few hours the patient required intubation and mechanical ventilation for increasing oxygen requirements and work of breathing according to the ARDS Network protocol for protective lung ventilation. ICU management also included correction of electrolyte imbalances and close monitoring of fluid status with central venous pressure and central venous oxygen status measurements.

Table 1: Signs/Symptoms Associated With Necrotizing Fasciitis at the Time of Admission[a]

FINDING	% OF PATIENTS (*n* = 89)	% OF PATIENTS (*n* = 192)	% OF PATIENTS (*n* = 122)
Erythema	100	66	95
Pain or tenderness beyond margins of erythema	98	73	95
Swelling	92	75	86
Crepitus or skin necrosis	13	31	0
Induration	12	45	
Bullae	45	23	41
Fluctuance	11		
Fever	53	32	
Hypotension	18	11	

[a] Adapted from Sarini et al.[1] Data from three retrospective chart reviews of patients with documented necrotizing soft tissue infection treated at single institutions.[14-16]

Table 2: Diagnostic Criteria for Sepsis.[a]
Diagnosis requires an ***infection***[b] (documented or suspected), and some of the following:[c]

VARIABLE	CRITERIA
1. **General Variables**	• Fever (core temperature >38.3˚C) • Hypothermia (core temperature <36˚C) • Heart rate >90 min^{-1} or >2 SD above the normal value for age • Tachypnea • Altered mental status • Significant edema or positive fluid balance (>20 mL/kg over 24 h) • Hyperglycemia (plasma glucose >120 mg/dL or 7.7 mmol/L) in the absence of diabetes
2. **Inflammatory Variables**	• Leukocytosis (WBC count >12 000 μL^{-1}) • Leukopenia (WBC count <4 000 μL^{-1}) • Normal WBC count with >10% immature forms • Elevated plasma C-reactive protein (>2 SD above the normal value) • Elevated plasma procalcitonin (>2 SD above the normal value)
3. **Hemodynamic Variables**	• Arterial hypotension[c] (SBP <90 mmHg, MAP <70, or decrease in SBP >40 mmHg in adults or <2 SD below normal for age) • Elevated mixed venous SaO_2 (>70%)c • Elevated cardiac index (>3.5 $L{\cdot}min^{-1}{\cdot}M^{-23}$)[c]
4. **Organ Dysfunction Variables**	• Arterial hypoxemia (PaO_2/FiO_2 <300) • Acute oliguria (urine output <0.5 $mL{\cdot}kg^{-1}{\cdot}h^{-1}$ or 45 ml/h for at least 2 h) • Creatinine increase >0.5 mg/dL • Coagulation abnormalities (INR >1.5 or aPPT >60 s) • Ileus (absent bowel sounds) • Thrombocytopenia (platelet count <100,000 μL^{-1}) • Hyperbilirubinemia (plasma total bilirubin >4 mg/dL or 70 mmol/L)
5. **Tissue Perfursion Variables**	• Hyperlactatemia (>1 mmol/L) • Decreased capillary refill or mottling

Abbreviations: WBC, white blood cell; SBP systolic blood pressure; MAP, mean arterial blood pressure; SaO_2, oxygen saturation; CI, cardiac index; INR, international normalized ratio; aPPT, activated partial thromboplastin time; FiO_2, fraction of inspired oxygen; PaO_2, partial pressure of oxygen in arterial blood; SD, standard deviation.
[a] Adapted from Levy et al.[3]
[b] Infection defined as a pathologic process induced by a microorganism.
[c] Mixed venous SaO2 >70% is normal in children (normally, 75-80%), and cardiac index 3.5-5.5 $L{\cdot}min^{-1}{\cdot}M^{-23}$ is normal in children; in children, diagnostic criteria for sepsis are signs and symptoms of inflammation plus infection with hyperthermia or hypothermia (rectal temperature >38.5 or <35˚C), tachycardia, and at least one of the following indications of altered organ function: altered mental status, hypoxemia, increased serum lactate level, or bounding pulses.

DISCUSSION

Necrotizing fasciitis (NF) is a rapidly progressing infection along fascial planes with secondary infection and necrosis of deep subcutaneous tissues. This rare condition has a mortality rate of up to 35% with the time to operative intervention being the primary determinant of mortality.[1] The diagnosis is a clinical one requiring a high index of suspicion (Table 1); treatment of NF is based on the removal of necrotic tissue, drainage, antibiotic therapy, and management of sepsis-related complications.[2] Antibiotic regimens usually include clindamycin for its anti-toxin effect.[2] Ceftriaxone is adequate for treating cellulitis but it is not sufficient antibiotic coverage for NF. When a necrotizing soft tissue infection is suspected it is important to have early broad-spectrum antibiotics coverage until cultures become available. The early management in this case highlights the importance of clinical suspicion; if a deeper infection was suspected earlier then perhaps some of the complications successfully managed in the ICU could have been avoided. In the OR, our patient underwent debridement and excision of dead fascia and muscle as source control as well as extensive fasciotomy of the left forearm to prevent compartment syndrome.

Classification of NF is based on microbiology. Type I NF is a mixed infection of aerobic and anaerobic bacteria occurring in patients with several other comorbidities. Type II NF is caused by group A streptococcus alone or in combination with another species, commonly Staphylococcus aureus.[1] This is less common than type I NF and typically occurs in otherwise healthy patients with a predisposing skin injury.[1] The complications of NF include sepsis related to its systemic toxicity, compartment syndrome from small vessel thrombosis, limb loss, and death.

Sepsis is defined as the combination of systemic inflammatory response syndrome (SIRS) and a source of infection. SIRS is clinical syndrome characterized by two or more of the following; tachycardia (HR >90/min), tachypnea (RR >20/min), altered leukocytes (WBC $<4\times10^9$ or $>12\times10^9$), or altered body temperature (<36˚C or >38˚C).[3,4] International guidelines provide a list of warning signs for recognizing developing sepsis (Table 2).[4]

Management of sepsis is divided in two parts: initial early goal-directed therapy (EGDT) to be accomplished within the first 6 hours and maintenance therapy in the ICU.[4] This strategy has been

Table 3: Berlin Definition of Acute Respiratory Distress Syndrome[a]

1. **Timing**	• Within **one week** of a known clinical insult or new/worsening respiratory symptoms
2. **Chest Imaging**[b]	• **Bilateral opacities** – not fully explained by effusions, lobar/lung collapse, or nodules
3. **Origin of Edema**	• **Respiratory failure** not fully explained by cardiac failure or fluid overload; need objective assessment (eg echocardiography) to exclude hydrostatic edema if no risk factor present
4. **Oxygenation**[c]	• **Mild:** 200 < PaO_2/FiO_2 ≤ 300, with PEEP or CPAP ≥ 5 cm H_2Od • **Moderate**: 100 < PaO_2/FiO_2 ≤ 200, with PEEP or CPAP ≥ 5 cm H_2O • **Severe:** PaO_2/FiO_2 ≤ 100, with PEEP or CPAP ≥ 5 cm H_2O

Abbreviations: CPAP, continuous positive airway pressure; FiO_2, fraction of inspired oxygen; PaO_2, partial pressure of oxygen in arterial blood; PEEP, positive end-expiratory pressure.
[a] Adapted from ARDS Definition Task Force.[17]
[b] Chest radiograph or computed tomography scan.
[c] If altitude > 1000 m, correction factor should be made as follows: $PaO_2/FiO_2 \cdot$ (barometric pressute/760).
[d] This may be delivered noninvasively in the mild acute respiratory distress syndrome group.

shown to reduce mortality.[4,5]

Early management focuses on prompt antimicrobial therapy, treating the source of infection, and cardiorespiratory resuscitation to prevent oxygen deprivation in peripheral tissues.[4] EGDT central venous pressure targets are maintained through IV fluids, mean arterial pressure targets through vasopressors, and continued oxygen delivery targets through transfusion of red cells, inotropic agents, and mechanical ventilation.[4]

ICU sepsis management focuses on continuing to maintain the established goals of EGDT.[4] This includes careful monitoring of organ function with necessary supportive therapies and the de-escalation of treatment whenever possible. The Surviving Sepsis Campaign (2012) provides standard guidelines for timely initiation of EGDT and ongoing management.[4]

Severe sepsis is sepsis complicated by acute organ dysfunction and has a mortality rate of approximately 30%.[6] The variability of organ systems affected contributes to the highly variable clinical manifestations of sepsis, including central nervous system dysfunction and acute kidney injury (AKI). During early management of sepsis, the lactate present in serum is assumed to be the byproduct of anaerobic metabolism and can be used to gauge organ hypoperfusion.[5] Organ dysfunction commonly affects the cardiovascular and respiratory systems, which classically manifests as ARDS.[7]

ARDS is a diffuse acute inflammatory lung injury with a recognizable injury pattern involving discontinuous endothelial injury, non-cardiogenic pulmonary edema, and atelectasis throughout both lungs.[8] Together, these lead to an inhibition of gas exchange and contribute to a clinical picture marked by hypoxemia and bilateral opacities on chest radiography. Pathologically, ARDS correlates with diffuse alveolar damage and has an approximate short-term mortality of 45%.[8] Diagnosis of ARDS in our patient was consistent with the Berlin Definition (Table 3).[8]

Management of ARDS focuses on supportive therapy and the treatment of hypoxia using mechanical ventilation. Supportive care involves sedation, hemodynamic monitoring, nutritional support, glucose control, and prevention of complications.[8,9] Our patient was sedated with continuous propofol infusion and bolus doses of midazolam, given the history of ongoing alcohol abuse. Morphine infusion was continued for ongoing pain control. Standard ventilator management involves a lung-protective ventilation strategy and in our patient followed the ARDS Network protocol.[10] As ARDS affects the lung heterogeneously, some areas of the lung remain aerated and relatively normal and are sometimes referred to as "baby lungs." The ARDS Network protocol incorporates a lower tidal volume strategy (6 cc/kg ideal body weight) to avoid overdistension of the functioning portion of the lungs and ventilator-induced lung injury.[8]

Patients being treated for ARDS are at a high risk for ventilator-associated complications, notably barotrauma from the positive pressure, volutrauma from excessive tidal volumes, atelectrauma from repeated opening and closing of the alveoli, biotrauma from the release of inflammatory mediators into the circulation, and ventilator-associated pneumonia.[8] The mortality form ARDS is typically due to associated multi organ dysfunction syndrome (MODS).[9]

The presence of ARDS in our patient presented another challenge for successful management of the patient's sepsis. The AKI was thought to be prerenal in origin, secondary to hypoperfusion during sepsis. Treatment of AKI was source control and IV fluids to maintain enough perfusion pressure. Maintenance of adequate volume status was key; keeping the patient dry enough to prevent pulmonary edema while maintaining adequate fluids to keep the kidneys perfused was a challenge.

CONCLUSION

The patient's clinical condition stabilized and improvements were seen in urine output, serum creatinine and blood urea nitrogen (BUN). Over the next 2 days vasopressor support was titrated off and the patient returned to the OR for repeat debridement and vacuum-assisted closure dressing changes. Prior to the OR the patient was thrombocytopenic and required 2 units of platelet transfusion to reduce risk of bleeding. The thrombocytopenia was attributed to complicated sepsis.[7] Blood and wound cultures subsequently came back positive for group A streptococcus and methicillin-resistant

Staphylococcus aureus (MRSA).[11,12,13] The patient's antibiotic regimen was changed to cefazolin, vancomycin, and clindamycin as per the sensitivity results.

The patient was eventually extubated 4 days after ICU admission. Postextubation she continued to improve with normalization of renal function. She required two more OR visits for subsequent debridements. Fortunately, the limb could be salvaged and the patient was eventually discharged to the floor. Antibiotics were continued on a 4-week course. The fact that this patient survived and did not require an amputation highlights the need for timely and effective surgical intervention in necrotizing fasciitis and the importance of supportive ICU care in recognizing and managing its complications.

REFERENCES

1. Sarani B, Strong M, Pascual J, Schwab C. Necrotizing fasciitis: current concepts and review of the literature. J Am Coll Surg. 2009;208:279-88.
2. Anaya DA, Dellinger EP. Necrotizing soft-tissue infection: diagnosis and management. Clin Infect Dis. 2007;44:705.
3. Levy MM, Fink MP, Marshall JC, et al. 2001 SCCM/ESICM/ACCP/ATS/SIS international sepsis definitions conference. Crit Care Med. 2003;31:1250-56
4. Dellinger RP, Levy MM, Rhodes A, et al. Surviving sepsis campaign: international guidelines for management of severe sepsis and septic shock. 2012. Crit Care Med. 2013;41:580-637.
5. Rivers E, Nguyen B, Havstad S, et al. Early goal-directed therapy in the treatment of severe sepsis and septic shock. N Engl J Med. 2001;345:1368-77.
6. Kumar G, Kumar N, Taneja A, et al. Nationwide trends of severe sepsis in the 21st century (2000-2007). Chest. 2011;140:1223-31.
7. Angus DC, Van der Poll R. Severe sepsis and septic shock. N Engl J Med. 2013;369:840-51.
8. Silverside JA, Ferguson ND. Clinical review: Acute respiratory distress syndrome – clinical ventilator management and adjunct therapy. Crit Care. 2013;17:225.
9. Leaver SK, Evans TW. Clinical review: Acute respiratory distress syndrome. BMJ. 2007;336:389-94.
10. The Acute Respiratory Distress Syndrome Network. Ventilation with lower tidal volumes as compared with traditional tidal volumes for acute lung injury and the acute respiratory distress syndrome. N Engl J Med. 2000;342:1301-08.
11. Liu C, Bayer A, Cosgrove SE, et al. Clinical practice guidelines by the Infectious Diseases Society of America for the treatment of methicillin-resistant Staphylococcus aureus infections in adults and children: executive summary. Clin Infect Dis 2011;52:285-92.
12. Rybak M, Lomaestro B, Rotschafer JC, et al Therapeutic monitoring of vancomycin in adult patients: a consensus review of the American Society of Health-System Pharmacists, the Infectious Diseases Society of America, and the Society of Infectious Diseases Pharmacists. Am J Health Syst Pharm 2009;66:82-98.
13. Stevens DL, Bisno AL, Chambers HF, et al Practice guidelines for the diagnosis and management of skin and soft-tissue infections. Clin Infect Dis 2005;41:1373-406.
14. Wong CH, Haw-Chong C, Shanker P, et al. Necrotizing fasciitis: clinical presentation, microbiology, and determinants of mortality. J Bone Joint Surg Am 2003;85:1454-60.
15. Elliot DC, Kufera JA, Myers RA. Necrotizing soft tissue infections. Risk factors for mortality and strategies for management. Ann Surg 1996;224:672-83.
16. Wang YS, Wong CH, Tay YK. Staging of necrotizing fasciitis based on the evolving cutaneous features. Int J Dermatol 2007;46:1036-41.
17. ARDS Definition Task Force, Ranieri VM, Rubenfeld GD, Thompson BT, Ferguson ND, Caldwell E, Fan E, Camporota L, Slutsky AS. Acute respiratory distress syndrome: the Berlin Definition. JAMA 2012;307:2526-33.

The baby blues

Challenges and limitations of delivering obstetrics care in rural Canada

Denise Darmawikarta (Meds 2016), Alexander Levit (Meds 2017)
Faculty Reviewers: Dr Constance Nasello, MD, FRCSC (Department of Obstetrics & Gynecology)

INTRODUCTION

Disparities in health are evident and pronounced across the Canadian urban-rural continuum. Studies documenting urban-rural differences in health status have identified several striking observations: greater prevalence of heart disease, cancers, long-term disability, diabetes, infectious diseases, and suicide and higher infant mortality rate in rural and remote communities.[1]

In addition to having poorer health status compared to their urban counterparts, rural Canadians are limited to a narrower range of health care providers and services. This has been, in part, attributed to the difficulty in recruitment and retention of medical graduates.[1] Other barriers affecting access to health care services in rural communities include socioeconomic status (SES), language and cultural barriers.[2] These barriers contribute to delay in early diagnosis and treatment, and can make travel to health care centres extremely challenging.

One of the most pressing health care issues in rural Canada is the decline in obstetrics and maternal care services. In fact, less than half of all family physicians across Canada currently offer maternity care in their practices, compared to almost 70% in 1983.[3] Specific to rural and remote regions, physician burnout and centralization of tertiary care centres and other health care services are amongst the most commonly cited reasons for suboptimal health care delivery.[1] In this review, we discuss the challenges associated with the delivery of obstetrics care in rural and remote Canada, and propose potential solutions.

MATERNITY CARE IN RURAL CANADA

HEALTH CARE PROVIDER

Obstetrics care in rural Canada is, for the most part, provided by family physicians.[4] Consequently, most women from rural areas were more likely than urban women to have their babies delivered by a family physician. Obstetrician/gynecologists (OB/GYNs) were less likely to be present at childbirth.[4] Further, Caesarean (C-)sections were more often performed by family physicians than specialists. Curiously, a study in the United States comparing C-section delivery outcomes between rural family physicians and OB/GYNs demonstrates no increased risks when the procedure was performed by family physicians.[5]

Surveys conducted in rural Ontario indicate that midwives can play crucial roles in filling the gap left by the shortage of OB/GYNs and family practitioners in rural areas.[6] In areas of limited access to maternity care services, midwives can not only provide clinical care for expectant mothers, but also serve as key sources of health information and support. Today, Ontario is host to approximately 700 registered midwives,[7] a welcomed increase from just under 300 back in 2003.[6] Unfortunately, midwifery faces many barriers to delivering optimal care, including inadequate remuneration models, limited opportunities for continuing professional development as well as geographical barriers involving difficulty accessing transportation to travel to very remote communities.

MODE OF DELIVERY

Childbirth occurs in one of three ways: (1) spontaneous vaginal birth, (2) assisted vaginal birth (using obstetric forceps and/or vacuum extractors) or (3) C-section.

A recent Canadian Institute for Health Information (CIHI) study on hospital births reported that women from rural areas were less likely to have C-sections and more likely to undergo spontaneous vaginal birth than their urban counterparts.[4] Interestingly, women from some remote areas, particularly those farther away from their closest local hospital, had higher rates of labour induction (ie artificially stimulating childbirth, especially in cases where prolonging pregnancy carries more risks). This has been attributed to the desire to plan the date and/or location of birth for those mothers who live in very remote communities.[4]

Not surprisingly, in rural and remote regions where C-section capability exists, hospitals are able to deliver more babies locally.[8] Further, C-section capability is found to be associated with a lower rate of preterm births.

OUTCOMES IN RURAL OBSTETRICS

As a consequence of the deterioration of maternity care services, rural Canadian women are often forced to leave their communities in order to give birth. The issue extends beyond a matter of inconvenience; it is also a matter of safety for both the mother and baby. Childbirth therefore becomes a stressful rather than joyful event for many families. In fact, it is not uncommon for mothers to experience labour and delivery without the presence and support of their family and community members.

Klein et al further suggest that loss of maternity services in rural communities can lead to a cascade of adverse consequences not only for mothers and their newborns, but also for the communities at large.[9] They propose that when a rural community becomes a "high outflow" community (ie one where the majority of women deliver at a facility away from their local health care centres), physicians and nurses become less satisfied and less dedicated to their own practices. Sooner or later, other aspects of women's health care, such as preventive gynecology and prenatal care, begin to disappear, leaving the

few remaining health care providers to cover extremely intensive call schedules. This leads to an eventual decline in physician retention and recruitment, resulting in a shortage of physicians who specialize in reproductive and women's health.[9]

MATERNAL & NEONATAL OUTCOMES

While little is yet known about the effects of declining obstetrics care in rural Canada specifically, studies from other countries that have experienced similar changes in rural and remote health care delivery elucidate a rather grim future. For instance, women in the state of Washington who travel far distances, even to an excellent urban tertiary care centre, were demonstrated to have poorer outcomes than those who receive care from local services.[10] More specifically, they were 1.5 times as likely to give birth prematurely (where preterm was defined as fewer than 37 completed weeks of gestation), had 67% higher rate of complications at birth and, consequently, paid double the health care costs. A recent population-based study in British Columbia corroborates these findings, showing that rural mothers who had to travel far distances to access maternity care services were more likely to experience adverse perinatal outcomes, including higher risks of perinatal mortality and preterm births.[11] These associations were significant even after controlling for confounding factors, including maternal characteristics and risk factors, as well as ecological determinants of outcomes (ie level of social vulnerability and proportion of Aboriginals residing within the catchment area).

CHALLENGES IN CARE DELIVERY

As of 2011, close to 20% of Canada's population lived in rural communities, defined in the Census as centres with a population of less than 1000 and areas with fewer than 400 persons per square kilometre. For these individuals, geographic, socioeconomic and cultural barriers play important roles in their ability to gain access to health care services.

In the last decade, the closure of many rural centres providing maternal care has led to a reduction in local births across Canada. Centres that do not provide C-section services have been particularly prone to closure.[12] Many newly graduated physicians refuse to practice in remote communities as rural practice is vastly different from urban medicine. Due to the smaller number of physicians, rural medicine requires that physicians practice longer hours and provide a greater range of services, all in a relatively less accessible environment. Moreover, physicians practising in remote and rural communities have less support from allied health professionals, fewer facilities and equipment and limited opportunities for continuing education.

For many, if not most, rural Canadians, low population density, lack of transportation infrastructure, language barriers and climate conditions are only some of the most common obstacles to accessing health care. Further, socioeconomic barriers may render prescription drugs unaffordable. Lower education level also hinders the capacity to understand health-related information and therefore reduces the ability to make informed decisions with respect to health and wellbeing.

PROPOSED RECOMMENDATIONS

In light of the above discussion surrounding the limitations of obstetrics care in rural Canada, we propose several recommendations that may alleviate this growing problem:

1. Establishing more health and birth centres to decentralize tertiary care facilities, thereby providing local comprehensive maternal care in remote regions. This would increase the rates of local births, improve medical outcomes and reduce the emotional, financial and logistical difficulties faced by women that require these services.
2. Increasing medical students' exposure to rural medicine through rural placements or distant learning facilitated by videoconferencing technologies.[14] Indeed, early exposure to rural maternity care played a large role in the placement decisions of current rural obstetricians.[15]
3. Considering the value of rotating internships which were previously abolished in the early 1990s. Rotating internships can provide new medical graduates with the broad skill set that is well suited to the practice of rural medicine.
4. Developing infrastructure to support the practice of both family medicine with OB specialization and rural midwifery by establishing flexible funding models for practicing in remote communities. This, in addition to providing further education, will allow midwives and family physicians to alleviate the burden of prenatal and perinatal care on OB/GYNs.
5. Stimulating physician interest to practice in remote areas through multiple approaches: encouragement of interprofessional health care teams, establishment of appropriate remuneration models that reflect population demand and skills required to address rural health-related challenges[13] and use of technology to facilitate distant learning. Facilitating the development of interprofessional and collaborative health care teams would also be conducive to the provision of integrated and higher-quality care, and the diffusion of workload placed on individual physicians.[13] Ultimately, while these approaches will require years of investment and effort to make a recognizable impact, they are intended to offer lasting improvements in both the quality and availability of rural maternity care services.

REFERENCES

1. Laurent S. Rural Canada: access to health care [Internet]. Ottawa: Economics Division, Government of Canada; 2002. Report No.: PRB 02-45E [cited 2013 Nov 10]. Available from: http://publications.gc.ca/Collection-R/LoPBdP/BP/prb0245-e.htm
2. National Collaborating Centre for Aboriginal Health. Access to health services as a social determinant of first nations, Inuit and Metis health [Internet]. Prince George (BC): National Collaborating Centre for Aboriginal Health; 2011 [cited 2013 Nov 10]. Available from: http://www.nccah-ccnsa.ca/Publications/Lists/Publications/Attachments/22/Access%20to%20Health%20Services%20(English).pdf
3. Kornelson J. Solving the maternity care crisis: making way for midwifery's contribution [Internet]. Vancouver: British Co-

lumbia Centre of Excellence for Women's Health; 2003 [cited 2013 Nov 12]. Available from: http://bccewh.bc.ca/publications-resources/documents/solvingmaternitycarecrisis.pdf
4. Canadian Institute for Health Information. Hospital births in Canada: a focus on women living in rural and remote Areas [Internet]. Ottawa: CIHI; 2013 [cited 2013 Nov 15]. Available from: http://www.cihi.ca/cihi-ext-portal/pdf/internet/BIRTH2013_SUMMARY_EN.
5. Homan FF, Olson AL, Johnson DJ. A comparison of cesarean delivery outcomes for rural family physicians and obstetricians. J Am Board Fam Med. 2013. Jul-Aug;26(4):366-72.
6. Sutherns R. In praise and search of midwifery well-suited to rural women - à la louange et à la recherche d'une pratique sagefemme. CJMRP. 2003;2(2):13-21.
7. Mahoney J, Fletcher J. Ontario opposes midwives' rights challenge seeking higher pay. The Globe and Mail 2013:Politics
8. Lynch N, Thommasen H, Anderson N, Grzybowski S. Does having cesarean section capability make a difference to a small rural maternity service? Can Fam Physician. 2005 Sep;51:1238-9.
9. Klein M, Johnston S, Christilaw J, Carty E. Mothers, babies, and communities. centralizing maternity care exposes mothers and babies to complications and endangers community sustainability. Can Fam Physician. 2002 Jul;48:1177-9.
10. Nesbitt TS, Connell FA, Hart LG, Rosenblatt RA. Access to obstetric care in rural areas: effect on birth outcomes. Am J Public Health. 1990 Jul;80(7):814-8.
11. Grzybowski S, Stoll K, Kornelsen J. Distance matters: a population based study examining access to maternity services for rural women. BMC Health Serv Res. 2011 Jun 10;11:147.
12. Kornelsen J, Grzybowski S, Iglesias S. Is rural maternity care sustainable without general practitioner surgeons? Can J Rural Med. 2006 Summer;11(3):218-20.
13. Miller KJ, Couchie C, Ehman W, Graves L, Grzybowski S, Medves J. Rural maternity care. J Obstet Gynaecol Can. 2012 Oct;34(10):984-91.
14. Ireland J, Bryers H, van Teijlingen E, Hundley V, Farmer J, Harris F, Tucker J, Kiger A, Caldow J. Competencies and skills for remote and rural maternity care: a review of the literature. J Adv Nurs. 2007 Apr;58(2):105-15.
15. Stretch N, Voisin A, Dunlop S. Survey of rural family physician-obstetricians in southwestern Ontario. Can J Rural Med. 2007 Winter;12(1):16-21.

DIAGNOSTIC REVIEW

Ultrasound in the rural and remote healthcare setting

Pei Jun Zhao (Meds 2017)
Faculty Reviewer: Dr Rob Arntfield, MD, FRCPC (Division of Emergency Medicine)

INTRODUCTION

Sound plays an integral role in modern medicine. We can all picture the familiar image of a physician listening intently through a stethoscope to the lub-dub of the heart and the Korotkoff sounds of the brachial artery. But ultrasound imaging takes sound to a whole new frequency. Ultrasonography has even been described as the "stethoscope of the future".[1] Through ultrasound, physicians are able to peer into the body to provide rapid bedside diagnosis of cholelithiasis, aortic aneurysm, hemoperitoneum, deep vein thrombosis, and much more.[2] Moreover, ultrasound can be used to guide procedures such as fine needle aspiration biopsy and central line insertion. With advancement in technology, ultrasound machines are becoming less expensive and more compact, even reduced to the size of a hand-held device.[2] Together, these factors allow ultrasound to be increasingly adopted by rural healthcare facilities.

PRINCIPLES OF ULTRASOUND

Ultrasound is defined as sound with frequency beyond the auditory range of the human ear—that is, 20 kHz and higher.[3] The frequency used in ultrasonography typically ranges from 2 to 12 MHz.[3] Ultrasound with higher frequency and shorter wavelength has sharper resolution but shallower penetration. There are three common types of ultrasound transducers, also called probes. The convex and the phase array probes generate fan-shaped images while the linear probe provides a rectangular field of view. The phase-array probe, being smaller, can also image between obstructing structures such as ribs.[4] Two very important dials on the ultrasound machine, other than the power button, regulate depth and gain. Depth controls how deeply or superficially the image is taken while gain adjusts the brightness of the display.[4] Most ultrasound machines also have a Doppler mode that allows the quantification of movement, such as the velocity of blood flow through an artery.[4] Lastly, air scatters ultrasound waves and creates fuzzy images, necessitating the liberal application of gel to minimize air interference between the skin and the probe.

TRAUMA ULTRASOUND IN RURAL EMERGENCY MEDICINE

In the rural healthcare setting, ultrasound can be used in many applications as a portable diagnostic tool to generate real-time images. It can be used to view arteries and veins, visceral organs such as the liver, gallbladder, kidneys, bladder, as well as the lung and the heart.[2] In remote regions with little access to medical facilities, ultrasound may be useful in providing rapid and non-invasive diagnosis on site. Focused assessment with sonography for trauma (FAST) is one important application of ultrasound imaging.[5] FAST is a bedside ultrasound protocol that examines the abdomen for hemoperitoneum and the heart for pericardial effusion.[5] In the case of trauma patients, for whom prompt treatment is crucial to outcome, FAST enables rapid initial diagnosis such that immediate management decisions can be made.

Moreover, research is showing that FAST can be successfully used not only in the emergency department, but also on the field. Studies have demonstrated the efficacy of FAST during air medical transport, natural disaster rescue, as well as on the frontlines of the battlefield.[6] Other conditions that can be assessed include high intra-cranial pressure, pneumothorax, high attitude pulmonary edema, and long bone fractures.[6] Thus, emergency medicine ultrasound is a valuable tool for physicians practicing in rural areas with limited access to rapid diagnostic equipment typically taken for granted at larger, urban hospitals. In a survey of rural physicians, the importance of ultrasound resonated with the majority of respondents.[7] Still, many physicians perceived a lack of immediate access to ultrasound equipment and felt that more training would be beneficial.[7] While the value of ultrasound in rural environments is acknowledged, it is evident that there is significant room for growth.

CARDIOVASCULAR SCREENING

Ultrasound is useful not only for acute conditions such as trauma, but also for monitoring chronic illnesses such as cardiovascular disease. For seniors over the age of 65, abdominal aortic aneurysms (AAA) affect 4 to 8% of men and 1.5% of women.[8] In AAA, aortic weakening over years and decades leads to the formation of an aneurysm. Since rupturing of the aneurysm is associated with an 80 to 90% risk of mortality, AAA screening is recommended by the Canadian Society for Vascular Surgery.[9]

In rural populations at risk for AAA, the rate of screening has consistently been low due to the lack of hospitals and screening programs.[9] Increased availability of ultrasound in rural clinics may increase the accessibility of AAA screening in these rural areas. In a recent study on the efficacy of ultrasound screening for AAA, rural family physicians in northern British Columbia trained in ultrasound imaging were able to safely screen a sample of 45 patients with no false positive or negative diagnoses.[9] Other applications of ultrasound for the management of cardiovascular disease include the screening of deep vein thrombosis, echocardiography to assess heart function, and carotid ultrasound to evaluate stenosis.

ULTRASOUND IN THE DEVELOPING WORLD

In areas with insufficient healthcare infrastructure, ultrasound provides a relatively quick and inexpensive option for medical imaging. The added value of ultrasound has been verified by several studies conducted in a variety of centres with poorer access to healthcare, from rural district hospitals in Rwanda, to tertiary care centers in Liberia, to the jungles of the Amazon.[10] In all of these cases, ultra-

sound diagnosis was found to provide clinical insight that otherwise would not have been found through available examinations. Ultrasonography is able to generate clues, evaluate differentials, and narrow down on diagnoses. For example, in rural Mexico, hand-carried cardiac ultrasound was able to provide preliminary diagnoses for 90% of cardiac patients.[11] In rural Zambia, imaging by focused maternal ultrasound prompted changes in clinical decision making for 17% of cases.[12] The relative ease of operating ultrasound machines, the portability of the devices, and their broad applicability will allow ultrasound imaging to become an increasingly important tool for rural, underdeveloped parts of the world.

TELESONOGRAPHY

With advances in information sharing through the internet, "telesonography" has the potential to connect rural patients with quaternary medical centers in real-time.[13] Ultrasound images generated at a relatively remote location—whether it is a community clinic, a farm, or even out in the wilderness—are transferred electronically to specialists who can provide an immediate diagnosis and medical advice.[14] This can offset the disadvantage of not having specialist physicians in remote and sparsely populated areas. Thus, telesonography can greatly expand healthcare services provided in rural areas and save rural patients from multiple trips to the city to see the doctor. Recently, FAST has even combined with mobile telesonography such that ultrasound images taken during an ambulance trip can be transmitted live to the emergency physician.[15] Training local healthcare providers in developing nations to operate ultrasound equipment can allow diagnoses to be made in consultation with medical colleagues at larger centers or even in another country.[16] Thus, ultrasound has great potential in bringing care to underserved populations, thereby increasing healthcare accessibility.

ULTRASOUND IN SPACE

Finally, even in the most remote region of all—space—ultrasound has proven to be an effective tool for point-of-care diagnosis. In the International Space Station, under conditions of microgravity, astronauts trained in ultrasound were able to generate medical images and video of diagnostic quality that have been interpreted by physicians back on earth.[17] Current applications of ultrasound in space include the monitoring of musculoskeletal health and the assessment of injuries due to trauma, and more applications are being studied and developed.[18]

CONCLUSION

Ultrasound imaging can and does play an important role in healthcare delivery in the rural and remote setting. The use of ultrasonography as a diagnostic tool at the point of care is gaining popularity, especially as ultrasound equipment becomes miniaturized and less expensive. Ultrasound is adaptable and versatile enough to serve a variety of clinical purposes, such as trauma assessment, cardiovascular screening, and astronaut health monitoring. With sufficient advances in technology and increased training opportunities, ultrasound imaging may soon evolve into an integral tool of all physicians' practices and become the stethoscope of this generation.

REFERENCES

1. Filly RA. Ultrasound: the stethoscope of the future, alas. Radiology 1988;167:400.
2. Minardi J, Davidov D, Denne N, Haggerty T, Kiefer C, Tillotson R, Whiteman C, Williams D, Williams D. Bedside ultrasound: advanced technology to improve rural healthcare. W V Med J. 2013;109:28-33.
3. Shipp TD. Basic principles and safety of diagnostic ultrasound in obstetrics and gynecology [Internet]. UpToDate. 2013 Jun 5 [cited 2013 Dec 1]. Available from: http://www.uptodate.com/contents/basic-principles-and-safety-of-diagnostic-ultrasound-in-obstetrics-and-gynecology.
4. Ultrasound Fundamentals Tutorial [Internet]. Point of Care Ultrasound at Western University. 2013 [cited 2013 Dec 1]. Available from: http://westernsono.ca.
5. Ballantyne B et al. The current role of focused assessment with sonography for trauma (FAST) in the ever–evolving approach to abdominal trauma. UWOMJ 2012;81:20-2.
6. Nelson BP, Melnicker L, Li J. Portable ultrasound for remote environments, part II: current indications. J Emerg Med. 2011;40:313-21.
7. Flynn CJ, Weppler A, Theodoro D, Haney E, Milne WK. Emergency medicine ultrasonography in rural communities. Can J Rural Med. 2012;17:99-104.
8. Andreoli T et al. Andreoli and Carpenter's Cecil Essentials of Medicine. 8th ed. Philadelphia: Saunders Elsevier; 2010. 167 p.
9. Blois B. Office-based ultrasound screening for abdominal aortic aneurysm. Can Fam Physician. 2012;58:172-8.
10. Sippel S, Muruganandan K, Levine A, Shah S. Review article: Use of ultrasound in the developing world. Int J Emerg Med. 2011;4:72.
11. Kobal SL, Lee SS, Willner R, Aguilar Vargas FE, Luo H, Watanabe C, Neuman Y, Miyamoto T, Siegel RJ. Hand-carried cardiac ultrasound enhances healthcare delivery in developing countries. Am J Cardiol. 2004;94:539-41.
12. Kimberly HH, Murray A, Mennicke M, Liteplo A, Lew J, Bohan JS, Tyer-Viola L, Ahn R, Burke T, Noble VE. Focused maternal ultrasound by midwives in rural Zambia. Ultrasound Med Biol. 2010;36:1267-72.
13. Sutherland JE, Sutphin D, Redican K, Rawlins F. Telesonography: Foundations and Future Directions. JUM 2011;30:517-22.
14. Sheehan FH, Ricci MA, Murtagh C, Clark H, Bolson EL. Expert visual guidance of ultrasound for telemedicine. J Telemed Telecare. 2010;16:77-82.
15. Ogedegbe C, Morchel H, Hazelwood V, Chaplin WF, Feldman J. Development and Evaluation of a Novel, Real Time Mobile Telesonography System in Management of Patients With Abdominal Trauma. BMC Emerg Med. 2012;12:19.
16. Pian L, Gillman LM, McBeth PB, Xiao Z, Ball CG, Blaivas M, Hamilton DR, Kirkpatrick AW. Potential Use of Remote Telesonography as a Transformational Technology in Underresourced and/or Remote Settings. Emerg Med Int. 2013;2013:986160.
17. Kirkpatrick AW, Hamilton DR, Nicolaou S et al. Focused assessment with sonography for trauma in weightlessness: a feasibility study. J Am Coll Surg. 2003;196:833-44.
18. Sargsyan AE, Hamilton DR, Jones JA et al. FAST at MACH 20: clinical ultrasound aboard the international space station. J Trauma 2005;58:35-9.

ETHICS

What should rural doctors expect?

A basic ethical challenge for rural practice

Arthur Shuster (Meds 2017)
Faculty Reviewer: Dr Saima Akhtar, MD, FRCSC (Department of Obstetrics and Gynecology)

Most physicians and medical students have some appreciation for the unique character of rural medicine, even if they have never experienced it first-hand. It is well understood that relative scarcity of medical facilities, technologies, specialists, and administrative support must always be a constant of rural practice. It is equally well understood that, as a result of this scarcity, rural physicians must be prepared to be generalists: they must perform multiple roles in their host communities and provide a wider range of health care services than they otherwise would in an urban setting. Yet for most physicians and physicians-in-training considering a job in a remote community, the social and professional aspects of rural medicine remain a mystery—perhaps coloured by preconceived notions of the simple pleasures and conservative ways of small-town life. The present brief article is intended to shed some light on a basic ethical challenge readers of this journal may expect to face when considering rural practice: the strong temptation to use a rural job as a waypoint to urban employment, at the expense of their host community.

NO ONE IS TO BLAME: FINANCIAL REALITIES AND RECRUITMENT STRATEGIES

An important source of conflict in rural health care is the potentially competing incentives of young physicians, their prospective rural employers, and neighbouring communities. A majority of medical students surveyed by one study reported feeling financial pressures (largely due to high levels of indebtedness) to consider taking jobs in rural areas, which routinely offer financial incentives, such as signing bonuses and debt repayment, in order to attract physicians.[1] With sharply rising medical school tuition rates, these financial pressures on students will only continue to increase. The same medical students surveyed in the study also reported that when choosing where to practice long-term, they were swayed just as much by nonfinancial considerations—especially by relative geographical proximity to their own families, employment for their partners or spouses (which may be harder to find in remote areas), and conveniences of urban life to which they have become accustomed. Thus, nonfinancial considerations seem to incline physicians to prefer urban practice. This may help to explain why, by at least one measure, 20% of Canadians live in rural areas, while only 10% of Canadian physicians service those same areas.[1]

While rural communities' recruitment strategies may be effective in attracting some physicians immediately after graduation, a significant proportion of these doctors may actually intend for their rural employment to be only a temporary step towards eventual urban employment. As a result, the relatively poor physician retention rates in rural communities create a revolving door effect in which continuity of care may be interrupted, patients may lose trust in their doctors, and quality of care may suffer.[2,3] To add to these difficulties, neighbouring communities hard-pressed to find doctors may try to take advantage of each other by "poaching" each other's physicians—only to create further uncertainty and instability.[2]

Yet no part of the above is intended to cast blame on rural communities or on physicians making decisions based on self-interested considerations. These problems are simply the consequences of the nature of the health care system in a country such as Canada. Within the prevailing legal and policy framework (see "Legal and policy issues in rural and remote medicine", in this issue), we could hardly demand that physicians selflessly sacrifice career goals or access to their families in order to service rural communities in need of their expertise, just as we can hardly blame those same communities for pursuing strategies that incidentally harm quality of care throughout the system. This is reflected by the fact that even the World Health Organization (in its 2010 "Global Policy Recommendations") effectively endorses recruitment strategies currently practiced by rural communities.[4]

These systemic (economic, social, and geographical) constraints notwithstanding, it would be a mistake to deny the possibility of meaningful ethical deliberation and choice within the context of rural medical practice. Recent literature on the ethics of rural medicine hints at a certain possibility of ethical resolution to the rural recruitment and retention dilemma we have just sketched.

AN ETHICAL CHALLENGE AND AN ETHICAL POSSIBILITY

One problematic consequence of existing rural recruitment strategies is that physicians and their rural employers are both tempted to misrepresent their long-term interests. Physicians—who may only want to stay for a few years to pay off their loans—may be inclined to promise a much longer time commitment to rural communities than they are actually willing to honour. Similarly, those same communities may be inclined to misrepresent the actual workload and range of responsibilities their hires would have to take on. The obvious ethical challenge here is one of mutual duplicity—a problem that is difficult to redress directly (as we have suggested) due to the incentive structure that exists in our health care system. Yet there is also to be found here a promising ethical possibility. The clash of incentives is probably unavoidable, but perhaps a reassessment of values—on both sides—can pave the way to a happy (or happier) solution for all parties.

It is true that, as we have already mentioned, medical students and young physicians express a strong preference for an urban way of life. Yet the preferences of Generation X and Y physicians (born 1962-77 and 1978-94, respectively) turn out to be much more complicated than they appear. In addition to wanting the many modern conveniences they can find in the city, those surveyed also reported

being attracted to rural employment because of the interconnectedness, familiarity, and sense of community that exist in rural settings, but are often absent in urban ones.[2,5] Physicians want opportunities for more interaction with their patients, and to develop deeper relationships of mutual trust, since physicians believe these interactions and relationships would improve quality of care as well as their own job satisfaction. One might think it possible for physicians to combine these two distinct goals (ie, urban comforts on the one hand and rural connectedness on the other) by seeking out rural communities that have, if not all, then at least many of the attractions of urban life: a well-trained support staff; quality medical equipment; amenities for life and leisure such as gyms, parks, restaurants and shops; and so on. Such a community would be not simply rural, but—as one interviewed physician put it—"latte rural".[5]

Should we then conclude that "latte rural" is the sought-after solution to the ethical problem faced by rural physicians? On the contrary, it takes only a little reflection to see that, in the first place, very few actual rural towns would be able to meet the requisite criteria of "latte rural." Most rural towns simply do not have the resources to create the sort of infrastructure that physicians covet. And, even if a community should have the option to expand so as to accommodate the tastes of affluent professionals, it is entirely possible that the very sense of togetherness and interconnectedness that physicians find so charming would diminish or even disappear as the town grows.

Nevertheless, the simple awareness that rural practice does offer unique advantages *that cannot be found in urban centres* is crucial, since it may lead physicians to re-evaluate their priorities in a new light, and to make a choice. If physicians are truly serious when they claim (as attested by the cited studies) that they value the unique advantages—both professional and personal—of small-town life, then they would do well to re-examine their preferences and to question both their presumption in favour of urban employment as well as the soundness of the tempting, but illusory, "latte rural" ideal. This could lead them to reconsider their priorities as to the relative importance (for themselves) of urban conveniences, on the one hand, and intimate community involvement on the other. To be sure, even after reassessing their priorities many physicians may continue to prefer urban over rural practice. Yet perhaps even if only a (not-insignificant) minority changed their minds, rural communities would begin to find themselves recruiting more willing and loyal doctors.

Rural recruiters could potentially play an important role in this process, by helping physicians to reassess their priorities. Currently, it may be tempting for rural communities to try to embody the "latte rural" ideal, which they believe most appeals to urban-educated physicians. They may even be tempted to go so far as to embellish the range of modern conveniences they have to offer to prospective hires. Or, perhaps more likely, rural communities may feel compelled to compensate for what they perceive are disadvantages of their remoteness by emphasizing what prospective hires stand to gain in terms of financial rewards. Thus far, this approach has not yielded satisfactory results. The problem may simply be one of rural recruiters underestimating the appeal of small-town life to urban doctors. The alternative is for rural recruiters to develop strategies to introduce physicians to the unique charms of small-town life, and to persuade them of the real professional advantages of rural medical practice. Such an approach would decrease the need for duplicity, and at the same time may prove to be more effective in the long run.

REFERENCES

1. Jutzi L, Vogt K, Drever E, Nisker J. Recruiting medical students to rural practice: perspectives of medical students and rural recruiters. Can Fam Physician. 2009;55:72-3.
2. Cook AF, H Hoas. Ethics and rural health care: what really happens? What might help? Am J Bioeth. 2008 Apr;8(4):5-56.
3. Simpson C, McDonald F. 'Any body is better than nobody?' Ethical questions around recruiting and/or retaining health professionals in rural areas. Rural Remote Health. 2011;11(4):1867.
4. World Health Organization. Increasing access to health workers in remote and rural areas through improved retention: global policy recommendations. Geneva: World Health Organization; 2010.
5. Laurence CO, Williamson V, Sumner KE, Fleming J. 'Latte rural': the tangible and intangible factors important in the choice of a rural practice by recent GP graduates. Rural Remote Health. 2010;10:1316.

Rural physician recruitment and retention

Michael Hewak (Meds 2016), Kyle Luong (Meds 2016)
Faculty Reviewer: Dr Munsif Bhimani, MSc, MD, CCFP(EM) (Deptartment of Family Medicine, Division of Emergency Medicine)

INTRODUCTION & BACKGROUND

The former executive director of the federal government's now-defunct Office of Rural Health once stated "If there is two-tier medicine in Canada, it's not rich and poor—it's urban versus rural".[1] Despite the Canada Health Act's guarantee of accessibility of healthcare to all Canadians, those living in rural communities face a different healthcare experience compared to urbanites. Approximately one third of Canadians live in rural communities—however, currently under one tenth of physicians practice rurally to serve these 10 million people.[3]

Although several technical definitions of "rural area" exist, Statistics Canada currently defines the term as a geographical area with fewer than 1000 people or a population density under 400 people per square kilometer.[2] Compared to their urban counterparts, the rural population on average suffers from lower self-reported health status, higher rates of premature death in young people, higher all-cause mortality, and lower life expectancy. They also experience higher rates of smoking, drinking, obesity, poor nutrition, violence, accidental death, and unemployment, as well as lower education rates and lower socioeconomic status.[1] Furthermore, they include a higher proportion of groups at increased risk for poor health status and healthcare access such as children, elderly, and Aboriginals. There are nearly 1.4 million First Nations and Inuit in Canada, and they are among the most vulnerable individuals in the country, experiencing nearly 3-fold incidence of HIV, up to 4-fold rates of infant mortality, 6-fold suicide rate, a 30- to 186-fold risk of tuberculosis, as well as an average life expectancy 7 years lower than the national mean.[4]

This unambiguously harsher risk profile for rural populations underscores the need for enhanced efforts to target the recruitment and retention of physicians to these at-risk areas which at present are served by only 16% of Canada's family physicians and a mere 2.4% of specialists.[3]

INCENTIVES TO ESTABLISH RURAL PRACTICE

What makes physicians more likely to establish a rural practice over an urban practice? For starters, recruitment of physicians to rural areas relies heavily on attracting those freshly graduating from medical school. Surveys of medical students have shown that expected lifestyle—including favourable geographic location and access to recreational opportunities—is the largest factor in medical students' decisions on where to practice.[5]

Not surprisingly, it has been shown that medical students with previous experience in rural communities are more likely to establish practice in such areas. It was found that the odds of establishing a rural practice are 5 times higher in those with a rural background or schooling compared to those with an urban background or schooling. Additionally, new doctors are 3 times as likely to establish a rural practice if their partner lives in a rural area.[6,7]

THE CURRENT STATE OF CANADIAN RURAL PHYSICIAN RECRUITMENT AND RETENTION

However, research shows that only 10.8% of those entering medical school come from rural backgrounds. Data from Ontario has shown that fewer rural than urban students actually apply to medical school, and those that do apply are accepted less often, even when possessing MCAT and GPA scores comparable to urban students. The discrepancy in number and acceptance rates of rural versus urban applicants is believed to be linked to differing educational status in these areas. Rural applicants receive less encouragement to participate in higher education, have fewer role models, and experience less intracurricular and extracurricular academic opportunity than their urban counterparts.[7]

Physician retention is similarly challenging for rural communities. Continuing medical education (CME) is a significant factor in reducing rural physicians' feelings of professional isolation, and thus influences retention. The reality, however, is that in rural communities, opportunities for CME are limited due to geographic isolation, financial burden of attending far-off CME events, and lost earnings from taking time off work, as well as organizational limitations such as insufficient staff to replace those who wish to take time for CME participation.[8]

Access to specialist care is markedly lacking in rural communities. In a study examining rural mental health specialists, it was found that geographic, financial, and systemic factors are most significant in creating the discrepancy in recruitment. Specialists tend to find rural communities less attractive as potential workplaces due to decreased resources and professional isolation, and rural communities are often too small to justify and financially support the presence of specialists. The few that do practice rurally tend to have very long waiting lists, ranging from months to over 2 years, and cover a disproportionately large geographic area, making patient access a challenge.[9]

RURAL RECRUITMENT STRATEGIES

In Canada, many strategies have been employed to improve rural physician recruitment and retention to these rural areas. Although varied, these strategies fit roughly into 3 broad categories: financial incentives, use of international medical graduates (IMGs), and programs implemented at the level of undergraduate medical training. Each of these strategies has been met with variable success and as such there has been no definite answer to improving the physician shortage.

FINANCIAL INCENTIVES

Financial incentives are the foremost approach to improving physician recruitment in rural areas. Although conventional, these types of incentives are quite varied in their scope and implementation. Offered by Regional Health Authorities (RHAs) and Northern Medical Services (NMS), these incentives can be divided into those that are offered before and after the completion of medical educa-

tion.[10] The former include bursaries and forgivable loans that are given in return for several years of service. The latter include anything ranging from travel or vehicle allowances and housing to licencing and insurance supports. Incentives can total up to $50,000 for the first year of service, with the average RHA support package totaling $20,000. Studies have shown that these incentive programs do accomplish their goal in the short term, attracting new graduates to underserviced areas. It has been speculated that the increasing cost of medical education and student debt have contributed to this short-term success. Unfortunately, long-term effectiveness is not nearly as promising, with many physicians migrating to urban centres shortly after their return-of-service obligations are fulfilled.[11]

INTERNATIONAL MEDICAL GRADUATES

IMGs are another resource that has been used to fill the physician void in rural areas. It is estimated that about a quarter of Canada's physicians are trained internationally, with the highest proportions concentrated in areas with largely rural populations.[12] An IMG's greatest obstacle to practicing in Canada is licencing. Provisional licences are often granted to IMGs so that they are able to practice under certain restrictions until they complete the required postgraduate medical training in Canada and become fully licenced. These provisional licences are often coupled with rural contracts and are used as a means of satisfying the immediate need for rural physicians. The use of IMGs has come under some scrutiny, both logistically and ethically. A major issue is that of assessing the equivalency of medical training. With the obvious concern for patient safety and the quality of healthcare delivered, the evaluation of international medical education is often controversial. Particularly troubling are the so-called "diploma mills" that produce medical graduates who have had little to no patient contact. Long-term, IMGs also tend to migrate disproportionately to urban centres once they become fully licenced. This has stirred up concern that IMGs use rural contracts as an expedient route to becoming fully licenced, ultimately allowing them to practice in an urban setting. Rural populations suffer as a consequence, contending with a high rate of physician turnover.

Ethically, the use of IMGs has come under fire for its tendency to recruit physicians from developing countries that are in desperate need of physicians.[13] In 2001, the South African High Commissioner to Canada criticized Canada for recruiting South African physicians at a time when the South African healthcare system was overwhelmed. There is also the issue of IMGs' right to determine where they practice and migrate to, rights that are stifled by these rural contracts.

UNDERGRADUATE MEDICAL EDUCATION

As mentioned earlier, medical students with rural experience or those who originate from a rural community are found to be more likely to practice in a rural setting. It is no surprise that there are many programs at the level of undergraduate medical education that seek to bolster rural recruitment by taking advantage of this. Aside from removing barriers to application and enrollment with policies such as lower GPA and MCAT cutoffs and rural student quotas, many medical schools also integrate rural medicine experiences into their curriculum.[14] Preliminarily, exposing students to rural medicine in their training years has been shown to benefit rural recruiting. However, data on the success of these programs remains limited, with the studies that do exist coming from only a few Canadian medical schools.[3] In addition, many of the studies rely heavily on surveys and questionnaires which are subject to quite a few biases. Nevertheless, interventions at the level of medical education seem to be one of the more successful and promising avenues to pursue in improving the rural situation.

CONCLUSION

There is a true disparity between urban and rural healthcare. At the heart of this inequity is the rural physician shortage. Although many strategies have been employed to attempt to rectify the issue, long-term outcomes are less than favourable. Constant physician turnover trickles down to a decreased quality of care. Fortunately, strategies to recruit rural students and expose medical trainees to rural medicine have shown early promise. More robust studies are required to adequately evaluate their effectiveness.

REFERENCES

1. Blankenau J. Comparing rural health and health care in Canada and the United States: the influence of federalism. J Federalism. 2010;40(2):332-49.
2. Du Plessis V, Beshiri R, Bollman D, Clemenson H. Definitions of rural. Rural Small Town Can Anal Bull. 2001;3(3):1-13.
3. Kapadia RK, McGrath BM. Medical school strategies to increase recruitment of rural-oriented physicians: the Canadian experience. Can J Rural Med. 2011;16(1):13-9.
4. Kulig JC, Williams AM. Health in rural Canada. Vancouver: UBC Press; 2011. 568 p.
5. Jutzi L, Vogt K, Drever E, Nisker J. Recruiting medical students to rural practice: perspectives of medical students and rural recruiters. Can Fam Physician. 2009;55(1):72-3.
6. Laven G, Wilkinson D. Rural doctors and rural backgrounds: how strong is the evidence? A systematic review. Aust J Rural Health. 2003;11(6):277-84.
7. Rourke, J. Strategies to increase the enrolment of students of rural origin in medical school: recommendations from the Society of Rural Physicians of Canada. CMAJ. 2005;172(1):62-5.
8. Curran VR, Fleet L, Kirby F. Factors influencing rural health care professionals' access to continuing professional education. Aust J Rural Health. 2006;14(2):51-5.
9. Boydell KM, Pong R, Volpe T, Tilleczek K, Wilson E, Lemieux S. Family perspectives on pathways to mental health care for children and youth in rural communities. J Rural Health. 2006;22(2):182-88.
10. Physician Recruitment Agency of Saskatchewan. Recruitment incentives. [place, publisher unknown]; 2011.
11. Sempowski I. Effectiveness of financial incentives in exchange for rural and underserviced area return-of-service commitments: systematic review of literature. Can J Rural Med. 2004;9(2):84-8.
12. Audas R, Ross A, Vardy D. The use of provisionally licensed international medical graduates in Canada. CMAJ. 2005;173(11):1315-6.
13. Dove N. Can international medical graduates help solve Canada's shortage of rural physicians? Can J Rural Med. 2009;14(3):120-3.
14. Society of Rural Physicians of Canada. Admission of rural origin students to medical school: recommended strategies. Shawville (QC): Society of Rural Physicians of Canada; 2004. 25 p.

Lifestyle modification for the primary prevention of type 2 diabetes mellitus in the Canadian Aboriginal population

Gabriela Meglei (Meds 2016), Keegan Guidolin (Meds 2017)
Faculty Reviewer: Dr Sylvia Orsini, MD, CCFP (Department of Family Medicine)

ABSTRACT

Canada's Aboriginal populations have significantly higher rates of type 2 diabetes compared to non-Aboriginal Canadians. In First Nations populations living on reserve, the rates are more than double. Large randomized controlled trials (RCTs) have shown that intensive lifestyle modification in individuals with impaired glucose tolerance can decrease the overall incidence of diabetes by up to 22%.

Implementing lifestyle interventions into clinical practice remains a significant challenge because of both limited resources and uncertainly about optimal program design. Most studies have focused on translation into the primary care setting, and have shown moderate benefits. However, there have been no trials examining the feasibility and effectiveness of RCT-based lifestyle modification in Canadian Aboriginal communities. Canadian initiatives have so far focused on school-based healthy lifestyle curriculum and community awareness, but have had little success in reducing weight.

Factors such as community remoteness, cultural diversity, poor retention of health care workers, and lack of access to healthy food are significant barriers to implementing lifestyle modification programs in Canadian Aboriginal communities. More importantly, these communities face systemic inequalities that must be addressed in order to achieve meaningful and sustained lifestyle changes.

DIABETES IN CANADIAN ABORIGINAL POPULATIONS

Canada's Aboriginal people include First Nations, Inuit, and Métis and constitute 3.8% of the population. Although a rare disease in Aboriginal populations prior to the 1940s, the prevalence of type 2 diabetes mellitus (T2DM) in this population has increased by up to 36% from 2001 to 2006. In 2010 15.3% of First Nations living on reserve, and 8.7% living off reserve reported they had T2DM, compared to 6% of non-Aboriginal Canadians. Diabetes complications and comorbidities also disproportionately affect Aboriginal people.[1]

Being overweight and obese are chief risk factors for T2DM. In 2010, 74% percent of First Nations adults living on reserve, and 62% living off reserve reported they were overweight or obese, compared to 52% of non-Aboriginal Canadians.[1] The disparity between Aboriginal people and the rest of Canada is also evident with respect to other T2DM risk factors and health determinants, highlighting the systemic inequalities facing these populations (Table).[1-2]

GOVERNMENT INTERVENTION

The Canadian government has recognized the diabetes epidemic spreading through First Nations populations. In 1999, Health Canada began the Aboriginal Diabetes Initiative (ADI) as part of the Canadian Diabetes Strategy.[3] The ADI began Phase 3 in 2012 with $275 million of funding over 5 years focusing on initiatives for youth, families, pregnancy and prepregnancy, improved access to healthy food options, and enhanced training for health care providers.

LIFESTYLE MODIFICATION PREVENTS DEVELOPMENT OF T2DM

Seven large randomized controlled clinical trials (RCTs) have been conducted internationally to examine the effect of lifestyle modification on preventing the development of T2DM in patients with impaired glucose tolerance (IGT).[4] These interventions were found to reduce the overall incidence of diabetes between 4 to 21.7% at a follow-up time of 3 to 6 years.[4]

The Diabetes Prevention Program (DPP) in the United States was the largest RCT, and relied on a lifestyle coach and frequent contact to encourage participants to attain a 7% weight reduction and increase moderate-intensity activity to 150 minutes per week.[5] The intervention was delivered on an individual basis at a cost of $1399 per participant and included 16 sessions and follow-ups. At 3 years, those with intensive lifestyle counseling reduced their relative risk of diabetes by 58%.[6] Weight loss was the single most important factor in reducing diabetes incidence.[7]

Unfortunately, several studies reported that the effects of lifestyle interventions decreased in the long term, and the only study that monitored mortality showed no effect on this outcome.[4] Although lifestyle modification shows promising results, these studies highlight the difficulty of implementing lasting lifestyle changes in high risk populations, even in highly controlled settings.

TRANSLATING PRIMARY PREVENTION STRATEGIES

The Canadian Diabetes Association Clinical Practice Guidelines (CDA-CPGs) recognize that Aboriginal peoples are at high risk for diabetes and recommend the use of structured lifestyle modification or pharmacological therapy to reduce this risk.[8] Aboriginal children should be evaluated for modifiable risk factors, prediabetes, and metabolic syndrome.[9] Screening for diabetes should be started early (age 10 or established puberty) and be more frequent (every 1-2 years) when one or more additional risk factor(s), such as excess weight, abdominal obesity, hypertension, or exposure to diabetes in utero, are present.[10]

Table: Determinants of Health in Aboriginal and Non-Aboriginal Canadians[a]

HEALTH DETERMINANTS	FIRST NATIONS (ON-RESERVE)	ABORIGINAL (ON-RESERVE)	TOTAL ABORIGINAL	NON-ABORIGINAL
Daily smoking (%)	46	41		22
Smoked during pregnancy (%)	37			19
Dwellings requiring major repairs (%)	34			8
Living in crowded dwellings (%)			15[b] (31[c])	3
Food insecurity or compromised diet (%)		51		18
Unemployment Rate (%)			22	7
Employment Rate (%)			49	62
Did not graduate high school (%)			48	30
College certificate / university certificate / bachelor's degree (%)			16	28
Incidence of low income in year 2000				
Living in families (%)			22	12
Unattached individuals (%)			57	38
Unmet health care needs in last 12 months				
Northern Territories (%)			18	14
Canada (%)			20	13
Contact with general practitioner in the last 12 months				
Northern Territories (%)			59	76
Canada (%)			77	79
Contact with nurse in the last 12 months				
Northern Territories (%)			49	22
Canada (%)			17	10

[a] Adapted from Reading & Wein, 2009.
[b] First Nations living on reserve and off reserve.
[c] Inuit.

The implementation of RCT-based interventions into clinical practice or community settings poses many challenges and is in the early stages in Canada. However, studies have shown that intensive lifestyle interventions are cost-effective in patients with IGT, leading to a cost saving of $84,700 per quality-adjusted life-year (QALY) for a median cost of $1,500 per QALY.[11] Below we will summarize implementation attempts in different settings and highlight some lessons learned. Finally, we will identify some important factors to consider for implementation in Aboriginal communities.

TRANSLATION TO PRIMARY CARE

The clinical setting is the most common site for implementing the lifestyle modifications described in RCTs. Adaptation of these interventions into routine clinical practice has required shorter program duration, delivery through group sessions, and intermittent support during the maintenance phase.[12] Challenges to program implementation include recruiting patients, preventing dropout, determining the optimal mode of intervention delivery, and achieving a sustained lifestyle change.[13-14] Interestingly, motivational interviewing, a key component of the DPP important in providing resolve to change, is not included in most translational programs.

Several reviews have concluded that implementing lifestyle modifications was feasible and achieved some benefits (eg mean loss at 1 year of 1.8 kg[12], 4%[13] weight loss).[12-15] Unfortunately, the impact from translational studies was less pronounced compared to that seen in RCTs like the DPP, which achieved a 5 to 7%[16] weight loss, and there were small or no improvements in fasting plasma glucose or glucose tolerance.[12] Diabetes incidence was usually not measured; however, we know from the DPP that a 5 kg weight loss is estimated to cut the incidence of diabetes in half at 3 years of follow-up.[7] Therefore, the weight loss achieved in translational studies can also be expected to elicit some reduction in diabetes incidence.

A meta-analysis found the number of sessions attended correlated with increased weight loss and longer programs were likely more effective. Delivery of intervention by lay community staff, use of electronic media, and the absence of a maintenance phase did not have

a significantly negative impact on weight loss—important findings, given limited resources in rural and Aboriginal communities.[13]

THE CANADIAN PRIMARY CARE EXPERIENCE– "AN OUNCE OF PREVENTION"

"An Ounce of Prevention" was the first study to implement the DPP into primary care in Canada.[17] The 4-week program consisted of a weekly 2-hour session, and was led by a registered nurse or dietician who delivered 90 minutes of education followed by 30 minutes of guided exercise. The cost of the program was $470 per participant. Challenges identified included the need for strong endorsement from clinical and administrative leadership to attain optimal space, staffing and recruitment, and the need for ongoing program evaluation.

TRANSLATION TO ALTERNATIVE SETTINGS

Translation studies have also examined the implementation of lifestyle interventions in community centers (eg YMCA), workplaces, and churches. These settings exhibit greater demographic diversity compared to primary care and may be a better model of how to deliver interventions to Aboriginal communities. Unfortunately, settings with the greatest diversity demonstrated lower, though still statistically significant, weight loss, and less session attendance compared to primary care.[15]

Whereas primary care may utilize existing relationships with health care providers to enhance efficacy and decrease attrition, they are limited by staff and space availability.[15] These problems are magnified in rural communities because primary care may be unavailable or unable to meet existing health care demands. Community settings use existing structures for program implementation, increase reach in rural communities, and can make use of volunteers.

TRANSLATION TO ABORIGINAL COMMUNITIES

Few studies have implemented lifestyle interventions into Canadian Aboriginal communities.[18-20] Challenges to implementation include rural and remote community isolation and unique geography, cultural diversity, low retention of health care professionals, poor continuity of care, lack of appropriate settings for physical activity, unsustained funding, and lack of access to healthy food.[21]

The CDA-CPGs recommend collaborative strategies to engage entire communities and build trusting relationships, incorporation of traditions and local culture, and use of existing community infrastructure when implementing lifestyle programs.[9] However, some argue that the CDA-CPGs fall short on how these goals should be achieved, and instead recommend that communities be engaged to develop their own unique practice guidelines.[21] This requires learning about the community and engaging with the chief and council, local health care professionals, and the wider community for support, design, and implementation of programs.

Despite the largely inclusive nature of Canadian interventions, results have been disappointing. One explanation might be the overemphasis on changing interpersonal determinants of health, rather than systemic and environmental factors hindering change in these communities.[22]

In the United States, government funding for the Special Diabetes Program for Indians Diabetes Prevention supported the implementation of a 16-session program delivered to 80 tribes in rural, reservation, and urban settings.[23] Program materials were translated to tribal languages and adapted to local culture. The study reported the average weight loss over 3 annual visits to be 2.5, 1.4, and 1.1 kg, respectively. Since the use of controls was considered unethical, it is uncertain whether the 4% incidence of diabetes among study participants represents a true decrease in incidence.[24]

THE CANADIAN ABORIGINAL EXPERIENCE

No RCT-based interventions have been implemented in Canadian Aboriginal communities. Lifestyle programs involving inclusive community consultation have been implemented on the Sandy Lake reserve,[25] in seven northwestern Ontario First Nations communites,[26] in the Kahnawake school district,[27] and in the rural Okanagan region.[28] These programs have focused on school children and the community at large, and have aimed to increase healthy living skills through a school-based curriculum, promotion of healthy food choices in stores, mass media campaigns, and community events. Unfortunately, despite some studies showing an increase in knowledge, none reported a change in weight or BMI.

Although community-based interventions have a broader reach, the lack of a targeted, intensive approach may have been a factor in the programs' limited success. Participants and staff identified earlier and sustained school intervention, one-on-one communication, increased community awareness, and lower prices for healthy food as ways of improving the program.[29]

CONCLUSIONS

Despite the largely disappointing outcomes of lifestyle interventions for the prevention of T2DM in Aboriginal communities, a few things are certain. First, Aboriginal communities face many systemic challenges that complicate the already lofty task of achieving sustained individual lifestyle changes through counseling. Second, community ownership and consultation is necessary but not sufficient for programs to deliver measurable risk reductions. Lastly, to achieve a sustained reduction in T2DM incidence, complementary strategies addressing systemic inequalities must be developed, implemented, and evaluated.

REFERENCES

1. Public Health Agency of Canada. Diabetes in Canada: Facts and figures from a public health perspective [Internet]. Ottawa (ON): Public Health Agency of Canada; 2011 [cited 2013 Jan 22]. 126 p. Available from: http://www.phac-aspc.gc.ca/cd-mc/publications/diabetes-diabete/facts-figures-faits-chiffres-2011/index-eng.php
2. Reading C, Wien F. Health inequalities and social determinants of Aboriginal Peoples' health [Internet]. Prince George (BC): National Collaborating Centre for Aboriginal Health; 2009 Jan [cited 2013 Jan 22]. 36 p. Available from: http://www.nccah-ccnsa.ca/en/publications.aspx?sortcode=2.8.10&publication=46
3. Health Canada. Aboriginal Diabetes Initiative Program Framework 2010-2015 [Internet]. Ottawa (ON); Health Canada; 2011 [cited 2013 Jan 22]. 22 p. Available from: http://www.hc-sc.gc.ca/fniah-spnia/pubs/diseases-maladies/_diabete/2010-2015-frame-cadre/index-eng.php

4. Yoon U, Kwok LL, Magkidis A. Efficacy of lifestyle interventions in reducing diabetes incidence in patients with impaired glucose tolerance: a systematic review of randomized controlled trials. Metabolism. 2013 Feb;62(2):303-14.
5. Diabetes Prevention Program (DPP) Research Group. The Diabetes Prevention Program (DPP): description of lifestyle intervention. Diabetes Care. 2002 Dec;25(12):2165-71.
6. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, Nathan DM; Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med. 2002 Feb;346(6):393-403.
7. Hamman RF, Wing RR, Edelstein SL, Lachin JM, Bray GA, Delahanty L, Hoskin M, Kriska AM, Mayer-Davis EJ, Pi-Sunyer X, Regensteiner J, Venditti B, Wylie-Rosett J. Effect of weight loss with lifestyle intervention on risk of diabetes. Diabetes Care. 2006 Sep;29(9):2102-7.
8. Ransom T, Goldenberg R, Mikalachki A, Prebtani APH, Punthakee Z. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada: Reducing the Risk of Developing Diabetes. Can J Diabetes. 2013 Apr;37(suppl 1):S16-9.
9. Harris SB, Bhattacharyya O, Dyck R, Hayward MN, Toth EL. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada: Type 2 Diabetes in Aboriginal Peoples. Can J Diabetes. 2013 Apr;37(suppl 1):S119-96.
10. Ekoé JM, Punthakee Z, Ransom T, Prebtani APH, Goldenberg R. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada: Screening for Type 1 and Type 2 Diabetes. Can J Diabetes. 2013 Apr;37(suppl 1):S12-5.
11. Li R, Zhang P, Barker LE, Chowdhury FM, Zhang X. Cost-effectiveness of interventions to prevent and control diabetes mellitus: a systematic review. Diabetes Care. 2010 Aug;33(8):1872-94.
12. Cardona-Morrell M, Rychetnik L, Morrell SL, Espinel PT, Bauman A. Reduction of diabetes risk in routine clinical practice: are physical activity and nutrition interventions feasible and are the outcomes from reference trials replicable? A systematic review and meta-analysis. BMC Public Health. 2010 Oct;10:653.
13. Ali MK, Echouffo-Tcheugui J, Williamson DF. How effective were lifestyle interventions in real-world settings that were modeled on the Diabetes Prevention Program? Health Aff (Millwood). 2012 Jan;31(1):67-75.
14. Johnson M, Jones R, Freeman C, Woods HB, Gillett M, Goyder E, Payne N. Can diabetes prevention programmes be translated effectively into real-world settings and still deliver improved outcomes? A synthesis of evidence. Diabet Med. 2013 Jan;30(1):3-15.
15. Whittemore R. A systematic review of the translational research on the Diabetes Prevention Program. Transl Behav Med. 2011 Sep;1(3):480-91.
16. Diabetes Prevention Program Outcomes Study Research Group. Protocol for the Diabetes Prevention Program Outcomes Study [Internet]. Version 3.3. Rockville (MD): George Washington University Biostatistics Center; 2013 Feb [cited 2013 Jan 22]. 93 p. Available from: http://www.bsc.gwu.edu/dpp./protocol.htmlvdoc
17. Liddy CE, Cullen-Arseneau P, Merizzi S, Blazhko V. "An ounce of prevention": a primary care based prevention program for pre-diabetic population. Can J Diabetes. 2013 Feb;37(1):12-7.
18. McNamara BJ, Sanson-Fisher R, D'Este C, Eades S. Type 2 diabetes in Indigenous populations: quality of intervention research over 20 years. Prev Med. 2011 Jan;52(1):3-9.
19. Teufel-Shone NI, Fitzgerald C, Teufel-Shone L, Gamber M. Systematic review of physical activity interventions implemented with American Indian and Alaska Native populations in the United States and Canada. Am J Health Promot. 2009 Jul-Aug;23(6):S8-32.
20. Edwards K, Patchell B. State of the science: a cultural view of Native Americans and diabetes prevention. J Cult Divers. 2009 Spring;16(1):32-5.
21. Shubair MM, Tobin PK. Type 2 diabetes in the First Nations population: a case example of clinical practice guidelines. Rural Remote Health. 2010 Oct-Dec;10(4):1505.
22. Lévesque L, Guilbault G, Delormier T, Potvin L. Unpacking the black box: a deconstruction of the programming approach and physical activity interventions implemented in the Kahnawake Schools Diabetes Prevention Project. Health Promot Pract. 2005 Jan;6(1):64-71.
23. Jiang L, Manson SM, Beals J, Henderson WG, Huang H, Acton KJ, Roubideaux Y; Special Diabetes Program for Indians Diabetes Prevention Demonstration Project. Translating the Diabetes Prevention Program into American Indian and Alaska Native communities: results from the Special Diabetes Program for Indians Diabetes Prevention demonstration project. Diabetes Care. 2013 Jul;36(7):2027-34.
24. Knowler WC, Ackermann RT. Preventing diabetes in American Indian communities. Diabetes Care. 2013 Jul;36(7):1820-2.
25. Saksvig BI, Gittelsohn J, Harris SB, Hanley AJ, Valente TW, Zinman B. A pilot school-based healthy eating and physical activity intervention improves diet, food knowledge, and self-efficacy for native Canadian children. J Nutr. 2005 Oct;135(10):2392-8.
26. Ho LS, Gittelsohn J, Rimal R, Treuth MS, Sharma S, Rosecrans A, Harris SB. An integrated multi-institutional diabetes prevention program improves knowledge and healthy food acquisition in northwestern Ontario First Nations. Health Educ Behav. 2008 Aug;35(4):561-73.
27. Paradis G, Lévesque L, Macaulay AC, Cargo M, McComber A, Kirby R, Receveur O, Kishchuk N, Potvin L. Impact of a diabetes prevention program on body size, physical activity, and diet among Kanien'keha:ka (Mohawk) children 6 to 11 years old: 8-year results from the Kahnawake Schools Diabetes Prevention Project. Pediatrics. 2005 Feb;115(2):333-9.
28. Daniel M, Green LW, Marion SA, Gamble D, Herbert CP, Hertzman C, Sheps SB. Effectiveness of community-directed diabetes prevention and control in a rural Aboriginal population in British Columbia, Canada. Soc Sci Med. 1999 Mar;48(6):815-32.
29. Rosecrans AM, Gittelsohn J, Ho LS, Harris SB, Naqshbandi M, Sharma S. Process evaluation of a multi-institutional community-based program for diabetes prevention among First Nations. Health Educ Res. 2008 Apr;23(2):272-86.

Bridging the distance

The evolution of transportation and communication technologies for medicine in rural Canada

Hao Li (Meds 2016), Wendy Cui (Meds 2016)
Faculty Reviewer: Dr Shelley McKellar, PhD (Department of History, Department of Surgery)

OVERVIEW

Amongst the many challenges to the implementation of medicine in rural and remote communities, those pertaining to transportation and communication have persisted throughout the history of Canada, a country with a vast geographical land area dotted with small and remote communities. This article explores the history of medical transportation and communication technologies in rural and remote Canada from the pre-Confederation years, where health care professionals depended largely on primitive means such as sleighs, boats, and foot power, through the early 20th century, which saw an expansion of roads and railways, and to the present day, which features a wide variety of motor transportation and electronic information systems. We examine the benefits and challenges that all of these systems posed, the health care profession's adaptation to them, as well as how the world of medical transportation and communication may further develop.

PRE-CONFEDERATION PERIOD

In the beginning of the 1800s, the main constraining factor for transportation methods was geographical. The earliest settlers ventured into areas accessible by water—canals were constructed and canoes or boats used primarily for movement of bulk commodities of relatively low value. Early, primitive roads made long-distance travel by land difficult and often hazardous, with horseback or walking being the primary means of transportation.[1] Due to these limitations, few centralized clinical institutions, such as hospitals as we now know them, existed. Hospitals were seen as places of last resort for the homeless and the poor. Often run by religious orders, and later municipalities, they represented insalubrious and potentially fatal places. Home visits were preferable until after 1890 to 1914, when public perception of hospitals, transformed by technological and diagnostic innovation, improved, and hospitals became the preferred home of medical treatment.[2] For those who received their health care at home, it was common for physicians to go to the sick patient's home, often by horse, by buggy, or on foot. These physicians carried their instruments and medicines with them.[3]

Obstacles to communication largely mirrored those to transportation. Prior to the widespread employment of the telegraph in 1844, communication was served mostly by time-consuming means such as foot power, dog- and horse-drawn sleighs, or ships.[4] As a result, a rural physician's network of practice would be largely confined to his or her home town. Those who covered more than one area, especially in regions of rural isolation, experienced considerably more stressful schedules. As well, clinics that did exist were largely walk-in as it was nearly impossible to establish an appointment system.[5] Inefficiency of communication between physicians, combined with a less expansive system of specialized knowledge, also meant minimal specialization in medicine. Most physicians possessed a broad skillset ranging from diagnosing ailments, to surgery, to setting bones.[5] One example of this was an early Canadian physician named John Hutchison (1823-1898), who made house calls while maintaining his own office. He was known for his skill in operating on cataracts, and as one of the first practitioners in Ontario to use obstetrical forceps.[6] Another case of the overwhelmingly prevalent 'wearer of many hats' type of rural general practitioner was Dr. Noel Murphy (1915-2005) of Newfoundland, who acted as physician, surgeon, anaesthetist, radiologist, and laboratory technician in his hospital.[5]

LATE 19TH/EARLY 20TH CENTURY

The first railways allowed for easier access to previously unsettled areas, but it was not until the early 1880s that the road system in the North-West Territories, which included present day Saskatchewan and Alberta, was developed. The development of roads and highways allowed for access to regions of Canada not served by railways. The Alaska Highway, built during World War II, linked British Columbia to Alaska and increased the volume of traffic to the north.[7] Improvements in access to remote and rural areas also allowed easier and faster transportation by rural physicians. Still, relatively few physicians were settling in rural provinces: in 1914, only 6 out of 7472 practitioners in Canada were located in the territories.[8] Larger cities like Montreal and Toronto had modern hospitals linked to university medical schools, but the continuing shortage of physicians in rural communities led to many rural physicians remaining general practitioners who continued to make house calls by car, horse and buggy, or sleigh.

Communication methods also advanced steadily during this time. Unfortunately, they would also bring about the initial manifestations of the "rural disadvantage", since urban areas were always the first to see and enjoy these developments. By 1876, thirty years after its invention by Samuel Morse, the electric telegraph linked all major cities in Eastern Canada. However, telegraphs were operated mainly in urban telegraph offices, post offices, schools, and railway stations. The message would arrive in one of those locations and be posted on a bulletin board outside. Rural areas could only receive a message through a messenger delivering it from an urban center.[9] This implementation likely expedited the practice of public health; however, its impact in the clinical setting is questionable.

Effective communication in rural medicine would not be truly facilitated until the widespread use of telephones. Invented by Alexander Graham Bell in 1874, the telephone in most rural areas remained of a primitive design, called the Magneto Phone, until the 1960s. This early phone required an operator and was not ideal

for long-distance communication.[10] This limited a physician's network of practice to a relatively small area. Other "side effects" of telephone use included information insecurity and inequity—most likely not everyone owned a telephone, and only areas that were connected by wiring could communicate by phone. However, the Magneto Phone definitely allowed for faster and more efficient transmission of information from person to person, and contributed to a culture of collaboration amongst rural physicians and between rural and urban physicians, as well as the establishment of an appointment system.

20TH CENTURY TO MODERN DAY

Continuing the evolution of transportation, modern, paved roads began to increase in number by the 1950s, altering the Canadian landscape. Cars became cheaper and more common.[7] The use of trucks established true physical access to many remote areas and the successful delivery of necessities and previously unattainable food. Sadly, the concurrent development of increasingly sophisticated medical equipment requiring specialized expertise necessitated in many areas the need for centralization of services and a disappearance of these services from rural care centres.[12] This factor, along with the increasing ease of transportation, may have led to the development of a more sophisticated referral system and the continued perpetuation of the traditionally central role of the general practitioner in a rural area as the main provider of care and referral access point.

Meanwhile, communication methods significantly improved in ease and speed, eventually bringing medicine to the modern age. In 1948, Claude Shannon published 2 benchmark papers on information theory discussing the basis for data compression (source encoding) and error detection and correction (channel encoding), ushering in the rise of wireless communications in urban centers by the 1960s and the continuing development and prevalent use of the Internet in communications by the 1990s.[13] While these technologies have facilitated medical communication greatly, the issue of inequity is similar in all cases of technology, and rural areas have lagged behind their urban counterparts. Some remote regions of Canada still have no access to high-speed or broadband internet.[13,14,15] Other current issues include suboptimal cell service and a shortage of digital skills and resources, partly due to a lack of technological education opportunities and rural-to-urban migration. Another issue with electronic communication lies in the lack of universality of Canada's electronic medical record (EMR). Only some types of information can be electronically transmitted, and the information that cannot be transmitted electronically must still be sent physically, putting rural and remote regions at a considerable disadvantage.

With regards to modern-day transportation, physical access remains a significant barrier to achieving equity of health care in rural areas; intrinsically inferior physical care services can stem from settlement conditions where transportation of resources is less efficient and more expensive. Strategies have been implemented to ameliorate this obstacle. For example, transport to rural regions inaccessible by land and water can be accomplished by air transport. As a result, emergency care is made faster and more available to those who do not own a private motor vehicle.[16] Improvements can also be found in other initiatives such as the Easy Ride program, a transportation system for seniors and those with disabilities in Ontario's Huron and Perth counties, aiding some of the most vulnerable rural populations. Mobile units with a traveling nurse practitioner have been piloted, serving very small communities such as those populations numbering less than one hundred.[17]

FUTURE DEVELOPMENTS

In conclusion, to sustain the medical health of the rural population, Canada has embraced a rapid evolution in transportation and communication technology over the last 2 centuries. This evolution was stimulated not only by the necessity of efficiently carrying people and equipment from one location to another, but also by the increasing demand for rapid transmission of sizeable amounts of information with minimal loss. The evolution in transportation and communication technology in medicine has allowed rural and remote health care to progress in terms of the efficiency of health care delivery, increased specialization, and improved collaboration between different health care professionals. Improvements in transportation technology within the same periods have also allowed more patient empowerment to remain in rural and remote communities.

Future developments in transportation and communication technology can be used as tools for the provision of better medical care. We hope to see further developments in collaboration between health care professionals as well as improvements in patient access to information (eg utilization of mobile technology to directly provide information to patients). Research in telehealth is currently engaging in the development of a universal EMR system allowing any medical information to be transmitted electronically so that any health care professional can access all relevant information on a patient upon presentation, thus resulting in optimal efficiency, specialization, and collaboration. However, in order to truly take advantage of these wonderful opportunities, it is imperative that rural areas enjoy equal access to them on par with their urban counterpart.

REFERENCES

1. Bothwell R. Transportation in the north [Internet]. Toronto: Historica Canada; 2006 Feb 7 [cited 2014 Jan 6]. Available from: http://www.thecanadianencyclopedia.com/en/article/transportation-in-the-north/.
2. Gagan D, Gagan RR. For patients of moderate means: A social history of the voluntary public general hospital in Canada, 1890-1950. Quebec: McGill-Queen's University Press; 2002. 280 p.
3. Stanley GD. Medical Pioneering in Alberta. Alta Hist Rev. 1953;1(1):1.
4. Higgins J. 19th century communications and transportation [Internet]. St. John's (NL): Memorial University of Newfoundland. 2008 [cited 2013 Oct 26]. Available from: http://www.heritage.nf.ca/society/19th_com.html
5. Connor JTH. Rural medical lives and times. Newfoundl Labrador Stud. 2008 Fall;23(2):231-43.

6. Roland, CG. Garnier, John Hutchison [Internet]. Toronto: University of Toronto/Université Laval; 2003 [cited 2013 Oct 26]. Available from: http://www.biographi.ca/en/bio/garnier_john_hutchison_12E.html
7. Ruppenthal KM. Transportation [Internet]. Toronto: Historica Canada; 2007 Jan 29 [cited 2014 Jan 6]. Available from: http://www.thecanadianencyclopedia.com/en/article/transportation/.
8. Canadian Museum of History. Making Medicare: the history of health care in Canada, 1914-2007: medical education and medical practice. [Internet]. Gatineau (QC): Canadian Museum of History; 2010 Apr 21 [cited 2014 Jan 6]. Available from: http://www.civilization.ca/cmc/exhibitions/hist/medicare/medic-1h04e.shtml
9. Petawawa Historical Society. MacKinnon D. The telegraph - then and now [Internet]. Petawawa (ON): Petawawa Historical Society; 2011 Dec [cited 2013 Nov 1]. Available from: http://www.petawawaheritagevillage.com/history/telegraph-then-and-now.
10. Corporation of the City of Brantford. Telephone history [Internet]. Brantford (ON): Corporation of the City of Brantford; [cited 2013 Nov 4]. Available from: http://www.bellhomestead.ca/HISTORY/Pages/TelephoneHistory.aspx
11. Diem Technologies. History of Fax [Internet]. Richardson (TX): Diem Technologies; 2013 [cited 2013 Nov 7]. Available from: http://www.allthingsfax.com/fax-university/history-of-fax/.
12. Savoie DJ. Reflections on rural development. Ottawa: Federation of Canadian Municipalities; 2008 June. 13 p.
13. Goldsmith J. Wireless Communications. Cambridge: Cambridge University Press; 2005. 57-81 p.
14. Lemoine M, Ramsey D. "Digital Youth": ICT use by young people in rural southwestern Manitoba. Prairie Perspectives: Geographical Essays. 2011;14:17-24.
15. NEOnet Inc. The importance of information and communications technology in north eastern Ontario [Internet]. Ottawa: Industry Canada; 2010 Jul 13 [cited 2013 Nov 16]. Available from: http://www.ic.gc.ca/eic/site/028.nsf/eng/00286.html
16. Transport Canada. Improving travel options in small & rural communities [Internet]. Ottawa: Transport Canada; 2009 [cited 2013 Nov 16]. Available from: http://www.fcm.ca/Documents/tools/GMF/Transport_Canada/ImprovingTravelSmallRural_EN.pdf
17. The Social Research & Planning Council. The road ahead: a study of transportation needs across Huron and Perth Counties [Internet]. Stratford (ON): The Social Research & Planning Council; 2012 Mar [cited 2013 Nov 16]. Available from: http://ruralontarioinstitute.ca/file.aspx?id=19b61f56-8abe-486e-b641-cbde475b5877.

Newborn screening project for the Old Order Amish

An interview with Dr Victoria Siu

Jeffrey Law (Meds 2016), Kyle Pangka (Meds 2016)
Faculty Reviewers: Dr Victoria Siu, MD, FRCPC (Division of Genetics & Development)

BACKGROUND

Amish communities can trace their roots to the Anabaptist movement, which was founded in the belief that baptism should be carried out as an adult when one can truly give consent to join the Christian community.[1] The Old Order Amish are the most conservative of the divisions of Anabaptists. McGuigan and Scholl write, "through each transition, one group has remained as the most conservative and austere guardians of strict traditional convictions; these are the Old Order Amish".[2] The Amish choose to dress plainly and restrict their use of modern technology, reflecting their belief that people should live a simple life and place their focus on community and religion.[2] To preserve their way of living the Old Order Amish choose to live separate from other societies.[2] In southwestern Ontario, there are 2 main Old Order Amish communities, based in Perth County and Aylmer, Ontario. The Perth County community was founded in the 1820s and over the years has remained genetically isolated from the general population.

ROLE IN GENETIC STUDIES

There are several reasons why Old Order Amish communities are conducive to genetic studies: they are a closed population with little gene inflow, they have a small number of founding members, and their genealogical records are extensive.[3] The Old Order Amish have a relatively high incidence of genetic disease in their communities.[3] A simplified explanation for this is that the founder effect and a higher rate of consanguinity[3] lead to an increased prevalence of autosomal recessive and polygenic multifactorial disorders. Analysis of Amish populations has enabled several rare genetic illnesses to be mapped and has demonstrated that many principles of population genetics remain relevant.[3]

THE NEWBORN SCREENING PROJECT

In 2003, a targeted newborn screening project was established to screen the Old Order Amish population for four specific treatable disorders: juvenile glaucoma, cystic fibrosis, galactosemia, and cystinosis.[4] The ongoing screening project values collaboration with community elders and healthcare providers and has gained recognition and acceptance in the community: over 300 babies have been screened over 8 years.[4] Over 90% of pregnant women referred to the project by midwives and other healthcare workers have opted to have newborn screening.[4] This has ensured that children born with the genetic diseases being screened for are identified and treated.[5]

INTERVIEW [CONDUCTED BY JEFFREY LAW]

As the medical director of the Medical Genetics Program of Southwestern Ontario, Dr Victoria Siu has a longstanding history with Western University. She attended the University of Toronto and earned her Arts and Science degree in 1978 followed by her MD in 1982. She completed her first year of fellowship training at the Hospital for Sick Children in Toronto and then moved to London in 1987, where she completed her postgraduate training. Dr Siu joined the Children's Hospital in 1989 and is currently ranked as an associate professor at Western University, where she has since established a rewarding and successful medical career.

Stepping into Dr Siu's office, I could not help but notice the family photographs and thank you notes that decorated her shelves. On a Wednesday morning, I was lucky enough to sit down and speak with the distinguished clinician at the London Health Sciences Center to chat about her initiative, the Old Order Amish Newborn Screening Program in southwestern Ontario.

When asked about the rationale behind the project, Dr Siu said that it didn't take a long time in her career to realize that she was seeing many patients with unique disorders from the Amish community and that there was a real need to provide aid to this population. The Amish are very knowledgeable about inherited diseases and keep excellent genealogical records. They are also interested in health maintenance and disease treatment, especially for children. However, they tend to seek medical advice late in the course of illness, when treatment may be less effective. Through previous research, Dr Siu and her colleagues had identified the specific DNA mutations causing juvenile glaucoma, cystic fibrosis, galactosemia, and cystinosis in the Amish. All of these disorders can be treated to improve or delay the onset of symptoms. Thus, in 2003, the Old Order Amish Screening Program was developed with funding from the Change Foundation to identify presymptomatic newborns at risk for these disorders.

When the project began, Dr Siu wanted to ensure that she and her team wouldn't be imposing on the Amish community and that the screening program was actually something the population wanted. As such, Dr Siu reached out to the highly regarded Amish bishops and established connections with community liaisons for their input. The goal was to establish a program that was culturally respectful and appropriate. Additionally, Dr Siu described the difficulties of finding an appropriate community liaison. Initially, a teacher from within the community was contacted to act as liaison but because she was unmarried and did not have children, the elders felt that she could not relate to the mothers in the newborn screening program. Ultimately, 3 woman elders volunteered their assistance to ensure that the project would be well integrated into the community.

Dr Siu was quick to give credit to all the different people who have been involved with the project. In terms of the initiation and ongoing promotion of the program, she spoke highly of Jane Leach, a public health nurse at the Perth District Health Unit who has established a close working relationship with Amish families. Ms. Leach

was instrumental in introducing Dr Siu to the Amish bishops during the conception of the project and has gained the trust of the community. The project was originally coordinated by Sharon Kuepfer, a Mennonite-raised nurse who had become aware of the unique health needs of the Old Order Amish through experiences in her early life and work with the community. The community liaison leaders eagerly helped to organize the initial community education events that exposed the Amish families to the idea of the screening program. As the project gained momentum, the midwives of Countryside Midwifery services as well as other public health nurses from within the region helped to spread further information about the newborn screening program to pregnant women.

The newborn screening project focuses on the Amish families in Perth County. Currently, screening occurs in homes where deliveries occur and blood samples are obtained through umbilical cord sampling after delivery. Dr Tony Rupar has been involved in the identification of the causative mutations for several Amish disorders and is an enthusiastic proponent of newborn screening. Relevant DNA mutation and enzyme analyses are carried out in Dr Tony Rupar's biochemical genetics laboratory at LHSC.

When asked about some of the challenges faced when working with a rural population, Dr Siu spoke of the barriers that the Amish face in accessing medical care. Amish women do not give birth in hospitals, where conventional newborn screening occurs. The Amish instead seek out midwives for at-home delivery. They prefer to receive their healthcare from family physicians or nurse practitioners who are located within their communities. It is time-consuming for the Amish to travel long distances by horse and buggy. Poor weather conditions, especially during the winter months, present additional challenges. Buggies can have sled runners attached, but the horses must get through snow and ice. Travel to the London Health Sciences Centre necessitates the hiring of a driver which typically costs about $150 a trip. In order to overcome this issue of distance, the newborn screening program relies on the midwives who do the home deliveries to collect blood samples, which are subsequently sent by courier to London. As such, screening is brought to the targeted population and the issues of distance, transportation and weather are minimized.

Dr Siu explained that the process of newborn screening has revealed an extremely high carrier rate of the genetic mutations tested. For example, it was found that 1 in 5 newborns are carriers for cystinosis, a figure that is 30 times higher than the carrier frequency in the general population. Since the initiation of the program, 4 infants, one affected with each of the disorders tested, have been identified. Married couples from the Old Order Amish community have come forward to request carrier testing. One of the current limitations of newborn screening is that the turnaround time for DNA results is long—the analyses are done in batches rather than continuously, so therapy for affected newborns may not be initiated until later than ideal. With testing of married couples, the hope is for carriers to receive proper genetic counseling so that genetic screening of their newborns can expedited in order to provide them with the best care possible.

Healthcare providers in Perth County are quick to contact Dr Siu if they identify a newborn with congenital anomalies. Through collaboration with Dr Robert Hegele at the Lawson Research Institute and the FORGE (Finding of Rare Disease Genes in Canada) consortium, the specific mutations associated with several rare disorders in the Ontario Amish and Mennonite population, such as ECO syndrome,[6] which was first described by Dr Piya Lahiry (Schulich MD graduate 2013) and congenital sodium diarrhea,[7] have been identified. As well, an online database for genetic disorders in the Amish, Mennonite, and Hutterite population was created in 2006 by Dr Siu's son, Geoffrey, and Dr Michael Payne (Schulich MD graduate 2010). This is publicly accessible at http://www.biochemgenetics.ca/plain-people/index.php.[8]

Seeing how successful the Amish newborn screening program has been, I couldn't help but ask Dr Siu whether she and her team had any plans to expand the initiative beyond Perth County. She noted that other Amish communities which are related to the Perth County families have already adopted Amish newborn screening. Dr Siu also described with enthusiasm a Mennonite community in Grey-Bruce County that has expressed interest in newborn and carrier screening. This is of great fascination to Dr Siu because there are several other genetic disorders which have been identified only in the Old Order Mennonite community and not in the Amish community. She and Dr Rupar are currently investigating new technology to provide rapid screening for multiple disorders in the Mennonite community, taking into account their unique disorders. Interestingly, there are many opportunities for direct genetic flow when an individual leaves the Amish community to join the somewhat less conservative Old Order Mennonite church. Therefore, it may be predicted that some of the disorders originally seen in high frequency in the Amish community may start to show up in the Mennonite community, and eventually the general population.

In concluding the interview, we asked Dr Siu whether she felt changed by her experience working with the Old Amish community. Dr Siu expressed her admiration for the Old Order Amish—their approach to life, their hard working attitudes and their down-to-Earth personalities. Dr Siu also expressed appreciation for their gratitude towards healthcare providers, their genuine sense of family, and the strong faith that they express in their beliefs. These are all reasons, she says, why she treasures the opportunities to work with such a population.

Dr Victoria Siu embodies how far-reaching a physician's contribution to medicine can be. Her passion is evident through her dedication to her patients and students. It is clear that Dr Siu loves what she does and her patients and students clearly appreciate all the time she gives.

REFERENCES

1. Schmidt S. The Amish of Ontario Part 1 [Internet]. [place unknown]: South Western Media Group; 2013 Apr 3 [cited 2013 Dec 11]. Available from: http://www.southwesternontario.ca/opinion/the-amish-of-ontario-part-1.
2. McGuigan W, Scholl C. The effect of contact on attitudes toward Old Order Amish. J Appl Soc Psychol. 2007 Oct; 37(11):2642-95.
3. Strass K, Puffenberger EG. Genetics, medicine, and the Plain People. Annu Rev Genom Human Genet. 2009 Jun;10:513-36.
4. Rupar, CA, Siu VM, Hegele R, Boycott K. Newborn and carrier

screening in Southwestern Ontario- Forge Canada, a history of collaboration. Presentation at the conference on Genomic Medicine and the Plain Populations of North America, Lancaster, PA [Internet]. [place unknown]: FORGE Canada Consortium; 2013 Jul [cited 2014 Jan 29]. Available from https://clinicforspecialchildren.org/wp-content/uploads/2013/07/Vicky-Siu.pdf

5. Siu, V. Targeted newborn screening for treatable genetic disorders in the old Amish population of Southwestern Ontario [Internet]. Toronto (ON): Health Council of Canada; 2013 May 2 [updated 2013 Mar 27; cited 2014 Jan 29]. Available from http://innovation.healthcouncilcanada.ca/innovation-practice/targeted-newborn-screening-treatable-genetic-disorders-old-order-amish.
6. Lahiry P, Wang J, Robinson JF, Turowec JP, Litchfield DW, Lanktree MB, Gloor GB, Puffenberger EG, Strauss KA, Martens MB, Ramsay DA, Rupar CA, Siu V, Hegele RA. A multiplex human syndrome implicates a key role for intestinal cell kinase in development of central nervous, skeletal, and endocrine systems. Am J Hum Genet. 2009 Feb;84(2):134-47.
7. Heinz-Erian P, Müller T, Krabichler B, Schranz M, Becker C, Rüschendorf F, Nürnberg P, Rossier B, Vujic M, Booth IW, Holmberg C, Wijmenga C, Grigelioniene G, Kneepkens CM, Rosipal S, Mistrik M, Kappler M, Michaud L, Dóczy LC, Siu VM, Krantz M, Zoller H, Utermann G, Janecke AR (2009). Mutations in SPINT2 cause a syndromic form of congenital sodium diarrhea. Am J Hum Genet. 2009 Feb;84(2):188-96.
8. Payne M, Rupar CA, Siu GM and Siu VM (2011). Amish, Mennonite, and Hutterite Genetic Disorders Database. Pediatr Child Health. 2011 Mar;16(3):e23-e24.

LAW

Legal and policy issues in rural and remote medicine

Saad Ahmed (Meds 2016)
Faculty Reviewer: Dr Kevin Coughlin, MD, FRCPC, MHSc (Department of Pediatrics, Division of Maternal, Fetal & Newborn Health)

Almost 15 years ago, Health Canada's Special Advisor on Rural Health declared,

> *"If there is two-tiered medicine in Canada, it's not rich and poor, it's urban versus rural."*[1]

That significant health inequities exist between rural areas and urban areas should not be surprising—it is the reasons for these inequities that are complex and often full of surprises.

BROAD OVERVIEW OF THE ISSUES

While an exact definition of "rural" is contentious, according to Health Canada roughly 20.3% of Canada's population in 2001 lived in rural areas,[2] and about 95% of Canada's land mass is considered rural.[3] There exists a vast diversity amongst rural communities in Canada, and thus the Ministry of Health and Long-Term Care (MOHLTC) also defines Northern communities separately from rural communities for planning purposes.[4]

Rural residents differ significantly from their urban counterparts on key health indicators and determinants of health. Life expectancy is generally lower in rural areas, from 65.4 years in northern Quebec to 81.2 years in Richmond, British Columbia.[3] All-cause mortality rates are also higher in rural areas, pushed up by circulatory diseases, injuries (especially occupational injuries) and suicide. Conversely, all-cancer mortality rates are significantly lower in rural areas, as is the prevalence of obesity.[5]

Demographic problems, geographic isolation and the socioeconomic status of rural residents all intertwine to perpetuate rural-urban health inequities. Demographically, rural areas have more younger and older people, as opposed to urban areas, which have a higher ratio of people aged 30 to 59.[3] Geographic isolation results in difficulty accessing and in bringing medical services to a community. Socioeconomic status is universally recognized as a key determinant of health and has been shown to significantly affect access to and ability to understand health information. Rural residents tend to have less higher education, more unemployment and lower incomes. For example, the average rural and urban unemployment rates in 2001 were 7.2% and 5.4% respectively.[3] Coupled with the fact that access to safe drinking water is a major concern in some rural areas (a twin problem of geography and poverty), these facts leave little doubt as to the existence of rural-urban health inequity.

The increasing centralization of health services has meant that many rural hospitals have been downsized or closed, without a concurrent improvement in primary care services. This has had the dual effect of reducing access to health services in rural areas, as well as increasing unemployment. Furthermore, the centralization of health services has meant the centralization of physicians, who have become unequally distributed between rural and urban areas. For instance, 10.1% of physicians in Canada practice in rural areas.[6]

The reasons for the physician shortage are manifold. Some of them involve the nature of rural practices, which tend to require longer hours, more on-call time and ask doctors to provide more comprehensive services, due to a lack of access to investigations, labs and specialist consults. It has also been argued that the elimination of rotating internships in favour of a 2-stream approach, in which medical students choose either a 2-year family medicine residency or a 5-year specialist residency, has channeled many medical students away from family medicine and limited the exposures of family medicine residents.[2] Furthermore, personal and lifestyle factors play a major role for physicians, in whether they choose to practice in rural areas. Arguably, medical schools choose socioeconomically advantaged students from urban areas, who are less likely to practice in rural areas than if they were from the areas themselves.[2] This has been the major impetus behind Northern Ontario School of Medicine's (NOSM) setup and the recruitment of students from rural, remote and Northern communities into medical schools, through initiatives such as SWOMEN (Southwestern Ontario Medical Education Network).

Other authors point to a host of barriers, such as professional licensing that restricts other health care professionals from being able to provide the same services that doctors do, despite being able to do same work for cheaper.[7] The authors also point out the fact that despite being called "collaborative" health care teams, the organization of many new models of primary care delivery still feature doctors as the managers of care. Nonetheless, it is important to recognize that there is a trade-off between expanding the scope of practice of allied health professionals to increase access to health care, and enacting professional licensing, which protects the public by ensuring the competency and adequate training of health professionals.

Rural areas are diverse and heterogeneous places. "Place"—in its physical, social, environmental and economic dimensions—matters.[8] It may also explain why an Australian survey of rural residents found that geographical considerations did not rank as the most important factor in choosing to consult a doctor. In fact, the top mentioned factor was the respondents' comfort with their doctor.[9] Certainly people must have physical access to health services, but their social access—in terms of how comfortable they feel in reaching out for help and understanding heath information—matters.

THE CANADA HEALTH ACT AND THE ETHICS OF THE MATTER

The primary objective of the Canada Health Act is to protect, promote and restore the physical and mental well-being of Canadian residents, by facilitating reasonable access to health services without financial or other barriers.[14] Thus, where the Canada Health Act guarantees reasonable access to health care on uniform terms and conditions, with no direct or indirect barriers, it should be reason-

able to presume that there should be equality of access to core health services whether a resident of a province lives in a rural or urban area. It is very difficult to make the delivery of health care services completely equal between rural and urban areas; to be frank, there isn't full equality of health care delivery between suburban and urban areas or even within urban areas. Many procedures and tests can only be done in tertiary care centres, which can only realistically exist in major urban centres, as they require key pieces of infrastructure and health personnel to function.

There is also a role for autonomy and personal choice in the rural-urban health divide. Residents of rural areas continue to live there while recognizing that they eschew certain benefits that might otherwise be available to city dwellers, including cultural, retail and education opportunities that lie outside of health care delivery. Is it really reasonable then to ask for full equality of access to all health care services? Furthermore from a utilitarian (and in turn a public health ethics) perspective, we should be funding whatever gives the most benefits for the largest number of people. As provinces tighten their belts in the age of austerity, this is a view that seems to resonate fiscally, especially since health care is seen as another "service" to be delivered. If other government services cannot be fully and equally delivered to rural and remote areas, then is it is reasonable to ask for full and equal delivery of health care, especially since the Canada Health Act specifically guarantees only "reasonable access" to health services?

Conversely, the Canada Health Act also lists various principles that provinces must abide by when delivering their health care. Arguably the law should ensure accessibility to core health services. From a rights-based ethical perspective, the rights of those living in rural areas to access health care are equal to the rights of those living in urban areas, and policies should be tailored around providing health services in that fashion. The philosopher John Rawls' concept of the veil of ignorance furnishes further grounds for a rights-based approach to planning health services delivery. The veil of ignorance asks us to structure society in our imaginations without knowing what sort of circumstances and what type of person we would be born as. As Rawls explained, most of us would see to it that society was organized in an egalitarian fashion that provided equal opportunity for all, whether they were born wealthy or impoverished, or perfectly healthy or disabled. Similarly, if we are born into or working in rural areas, in industries such as farming or natural resource extraction, we should have equal access to core health services that provide equal opportunity to "protect, promote and restore" our physical and mental well-being as much as Canadians living in urban areas do. Simply put, this is the promise of the Canada Health Act.

It is vitally important, however, to distinguish health inequity from disparities in health care delivery. The Canada Health Act guarantees reasonable access to health services, and yet as mentioned above, the social determinants of health, which tend to lie outside of health care delivery, play major roles in individual well-being. Health care delivery is only a piece of the puzzle: healthy public policy that addresses the root causes of poor health is just as important.

RECOMMENDATIONS

The list of proposed solutions for health care in rural areas is lengthy, and some have already materialized, as in the cases of the creation of the NOSM to recruit students from rural and Northern areas, or more general funding for rural health care. For instance, some current projects being funded in the Champlain Local Health Integration Network (LHIN) involve electronic medical record (EMR) funding, more regional pharmacies, support for a policy that takes care of patients at home as opposed to in hospital and support for patient-order sets based on evidenced-based practice guidelines.[10] LHINs are regional health authorities in Ontario that are responsible for distributing health care funding and organizing health care services in their geographical area.

Many of the reports on the state of rural healthcare share common recommendations with a 2002 report titled "Rural Health in Rural Hands", which was prepared by Health Canada's Ministerial Advisory Council. In the intervening years, provinces have undertaken ambitious efforts to restructure their health systems, from Ontario's decentralization of health planning to its LHINs, to Alberta's formation of a singular Health Services superboard.

In 2006 the Government of Ontario created HealthForceOntario in order to plan for the recruitment, retention and distribution of regulated health professionals in Ontario. The strategies that HealthForceOntario and other provinces use have been mentioned above. The ethical issues behind them are explored in another article in this issue (see "What should rural doctors expect? A basic ethical challenge for rural practice"). The Government of Ontario's own recommendations in 2011 suggested the further creation of a group responsible for rural, remote and northern health care within the MOHLTC.[4]

Conversely, the Rural Ontario Institute (ROI) has argued that the doctor shortage has not been solved by financial incentives only. They have argued for more organic approaches instead, such as recruiting medical students from rural areas, having more training in rural areas and having more satellite campuses in rural areas of urban medical schools.[11] In a separate report the ROI[12] also argued that provinces should expand the role of other health professionals, particularly nurse practitioners, in order to increase access to health care in rural areas.[13]

Whatever the proposals are, one can only hope that they work out. The Canada Health Act will turn 30 years old in a year from now and in my regards; its promise of free, public health care for all Canadians still has not been lived up to.

REFERENCES

1. Wooton J. New office to focus on rural health issues. Farm Family Health. 1999 Spring;7(1).
2. Laurent S. Rural Canada: access to health care [Internet]. Ottawa: Health Canada, Economics Division; 2002 [cited 2014 Jan 19]. Available from: http://publications.gc.ca/Collection-R/LoPBdP/BP/prb0245-e.htm
3. Rural health in rural hands [Internet]. Ottawa: Ministerial Advisory Council on Rural Health (Canada); 2002 [cited 2014 Jan 19]. Available from: http://www.srpc.ca/PDF/rural_hands.pdf

4. Rural and northern health care framework/plan [Internet]. Toronto: Ministry of Health & Long Term Care (MOHLTC); 2011 [cited 2014 Jan 19]. Available from: http://www.health.gov.on.ca/en/public/programs/ruralnorthern/docs/report_rural_northern_EN.pdf
5. How healthy are rural Canadians [Internet]? Ottawa: Public Health Agency of Canada; 2006 Sep [cited 2014 Jan 19]. Available from: https://secure.cihi.ca/free_products/summary_rural_canadians_2006_e.pdf
6. Main page [Internet]. Shawville (QC): Society of Rural Physicians of Canada; 2014 [cited 2014 Jan 19]. Available from: http://www.srpc.ca
7. Bourgeault IL, Mulvale G. Collaborative health care teams in Canada and the US: confronting the structural embeddedness of medical dominance. Health Soc Rev. 2006;15:481-95.
8. Kulig JC, Williams AM. Health in rural Canada [Internet]. Vancouver: UBC Press; 2011 [cited 2011 Jan 19]. Available from: http://www.ubcpress.ca/books/pdf/chapters/2011/healthinruralcanada.pdf
9. Humphreys JS, Mathews-Cowey S, Weinand HC. Factors in accessibility of general practice in rural Australia. Med J Aust. 1997;166(11):577-580.
10. Improving patient care in small and rural hospitals [Internet]. Ottawa: Champlain Local Health Integration Network; 2013 May [cited 2014 Jan 19]. Available from: http://www.champlainlhin.on.ca/newsroom_display.aspx?id=7590.
11. Pong R, Russell N. A review and synthesis of strategies and policy recommendations on the rural health workforce [Internet]. Sudbury (ON): Rural Ontario Institute, 2003 [cited 2014 Jan 10]. Available from: http://ruralontarioinstitute.ca/file.aspx?id=fdc2fb3f-7771-4791-89cd-86856524fd74.
12. The Ontario Rural Council. Rethinking rural health care: innovations making a difference. Guelph (ON): Rural Ontario Institute; 2009 [cited 2014 Jan 19]. Available from: http://ruralontarioinstitute.ca/file.aspx?id=1fb3035d-7c0e-4bfa-a8d7-783891f5c5dc.
13. Supply, distribution and migration of Canadian physicians, 2011. Ottawa: Canadian Institute for Health Information; 2011 [cited 2014 Jan 19]. Available from: https://secure.cihi.ca/estore/productFamily.htm?locale=en&pf=PFC1968.
14. Canada Health Act of 1985, R.S.C., c. C-6.

Telehealth in rural Canada

Successes and challenges

Abdullah Nasser (Meds 2017), Nancy Chen (Meds 2016)
Faculty Reviewer: Dr Ted Osmun, MD, MCISc, CCFP (Department of Family Medicine)

With a growing and rapidly ageing population, Canada continues to face numerous challenges meeting the health care demands of its population. Further complicating the situation is the vast geographic area over which 33 million Canadians are distributed. This has created an urban concentration of medical care and left most rural areas severely underserved. Technology is being increasingly utilized to bridge the gap between what essentially morphed into a two-tiered system of health care: one for rural areas and another for urban ones.[1] Chief among the technologies used in this arena is telehealth. Despite the many benefits telehealth offers, there is still some hesitation to adopting the technology on a wide scale in rural Canada.

BACKGROUND

An examination of the role of telehealth in rural Canada is not complete without first elucidating the medical situation in rural areas. A defining feature of health care in rural areas is the physician shortage. It is estimated that close to 1400 additional family physicians are needed to equalize rural and urban physician coverage in Canada. Similarly, rural regions suffer from a severe specialist shortage where only 2.4% of specialists practice in rural areas.[2] Other issues plague health care facilities, including the unequal distribution and underservicing of rural facilities.[3]

Combined, the above factors contribute to unequal access and quality of care for rural residents vis-à-vis residents in metro regions. This is reflected in studies showing worse health outcome measures following episodes of illness, worse general health indicators, and increased unmet health needs in rural areas.[4,5]

TELEHEALTH

Telehealth is the provision of health care over various geographic distances using communication technology—most notably the internet. Telehealth has been employed to connect physicians with distant patients and provide the latter with specialized medical consults. This saves the patient the time and cost of travel and ensures faster access to medical advice.

In Canada, telehealth has been used for many decades to varying degrees of adoption and success among provinces. Although telemedicine sessions took place in all provinces in 2010, the highest per-capita penetration was recorded in the Territories, underlining the importance of the technology to rural and northern communities. Close to 100 000 clinical telehealth sessions—about half of all sessions—took place in rural Canada.[6]

Telehealth is increasingly utilized for a number of purposes, with most teleconferencing sessions conducted primarily for clinical purposes, followed by educational and administrative reasons. There has been an overwhelmingly positive patient response to telemedicine.[7] With regard to psychiatric diseases, telemedicine is cost-effective as an alternative to expensive travel to seek specialized medical consults.[8] Overall, it is estimated that telehealth saved the Canadian health care system $55 million in 20106—much of the savings came from decreased inpatient costs, emergency department visits, and transports. In a recent feasibility study in a northern Inuit community, Mendez et al showed that only 40% of the cases that would have required air transport prior to telehealth were transported after the technology's implementation.[9]

One area where telemedicine has lent itself easily to clinical applications is psychotherapy. Slightly more than half of clinical telehealth sessions conducted in Canada in 2010 were for mental health and addictions reasons.[6] In an extensive review of literature on the topic, Gros et al found that telemedicine produced results similar to those of in-person therapy or counseling.[10] Experts' concerns about the difficulty of patient assessment (eg observing tics) did not have a detrimental impact on session outcomes. In some areas of psychotherapy, such as dignity psychotherapy, the ability to deliver care to advanced disease patients in their homes is a particularly important attractive feature of telemedicine.[11]

Telehealth can also play a role in increasing access to medical education for both medical students and practicing rural physicians. Professional isolation is frequently cited as one of the main challenges to recruiting and retaining physicians in rural areas.[12,13] Increasing communication between urban centres of care and rural areas through telehealth can potentially address many of the aspects of perceived professional isolation and remove one obstacle to practicing in rural areas.

COSTS

In recent years, most provinces have introduced billing codes to allow physicians to claim telemedicine services provided under certain conditions. For instance, physicians in Ontario offering telehealth services, once registered and approved, can have their billings processed by the Ontario Health Insurance Plan (OHIP) claims processing system. Certain restrictions, such as those on location and type of service, apply to the claims.[14] Similar limitations apply in other provinces such as British Columbia and Manitoba.[15]

SUCCESSES AND CHALLENGES

Although the use of telehealth has the potential to have a more positive impact on rural medicine, the introduction of change creates some resistance in the beginning. This is shown in a survey of employees of rural hospitals that have adopted new technologies: while 66.7% of polled employees were comfortable with the adoption of information and communication technologies, 15% were still uncomfortable.[16] Education on the use of technology may help to overcome this initial apprehension.

Important factors shown to influence practitioners' willingness to adopt technology into their practice include economic ramifica-

tions, efficacy, social pressure, and apprehension.[17] Providers who were initially apprehensive found it useful after it was implemented. For instance, it allowed for monitoring of the patients' status, including blood pressure. They were initially worried about having less contact with patients through telehealth but found it actually provided opportunities for more frequent contact, the ability to interact with the patients in their own homes by transmission of physiological data directly to the physician, increased service to the underserved, and more timely and accurate medical monitoring of physiological and daily symptomatic information.[18]

Similarly, patients had positive experiences with telehealth. They reported it lessened the burden of travel and taking time away from work, and allowed them to have access to supports such as friends and families since they did not have to travel to another location.[19] It also allowed for a more timely access to health care given the ease of consulting specialists. Thus, telehealth is beneficial to both patient and practitioner.

More research is needed to firmly establish telehealth as a safe alternative to in-person consults. In several studies, telemedicine has emerged as a safe modality for several clinical situations, including minor injuries[20] and providing neurology consults.[21] However, these results need to be carefully interpreted in the context of the small samples used, and future research is expected to further elucidate the long-term outcomes of using telehealth.

FUTURE

Despite the challenges, uptake of telehealth continues to rise throughout the country. In recent years, telehealth has experienced an average annual growth of 35% in Canada. At this rate, annual consultations can reach more than 1,000,000 in 5 to 10 years. The estimated cost savings at this level to the Canadian health care system would exceed $700 million.[6]

CONCLUSIONS

In conclusion, telehealth can help equalize care delivered throughout Canada. Since Canada is a vast country, it is impossible to have equal access to health care resources universally. Telehealth has allowed patients access to specialist physicians without the need to traveling far, making it more convenient for both patients and doctors, and more cost-efficient for the Canadian government. Even though there is some initial apprehension to adopting technology into health care practices for some segments of the population, once it is implemented both practitioners and patients find it more convenient and accessible. With uptake on the rise, telehealth's role within the Canadian health care system is expected to continue to grow well into the future.

REFERENCES

1. Laurent S. Rural Canada: access to health care [Internet]. Ottawa: Economics Division, Research Branch, Library of Parliament; 2002 [cited 2014 Jan 22]. Available from: http://publications.gc.ca/Collection-R/LoPBdP/BP/prb0245-e.htm
2. Rourke J. Increasing the number of rural physicians. CMAJ. 2008, 178(3): 322-5.
3. Jennissen T. Health issues in rural Canada [Internet]. Ottawa: Political and Social Affairs Division, Research Branch, Library of Parliament; 1992 [cited 2014 Jan 22]. Available from: http://publications.gc.ca/Collection-R/LoPBdP/BP/bp325-e.htm
4. Pampalon R, Martinez J, Hamel D. Does living in rural areas make a difference for health in Québec? Hlth Plc. 2006;12(4):421-35.
5. Smith KB, Humphreys JS, Wilson MG. Addressing the health disadvantage of rural populations: how does epidemiological evidence inform rural health policies and research? Aust J Rural Health. 2008 Apr;16(2):56-66.
6. Canada Health Infoway. Telehealth benefits and adoption connecting people and providers across Canada [Internet]. Stamford (CT): Gartner Inc; 2011 [cited 2014 Jan 22]. Available from: https://www.infoway-inforoute.ca/index.php/component/docman/doc_download/188-avantages-et-adoption-de-la-telesante-rapport-complet.
7. Saqui O, Chang A, McGonigle S, Purdy B, Fairholm L, Baun M, Yeung M, Rossos P, Allard J. Telehealth videoconferencing: improving home parenteral nutrition patient care to rural areas of Ontario, Canada. JPEN J Parenter Enteral Nutr. 2007 May-Jun;31(3):234-9.
8. Jong M. Managing suicides via videoconferencing in a remote northern community in Canada. Int J Circumpolar Health. 2004 Dec;63(4):422-8.
9. Mendez I, Jong M, Keays-White D, Turner G. The use of remote presence for health care delivery in a northern Inuit community: a feasibility study. Int J Circumpolar Health. 2013 Aug 5;72.
10. Gros DF, Morland LA, Greene C, Acierno R, Strachan M, Egede L, Tuerk P, Myrick H, Frueh C. Delivery of evidence-based psychotherapy via video telehealth. J Psychol Behav Assess . 2013, 35(4): 506-21.
11. Passik SD, Kirsh KL, Leibee S, Kaplan LS, Love C, Napier E, Burton D, Sprang R. A feasibility study of dignity psychotherapy delivered via telemedicine. Palliat Support Care. 2004 Jun;2(2):149-55.
12. Curran VR, Fleet L, Kirby F. Factors influencing rural health care professionals' access to continuing professional education. Aust J Rural Health. 2006 Apr;14(2):51-5.
13. Zollo SA, Kienzle MG, Henshaw Z, Crist LG, Wakefield DS. Tele-education in a telemedicine environment: implications for rural health care and academic medical centers. J Med Syst. 1999 Apr;23(2):107-22.
14. Ontario Telemedicine Network. OHIP billing information for telemedicine services [Internet]. [place unknown]: Ontario Telemedicine Network; 2011 [cited 2014 Jan 22]. Available from: http://otn.ca/sites/default/files/ohip_telemedicine_billing_information_manual.pdf
15. Medical Services Commission. General preamble to the payment schedule [Internet]. Victoria (BC): Medical Services Commission; 2013 [cited 2014 Jan 22]. Available from: http://www.health.gov.bc.ca/msp/infoprac/physbilling/payschedule/pdf/1-preamble.pdf
16. Demiris G, Courtney KL, Meyer W. Current status and perceived needs of information technology in Critical Access Hospitals: a survey study. Inform Prim Care. 2007;15(1):45-51.
17. Campbell J, Harris K, Hodge R. Introducing telemedicine technology to rural physicians and settings. J Fam Practice. 2001, 50(5): 419-24.
18. Sandberg J, Trief PM, Izquierdo R, Goland R, Morin PC, Palmas W, Larson CD, Strait JG, Shea S, Weinstock RS. A qualitative study of the experiences and satisfaction of direct telemedicine providers in diabetes case management. Telemed J E Health. 2009 Oct;15(8):742-50.
19. Sevean P, Dampier S, Spadoni M, Strickland S, Pilatzke S. Patients and families experiences with video telehealth in rural/remote communities in Northern Canada. J Clin Nurs. 2009 Sep;18(18):2573-9.
20. Sargeant J, Allen M, Langille D. Physician perceptions of the effect of telemedicine on rural retention and recruitment. J Telemed Telecare. 2004;10(2):89-93.
21. Duncan C, Dorrian C, Crowley P, Coleman R, Patterson V. Safety and effectiveness of telemedicine for neurology outpatients. Scott Med J. 2010 Feb;55(1):3-5.

Championing rural medicine

Interview with Dr Ken Milne

Sissi Cao (Meds 2016), Han Yan (Meds 2017)
Faculty Reviewer: Dr Ken Milne, MD, MSc, CCFP(EM), FCFP (Department of Emergency Medicine)

Dr Ken Milne is an emergency department physician, Chief of Emergency and Chief of Staff at South Huron Hospital Association in Exeter, Ontario. He has been an advocate for advancing the practice of rural medicine throughout his career. Originally from a farm just outside of London, Dr Milne completed both his undergraduate and graduate degrees at Western University before attending medical school in Calgary. He returned to Western in 1997 for family medicine training and began his medical career in Goderich, where he currently resides with his wife and 3 children. In addition to being a clinician, Dr Milne has been conducting research on rural medicine for the last 17 years and helped establish what is now Discovery Week, an integral part of the Schulich School of Medicine's first-year curriculum. He is also the creator of the knowledge translation project "The Skeptic's Guide to Emergency Medicine" (SGEM), which disseminates evidence-based information online so patients can receive the best care. We met with Dr Milne over Google Hangouts to talk about his colourful career, the unique aspects of rural medicine and the challenges he faces working in a remote location.

UWOMJ: What was your path to choosing rural medicine?

Ken Milne: In 1997, when I graduated and came back for my residency, the OMA came out with the Geographic Redistribution Program to drive physicians out of urban centers. If you stayed in a city where there was a medical school, you would only be paid 70% of your billings. But if you moved away, you could get 100%. My wife and I drew a circle around London, where all our family was, and an opportunity came up in Goderich where we live now.

Describe to us the community you currently serve and what makes it unique.

The community I serve now is Exeter in South Huron. It has about 4000 residents and it's mainly a farming community. It also services the tourist community of Grand Bend. The unique aspect of practicing in a rural area is that I get to be the "ologist": I get to be the cardiologist, the gastroenterologist, the orthpediologist, the pediatrologist and the gynecologist. We don't have any operating rooms or regular access to a surgeon. General surgery, pediatrics, gynecology, dermatology and internal medicine rotate through weekly, biweekly or monthly during visiting clinics. So in between the one time a month when a pediatrician comes, I am taking care of all the children. We are able to take care of most of the cases without referring to someone in an urban center.

What do you enjoy most about rural medicine?

I get to use all my skills, knowledge and abilities to their fullest. In an urban environment, you have to have more of a niche practice because of all those other specialists and sub-specialists around you. As a rule in rural areas, we are it. And I love that.

Tell us about your research. Is there anything specific you focus on?

My research for the last 17 years has been on rural medicine. It involves focusing on issues in rural medicine and the delivery of rural care. It's a golden age for rural research. There are so many untapped questions out there that haven't been answered. They have been answered in urban environments but they haven't been answered in rural environments and there's a big difference between urban and rural delivery of care. The more research I do, the more I understand the kind of care we give.

You were mentioning the differences between rural and urban delivery of medicine. Can you go into some of those differences?

In rural medicine, we are very much "high thought, low tech." I don't have access to an x-ray lab after a certain time of night. Unless I ship my patient out, I don't get that CT scan, or MRI, or consult. We really have to use my brain: we are inventive, we are early adaptors, we are creative out of necessity. We don't have access to the advanced imaging or to specialists. A patient would have to travel a great distance to get to them. If we can figure out something that would normally be referred out, we can take care of them locally.

We wanted to highlight the fact that you don't have to be at a tertiary care center or have a master of clinical epidemiology in order to conduct good research.

Yes, you don't need to. I have support through the Southwestern Ontario Education Network (SWOMEN) and Gateway Rural Health Research Institute, the only rural research institute in Canada, where I am currently the Chair of Rural Medicine. These are institutions that make a huge difference by supporting rural teaching and research. And I like that SWOMEN sends me students who challenge me and keep me on my toes.

What are the most challenging aspects of rural medicine?

Professionally, the biggest challenge is obtaining access to advanced imaging and to specialists when I need them. The farther you are from a patient, the more dismissive a physician tends to be. I

need to make sure that rural patients get the care that they deserve, no matter where they are. On a personal level, living in a small town can be a challenge for a spouse, for children and in terms of opportunities you may or may not want them to have, be it parks, or sports, or academics. That might be hard for certain people. Rural communities tend to be lovely, but homogenous. .

How do you address these challenges?

Advocate for your patients. Never give up. That's the only thing. It starts with patient care and ends with patient care. The stuff in the middle doesn't matter. They get the care they need and deserve. And do it in polite and professional way.

How do you think rural medicine or research will change in the future?

Research may become more difficult due to centralization—everyone seems to be choosing the care closest to home. We are rural academic centers of excellence with amazing programs and success stories from the periphery that Schulich can learn from. It's a two-way street.

In going rural, one of the most amazing things I've seen happen is information technology. It has shrunk the world and made access to information easier than ever before. We need to start teaching medical informatics instead of the procedures themselves. You can't possibly cram every procedure and every clinical scenario into your head, but you can learn an approach and how to access the knowledge you need.

Tell us about your involvement with what is now Discovery Week. What was the drive to start a rural week?

James Rourke, now the dean of Memorial University, and I set up Rural Week in 1997. He knew I was interested in research and teaching and he made me its undergraduate coordinator for the first three years. He founded Southwestern Ontario Rural Medicine (SWORM), before it became SWOMEN. He wanted to give every single first-year student exposure to rural medicine, even if he or she may never want to do rural medicine. We conducted research and Rural Week was the most highly rated mandatory course of first year, for educational value, and it gave people great first experiences.

Is there a certain personality that fits with rural medicine? Is there anything else you wish you had known as a medical student?

The personalities that go rural are the early adapters who can really use all their skills and knowledge and resources.

What I would tell anybody is just figure out what gets you out of bed in the bed, what keeps you working hard all day and what makes you stay late. That's what you should do the rest of your life. If it happens to be rural, great; if it's not, great too.

Any last take-home words about rural medicine?

Rural medicine generally allows people to have full practice patterns and the opportunity to exercise their abilities, knowledge and skills to the fullest. You have the privilege of an intimate relationship with your patients, you are able to make a difference at a one-on-one level and also see patients around town. I'm not only part of that patient's life, but I am part of the community life. I get to make a difference on an individual basis, on a community basis, and because of research, I get to advance medicine for all rural communities. .

Dr Milne has recently been awarded the Teacher of the Year Award for Canada by the Canadian Association of Emergency Physicians for his work on SGEM and the Schulich Award for Excellence for Faculty in Distributive Sites for his outstanding contributions to medical education. His passion for patient advocacy, innovative nature and ability to put his ideas into motion makes him the perfect champion for rural medicine and medical education.

THINKING ON YOUR FEET

Door-to-door-to-door

Interhospital transfer for urgent percutaneous coronary intervention

Anthony Chow (Meds 2016), Bashiar Thejeel (Meds 2016)
Faculty Reviewer: Dr Carolin Shepherd, MD

A family physician practising in Perth County is just about to begin a Rourke Baby Record when a call comes in from the front desk of the clinic: a patient complaining of chest pain is on his way to the emergency department. Apologizing gently, the physician cuts the appointment short and jogs across the street to the hospital.

Arriving at the ambulance bay is a 59-year-old man who is diaphoretic, cyanosed and in clear distress. According to the man's wife, the two had been preparing to go for a walk when, about 15 minutes ago, he suddenly doubled over in pain, clutching his chest. The accompanying primary care paramedic helpfully clarifies that the chest pain is retrosternal, pressure-like in nature and radiating down the left arm beyond the elbow. Vitals obtained during transit reveal an elevated heart rate of 85 and mild hypotension (115/75). To nobody's surprise, the automated 12-lead ECG interpretation reads "Acute Inferior STEMI" (ST-elevation myocardial infarction).

INITIAL MANAGEMENT OF ACUTE CORONARY SYNDROME

Acute coronary syndrome (ACS) is a disease of coronary vessel obstruction, primarily due to the formation of clots secondary to atherosclerotic plaque rupture. Myocardial infarction (MI) refers to situations where cardiac tissue sustains irreversible damage, which can happen with as little as 15 minutes of ischemia.[1] As such, prompt assessment and management are key when ACS is strongly suspected. After airway, breathing and circulation have been stabilised, a cardiac-focused history and physical examination should be obtained and 12-lead ECG taken. Blood should also be drawn for evaluation of cardiac biomarkers, coagulation, glucose, lipid profile and standard chemistry.[2] Aspirin is indicated and to be continued indefinitely primarily for its antiplatelet properties, which have been exhaustively shown to reduce the incidence of negative outcomes in patients with all manner of cardiovascular disorders.[3] Nitroglycerin is indicated for vasodilation of coronary and systemic vessels to improve blood flow to ischemic areas of the heart and reduce cardiac stress via decreasing preload and afterload. Since both these mechanisms may potentiate severe hypotension and hemodynamic decompensation, pre-existing hypotension, bradycardia and recent phosphodiesterase inhibitor use (as for erectile dysfunction) are important contraindications to nitroglycerin use.[4] Morphine is used in this setting for its analgesic and anxiolytic effects,[2] but it must be carefully titrated because it causes systemic vasodilation and can worsen hypotension.[5] Uniquely, inferior MIs may trigger the Bezold-Jarisch reflex, a phenomenon that also leads to vagal stimulation and hypotension. IV fluids or atropine can reverse this effect.[6]

Aggressive treatment and an immediate cardiology consult are necessary when ACS is complicated by cardiogenic shock, left heart failure, or sustained ventricular tachyarrhythmia. Relevant signs include hypotension, tachycardia, confusion, cool, pale skin and pulmonary crackles.[2]

The physician, observing the ST-segment elevations in leads II, III and aVF characteristic for an inferior STEMI, quickly rules out relevant medical contraindications and orders STAT chewed aspirin and intravenous fluids. Sublingual nitroglycerin and intravenous morphine are ordered with the risk of hypotensive crisis in mind. Blood is drawn and immediately sent to the laboratory. An urgent consult to the internal medicine service at the nearest tertiary care centre is made due to concern about cardiogenic shock.

THROMBOLYSIS AND PERCUTANEOUS CORONARY INTERVENTION

Given the underlying pathology, there are two approaches to patients presenting with ACS: thrombolysis and percutaneous coronary intervention (PCI). Thrombolysis is induced via IV administration of fibrinolytic agents, and second-generation fibrinolytics like tenecteplase (TNK) preferentially activate clot-associated plasminogen to effect clot lysis while limiting the increase to systemic hypocoagulability. Such measures can restore coronary artery patency in 80 to 90% of cases overall, thereby reducing the risk of complications and death.[7] Concomitant use of low-molecular weight heparins like enoxaparin decreases the risk of disease recurrence and improves vessel flow.[8]

PCI is an umbrella term that includes several non-surgical measures for restoring coronary blood flow. Generally, instruments are inserted through catheters in the inguinal femoral or radial artery and guided via angiography to sites of reduced perfusion. Balloon angioplasty compresses vessel obstructions to the sides of the lumen, while atherectomy mechanically disrupts the blockage for subsequent removal. Either technique may be augmented with the placement of an intracoronary stent that helps prevent the recurrence of stenosis.[9]

There is ample evidence that PCI is more effective than thrombolysis at reducing death, reinfarction and stroke,[10] but this advantage is less certain where PCI is not available. The theoretical benefit of PCI over thrombolysis must be weighed against the delay in treatment incurred during transfer to a PCI-capable facility. Currently, the American College of Cardiology Foundation and American Heart Association recommend thrombolysis as a first-line treatment when it is anticipated that PCI cannot be performed earlier than 120 minutes after first medical contact (FMC). In addition, urgent transfer to a PCI-capable hospital for coronary angiography is recommended even if thrombolysis appears to be successful.[11]

Many factors complicate the estimation of this timeframe in the setting of a rural hospital. In Huron County, for example, 6 ambulances cover an area of 3400 km^2 while in Middlesex-London, 22

units cover a similar area (and 8 of 13 ambulance stations are in the city of London).[12-14] This illustrates the greater distances that must be covered between responding to an emergency call, making FMC and arriving at a local hospital and the fewer number of emergency response vehicles available to do so in a rural setting. In certain areas and times of the year, factors such as road accidents and inclement weather further increase the uncertainty of any estimation of FMC-to-PCI time.[15]

Returning to the case, the physician barks out an order for TNK and enoxaparin while waiting for the local cardiologist to pick up the phone. Several frustrating minutes of call routing later, a general internist on the other end of the line agrees that the patient would benefit from PCI, but gently rejects the request for transfer as the lone PCI suite was unavailable. Eventually, a transfer is secured to another hospital, 83 km away.

.

INTERHOSPITAL TRANSFER

Interhospital transfer of critically ill patients carries substantial risk—patients in ground and air ambulances can become unstable when jostled and are in a small space that is ill-equipped for medical manoeuvers and cut off from outside help. As such, it is usually advisable to ensure patients are hemodynamically and otherwise stable before departure.[16] That said, stabilization efforts would be carried out at the expense of PCI timeliness, and thus, some guidelines for interhospital transfer from PCI-incapable hospitals do not recommend allowing patient instability to delay transport.[17]

Telemetry should transition seamlessly from the emergency room to the ambulance, if possible. Invasive blood pressure monitoring is additionally recommended except for hemodynamically stable patients with short predicted travel times. Where possible, electrical equipment should be battery-powered and IV fluids and medications delivered by syringe or infusion, rather than by gravity.[18]

Ideally, a pair of physicians trained in airway management, advanced cardiac life support (ACLS) and critical care should accompany an unstable patient during transport; realistically, this standard is seldom met.[15] In rural southwestern Ontario, essentially all emergency department physicians are ACLS-trained, but formal emergency medicine training is rare. Moreover, limited staff numbers at these centres can make the formation of an ideal transport team impossible.[19,20]

In the present case, the medical team manages to correct the earlier hypotension somewhat while the consults were made. The patient is quickly bundled back into the ambulance he had arrived in and the physician climbs into the back with him. The second emergency physician on call is contacted and, leaving some home renovations unfinished, joins the 2 nurses left to staff the emergency department. With that, the ambulance speeds off with lights and sirens active.

After half an hour of travel, the patient develops an atrioventricular (AV) block that rapidly progresses to ventricular tachycardia (VT) with cardiac arrest.

ARRHYTHMIC COMPLICATIONS OF STEMI

Electrolyte imbalances, hypoxia, myocardial damage and abnormal sympathetic discharge secondary to MI together contribute to a high risk of peri-infarction arrhythmias. Indeed, such events occur in approximately 90% of all patients with myocardial infarction and are especially common in STEMI.[21]

Both first-degree and second-degree (Mobitz) type I AV blocks are potentiated by right coronary occlusion and these occur most commonly with inferior MI.[22] Neither usually requires treatment if cardiac output remains adequate. Mobitz type II AV blocks, on the other hand, indicate a poor prognosis and should be treated immediately with transcutaneous pacing or atropine, if possible. Caution should be used with atropine, however, as an increase in heart rate can improve cardiac output but decompensate the heart.[21]

All types of sustained VT require urgent intervention because they severely decrease cardiac output, not infrequently to the point of cardiac arrest, and have a tendency to progress to life-threatening ventricular fibrillation. Monomorphic VT should be treated immediately with synchronized electrical cardioversion starting at 100 J, unless it is hemodynamically well-tolerated, in which case IV amiodarone may be tried. Polymorphic VT is less common during acute STEMI, but should it occur, it should be treated with immediate unsynchronized electrical defibrillation starting at 120 or 200 J.[23] Synchronized cardioversion can resolve VT with lower energy and therefore expose the heart to less electrical damage, but it is contraindicated in polymorphic VT because delivery of a charge during a T wave can provoke ventricular fibrillation.[24]

As the patient monitor alarms go off, the driver parks the ambulance at the side of the highway and offers to help manage vitals. Meanwhile, the physician abandons a vial of atropine half-drawn up and reaches for the defibrillator instead. Though telemetry revealed a mostly monophasic pattern, defibrillation at 120 J was deemed safer and thus administered.

Post-shock, the patient alternates between normal sinus rhythm and Mobitz type II. The rhythm is of concern, but the patient seizes and bites his tongue, which begins to bleed freely and compromises his airway. A nasopharyngeal tube is successfully inserted despite the cramped setting and the physician, never forgetting the ABCs, switches to providing bag-valve-mask ventilation to preempt a drop in O2 saturation. Without having to be told, the paramedic returns to the driver's seat and sets off. The remainder of the journey is mercifully uneventful.

The patient is received by a six-person team at the destination interventional cardiology suite, just over 180 minutes after the 911 call was made. Our intrepid physician catches a ride back to the clinic with the same ambulance and quietly prepares for the afternoon's appointments.

REFERENCES

1. Verma S, Fedak PW, Weisel RD, Butany J, Rao V, Maitland A, Li RK, Dhillon B, Yau TM. Fundamentals of reperfusion injury for the clinical cardiologist. Circulation. 2002 May;105(20),2332-6.
2. Ryan TJ, Reeder GS. Initial evaluation and management of suspected acute coronary syndrome in the emergency department [Internet]. UpToDate; 2013 Sep 6 [updated 2013 Sep 6; cited 2013 Nov 13]. Available from: http://www.uptodate.com/contents/initial-evaluation-and-management-of-suspected-acute-coronary-syndrome-in-the-emergency-department.
3. Lincoff AM. Antiplatelet agents in acute ST elevation myo-

cardial infarction [Internet]. UpToDate; 2013 May 8 [updated 2013 May 8; cited 2013 Nov 14]. Available from: http://www.uptodate.com/contents/antiplatelet-agents-in-acute-st-elevation-myocardial-infarction.
4. Reeder GS. Nitrates in the management of acute coronary syndrome [Internet]. UpToDate; 2012 Feb 14 [updated 2012 Feb 14; cited 2013 Nov 20]. Available from: http://www.uptodate.com/contents/nitrates-in-the-management-of-acute-coronary-syndrome.
5. Conti CR. Intravenous morphine and chest pain. Clin Cardiol. 2011 Aug;34(8),464-5.
6. Alpert JS, Douglas PS, Wilson PWF, Simons M, Breall JA. Risk factors for adverse outcomes after ST-elevation myocardial infarction [Internet]. UpToDate; 2013 Apr 25 [updated 2013 Apr 25; cited 2013 Nov 27]. Available from: http://www.uptodate.com/contents/risk-factors-for-adverse-outcomes-after-st-elevation-myocardial-infarction.
7. Zafari AM. Myocardial infarction treatment & management [Internet]. Medscape; 2013 Oct 21 [updated 2013 Oct 21; cited 2013 Nov 20]. Available from: http://emedicine.medscape.com/article/155919-treatment.
8. Rubboli A, Capecchi A, Di Pasquale G. Utilizing enoxaparin in the management of STEMI. Vasc Health Risk Manag. 2007 Oct;3(5):691-700.
9. Stouffer GA III. Percutaneous coronary intervention [Internet]. Medscape; 2013 Nov 11 [updated 2013 Nov 11; cited 2013 Nov 20]. Available from: http://emedicine.medscape.com/article/161446-overview.
10. Keely EC, Boura JA, Grines CL. Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomised trials. Lancet. 2003 Jan;361(9351):13-20.
11. Reeder GS, Kennedy HL, Rosenson RS. Overview of the acute management of ST elevation myocardial infarction [Internet]. UpToDate; 2013 Oct 2 [updated 2013 Oct 2; cited 2013 Nov 21]. Available from: http://www.uptodate.com/contents/overview-of-the-acute-management-of-st-elevation-myocardial-infarction.
12. Huron County [Internet]. Goderich (ON): County of Huron; c2013. Ambulance (EMS); c2013 [cited 2013 Nov 21]. Available from: http://www.huroncounty.ca/ambulance.
13. Statistics Canada [Internet]. Ottawa: Statistics Canada. 2012. Middlesex, Ontario (Code 3539) and Huron, Ontario (Code 3540) (table). Census Profile. 2011 Census. Statistics Canada Catalogue no. 98-316-XWE; [cited 2013 Nov 21]. Available from: http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E
14. Middlesex-London EMS [Internet]. London (ON): Middlesex-London EMS; c2013. [cited 2013 Nov 21]. Available from: http://www.mlems.ca
15. Fleet R, Archambault P, Plant J, Poitras J. Access to emergency care in rural Canada: should we be concerned? CJEM. 2013 Jul;15(4),191-3.
16. Wallace PG, Ridley SA. ABC of intensive care: transport of critically ill patients. BMJ. 1999 Aug;319(7206):368-71.
17. Central Area Trauma Regional Advisory Council. Non-PCI hospital STEMI guidelines [Internet]. Version 04.13. Austin (TX): Central Area Trauma Regional Advisory Council; 2013 [cited 2013 Nov 21]. Available from: http://www.catrac.org/Mission_Lifeline/MLCCW/OtherDocs/2013/Non-PCISTEMI-GuidelinesFINALApproved4-10-2013.pdf
18. Dunn MJ, Gwinnutt CL, Gray AJ. Critical care in the emergency department: patient transfer. Emerg Med J. 2007 Jan;24(1):40-4.
19. Bhimani M, Dickie G, McLeod S, Kim D. Emergency medicine training demographics of physicians working in rural and regional southwestern Ontario emergency departments. CJEM. 2007 Nov;9(6):449-52.
20. Carter KW, Cassidy K, Bhimani M. Barriers to patient care in southwestern Ontario rural emergency departments: physician perceptions. Can J Rural Med. 2012; 17(3):87-91.
21. Kondur AK. Complications of myocardial infarction [Internet]. Medscape; 2013 May 10 [updated 2013 May 10; cited 2013 Nov 22]. Available from: http://emedicine.medscape.com/article/164924-overview.
22. Zimetbaum PJ, Josephson ME. Conduction abnormalities after myocardial infarction [Internet]. UpToDate; 2013 Oct 14 [updated 2013 Oct 14; cited 2013 Nov 22]. Available from: http://www.uptodate.com/contents/conduction-abnormalities-after-myocardial-infarction.
23. Podrid PJ, Ganz LI. Clinical features and treatment of ventricular arrhythmias during acute myocardial infarction [Internet]. UpToDate; 2012 Jul 11 [updated 2012 Jul 11; cited 2013 Nov 22]. Available from: http://www.uptodate.com/contents/clinical-features-and-treatment-of-ventricular-arrhythmias-during-acute-myocardial-infarction.
24. Knight BP. Cardioversion for specific arrhythmias [Internet]. UpToDate; 2013 Aug 29 [updated 2013 Aug 29; cited 2013 Nov 22]. Available from: http://www.uptodate.com/contents/cardioversion-for-specific-arrhythmias.

ZEBRA FILES

A fungus in the haystack

An unusual pediatric case of otomycosis from a rural farming area

Eric Roszell (Meds 2016), Craig Olmstead (Meds 2017)
Faculty Reviewer: Dr Michael John, MD, FRCPC (Department of Medicine, Division of Infectious Diseases)

INTRODUCTION

When medical professionals are presented with a new patient, the likely diagnoses are worked through first before some of the rarer diagnoses, the zebras, are fully considered. What is important to consider in the domain of rural medicine is that what may be uncommon in big cities is common in a rural setting. In this edition of the zebra files, we are introduced to a case that exemplifies this idea.

CASE PRESENTATION

Our zebra case begins with a 17-year-old Caucasian female that presented to pediatric acute care with a 3-day history of right ear pain.[1] When interviewed, she denied any recent airplane rides, loud noises, swimming, or using cotton buds to clean her ears. Other pertinent negatives included no history of nausea, dizziness, or upper respiratory symptoms. She did, however, complain of decreased hearing in her right ear, as well as ear drainage and pain upon pinna manipulation. Otoscopy was performed and revealed a normal tympanic membrane. Direct observations of inflammation were not explicitly recorded at the time of initial presentation. Based on these findings a diagnosis of otitis externa, or inflammation of the external auditory canal, was made and the patient was started on oral ciprofloxacin as well as ciprofloxacin-hydrocortisone otic drops. It should be noted that topical agents are usually sufficient for the treatment of uncomplicated otitis externa; oral ciprofloxacin is usually reserved for those at risk of malignant otitis externa. For most patients in this age group presenting with this constellation of symptoms, antibiotic treatment of the bacteria underlying an otitis externa would end the case here.[2]

Our zebra case, however, was not resolved so quickly. The patient returned to the clinic 9 days later complaining of worsening right-sided hearing loss. Physical examination revealed a right ear canal occluded with cerumen (earwax). Curettage and irrigation of the external auditory canal were performed to remove the excess wax, and the patient reported improved hearing. Five days later the patient presented again to the emergency room, complaining of right ear discomfort and hearing difficulties. Upon repeat curettage and irrigation, purulent material and debris were removed. A neomycin/polymyxin/hydrocortisone otic suspension was started and the patient was asked to follow up in pediatrics. Five days later, the patient still reported trouble hearing with the right ear. At this time, it was noted that our zebra patient had several moist pieces of hay in her hair and further history revealed that the patient had been baling hay on a farm all summer. On physical examination, a white mucoid material was visualized on the right tympanic membrane. A culture of this material was obtained, resulting in an identification of the fungus, *Aspergillus niger*, and a diagnosis of otomycosis was confirmed.

OTOMYCOSIS

Otomycosis, or a fungal infection of the ear, can be caused by many different fungal varieties, most commonly of the *Aspergillus* or *Candida* genera.[3,4] Almost all patients with otomycosis present with pruritus of the ear;[4] otalgia, otorrhea, and hearing loss are also common symptoms.[3,4] In healthy patients, such fungal infections are generally superficial in nature, presenting with chronic otitis externa.[4] In immunocompromised patients otomycosis can progress beyond the outer ear, causing perforation of the eardrum and in rare cases spread of infection to the middle ear or even to the meninges or mastoid process. Being fungal in origin, otomycosis is expectedly unresponsive to antibiotics.[3] Swimming,[1,3] exposure to polluted water,[3] the presence of skin-compromising conditions such as psoriasis,[3] as well as recent use of aural antibiotics are associated with otomycosis.[3,4]

Diagnosis is based on history, physical exam, and visualization of the external ear.[3] If necessary, laboratory tests including cultures can be employed to confirm that the nature of the infection is indeed fungal and to determine its etiology.[3,5] Where there is suspicion of more advanced infection, both computed tomography (CT) of the head and nuclear medicine bone scans can help characterize the extent of disease by demonstrating destructive changes to nearby cranial bones,[3,5] while enzyme-linked immunosorbent assays (ELISA) can detect fungal antigen in the serum and cerebrospinal fluid.[3]

When the infection is confined to the outer ear, treatment of otomycosis typically involves mechanical removal of fungal material from the ear in addition to administration of topical antifungal agents.[1,3] The specific topical antifungal used should depend on the organism responsible for the infection.[3] Agents that work against the most common fungi responsible for otomycosis, namely those of the *Aspergillus* or *Candida* genera, are therefore preferred.[6] Ketoconazole, clotrimazole, and micozanole are examples of appropriate topical antifungals.[3,6]

When the infection has progressed beyond the outer ear, systemic antifungal treatments are necessary. Orally-administered antifungals such as itraconazole and voriconazole function well against both *Aspergillus* and *Candida* infections,[3] with voriconazole demonstrating particular effectiveness against *Aspergillus niger*[6] and invasive fungal infections.[3]

RETURNING TO THE CASE

Culture of the exudates from our patient's ear canal revealed *Aspergillus niger*. *Aspergillus niger* is a common fungus found throughout the world,[4] known to cause black mold growth on certain fruits and vegetables, particularly onions.[7] This fungus grows most readily in hot and humid climates,[7] and the ear canal provides a suitable environment for its growth, particularly after exposure to water.[3,4] This

patient's time spent baling moist hay was suspected as a contributing factor to her otomycosis.[1] The patient was subsequently treated with oral itraconazole, which resolved the infection. The usage of an oral agent instead of a topical agent may suggest that there was a concern that malignant otitis externa would develop in our patient; however, the specific reasons leading to this clinical decision were not recorded. Generally, oral agents are only used in uncomplicated otomycosis patients after topical agents have failed to resolve the infection.[6]

This case is unusual due to the conditions that led to the episode of otomycosis. Although otomycosis is not rare, as 9 to 25% of otitis externa is caused by fungi, it is generally not found without multiple risk factors and is more common in tropical countries.[1] Most cases are associated with immunodeficiency, swimming, topical steroids, or other fungal skin infections, which were all determined to not be factors in our zebra patient.[1] Our patient did, however, have some risk factors: recent antibiotic use and exposure to farming activities. It has been reported in the literature that farmers are exposed to high levels of molds and fungi during hay- or grain-handling activities.[1] Although it has not been previously reported, this case of otomycosis is believed to have originated from fungal exposure during hay baling by our zebra patient. Furthermore, the use of antibiotics may have exacerbated the initial fungal colonization. This case suggests that otomycosis should be considered in rural farming communities when patients present with otalgia and otorrhea. As a result, this case demonstrates how in rural medicine practices, one must consider how unique exposures can lead to diagnoses that are not seen in larger centres.

REFERENCES

1. Aswani V, ShuKla SK. Two unusual pediatric cases of fungal infections in farming families. J Agromedicine. 2011 Apr;16(2):153-7.
2. Piercefield EW, Collier SA, Hlavsa MC, Beach MJ. Estimated burden of acute otitis externa--United States, 2003-2007. Morb Mortal Wkly Rep. 2011 May;60(19):605-9.
3. Vennewald I, Klemm E. Otomycosis: diagnosis and treatment. Clin Dermatol. 2010 Mar;28(2):202-11.
4. García-Agudo L, Aznar-Marín P, Galán-Sánchez F, García-Martos P, Marín-Casanova P, Rodríguez-Iglesias M. Otomycosis due to filamentous fungi. Mycopathologia. 2011 Oct;172(4):307-10.
5. Hsu C, Chen C, Wang H. Iatrogenic invasive otomycosis. Tzu Chi Med J. 2011;23(2):66-8.
6. Ho T, Vrabec JT, Yoo D, Coker NJ. Otomycosis: clinical features and treatment implications. Otolaryng Head Neck. 2006 Nov;135(5):787-91.
7. El-Nagerabi SAF, Ahmed AHM. Storability of onion bulbs contaminated by Aspergillus niger mold. Phytoparasitica. 2003 Oct;31(5):515-23.

NOTES

NOTES

NOTES