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## COLUMNS

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**Conseil canadien des infirmières et infirmiers en soins cardiovasculaires**

**CLINICAL COLUMN**

# Heart Sounds: Are You Listening? Part 1

Jocelyn Reimer-Kent, RN, MN


## Abstract

*All nurses should have an understanding of heart sounds and be proficient in cardiac auscultation. Unfortunately, this skill is not part of many nursing school curricula, nor is it necessarily a required skill for employment. Yet, being able to listen and accurately describe heart sounds has tangible benefits to the patient, as it is an integral part of a complete cardiac assessment. In this two-part article, I will review the fundamentals of cardiac auscultation, how cardiac anatomy and physiology relate to heart sounds, and describe the various heart sounds. Whether you are a beginner or a seasoned nurse, it is never too early or too late to add this important diagnostic skill to your assessment tool kit.*


**Key words:** cardiac cycle, cardiac auscultation, S1, S2, S3, S4

A complete cardiac examination is a multisensory experience that requires the integration of inspection, palpation, and auscultation. When auscultation is performed correctly, most cardiac abnormalities can be accurately detected. Yet, did you know that cardiac examination skills are declining and often inaccurately performed? Researchers have found disturbingly low identification rates of commonly encountered heart sounds by both internal medicine and family practice trainees; and that heart sound proficiency did not improve after the third year as a medical student (Mangione & Nieman, 1997; Vukanovic-Criley et al., 2006).

How would nurses have fared if they were study participants? Nurses tend to lack confidence when it comes to stating their findings related to cardiac auscultation. Mastering this skill requires an understanding of cardiac anatomy and physiology, especially as it relates to the cardiac cycle, and being able to differentiate the first heart sound (S1) from the second heart sound (S2) and any other heart sounds before, between and after.

Cardiac auscultation is a fundamental, yet exceedingly difficult-to-master clinical skill. Often high-tech, high-cost medical imaging takes the place of listening to heart sounds (Chizner, 2008; Mangione & Nieman, 1997; RuDusky, 2005). This is deemed to be linked to the fact that, traditionally, heart sounds have been taught as an intellectual skill with didactic lectures followed by brief demonstrations. The results of this teaching method have been disappointing. The psychoacoustic learning principle, which is based on developing an auditory template that comes from repeated and attentive listening, has yielded better results. One needs to hear a sound between 400 and 600 times for the brain to recall and recognize the sound. Once the sound has been mastered it is reinforced each time the skill is applied in the clinical setting (Barrett, Lacey, Sekara, Linden, & Gracely, 2004).

To accurately identify heart sounds will require the right stethoscope, as not all are equal in their ability to transmit sound. If your stethoscope is less than ideal, you may know heart sounds, but you may not hear them. Prior to the early 1800s the unaided ear was used to listen to a patient. Dr. Rene Laennec is credited with the first stethoscope in 1819, which was no more than a cylindrical tube. He is also credited with being the first to distinguish S1 and S2 (Roguin, 2006).

The modern stethoscope consists of two earpieces connected via tubing to a chest piece consisting of a diaphragm and bell. The diaphragm is used to pick up high-frequency sounds such as systolic murmurs, S1, and S2. The bell is used to pick up low-pitched sounds such as diastolic murmurs, the third heart sound (S3), and the fourth heart sound (S4). If pressure is applied to the bell, it behaves like a diaphragm.

## Techniques for Listening to Heart Sounds

To help practitioners improve their ability to hear heart sounds, several techniques can be applied, such as a quiet room, adequate exposure to the precordium without interference from clothing and body hair, standing on the right-hand side of the patient, and patient positioning that help amplify heart sounds (Walker, Hall, & Hurst, 1990).

For most of the exam the patient (if possible) should be supine with the head-of-the-bed at 30 degrees. To bring out an easily missed mitral stenosis murmur, or a soft S3 or S4 have the patient roll onto his or her left side and place the bell of your stethoscope lightly at the apex. This manoeuvre brings the heart closer to the chest wall. To bring out an easily missed soft aortic regurgitation murmur have the patient sit up, lean forward, exhale completely and stop breathing after he or she has exhaled, and place the diaphragm of the stethoscope firmly against the chest wall along the left sternal border. Remember to pause during the examination to let the patient take a breath. This manoeuvre brings the left ventricular outflow track closer to the chest wall.

Auscultation sites closely correlate to the location of the valves. It is best to have a sequence when listening to heart sounds. You can start at the base of the heart and move down towards the apex in the following manner: second right intercostal space (RICS), also known as the aortic area, across to the second left intercostal space (LICS), also known as the pulmonic area, inch along the left sternal border to the fifth LISC, also known as the tricuspid area, and end as you move across to the midclavicular line or apex, also known as the mitral area. If you start at the apex, you would retrace these steps in the opposite direction (Huebner, 2010; Walker et al., 1990).

## Heart Sounds in Relation to the Opening and Closing of the Cardiac Valves

There are four valves in the heart—the tricuspid valve (TV) and mitral valve (MV), also known as atrioventricular valves, and the pulmonic valve (PV) and aortic valve (AV), also known as semilunar valves. Heart sounds come from the valves closing and vibrations that emanate from the valve leaflets, adjacent cardiac structures, and blood flow.

Figure 1 shows cardiac diastole and systole. Diastole is a long phase that occurs when the atrioventricular valves (TV and MV) are open (atria contracting and emptying) and the semilunar valves (PV and AV) are closed (ventricles relaxed and filling). Diastole lengthens with bradycardia and shortens with tachycardia. At a heart rate of 120 beats per minute or greater diastole may be indistinguishable from systole.

Systole is a short phase that occurs when the atrioventricular valves (TV and MV) are closed (atria relaxed and filling) and the semilunar valves (PV and AV) are open (ventricles contracting and emptying). Timing and identifying what is systole and what is diastole are essential to being able to decipher various heart sounds.

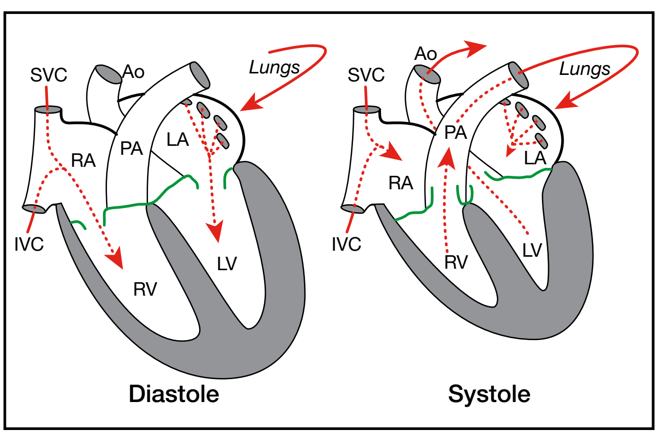


**Figure 1: Heart in diastole and systole**
*Klabunde, R.E. (2011). http://cvphysiology.com/Heart%20 Disease/HD002.htm*
*Image used with permission*

## Heart Sounds in Relation to the Cardiac Cycle

Heart sounds relate to the events within the cardiac cycle, as well as those displayed on an electrocardiogram (ECG) tracing (see Figure 2) (Klabunde, 2011). It is important to note that the heart sound will lag behind the electrical events recorded by the ECG (Malarvili, Kamarulafizam, Hussain, & Helmi, 2003). The description that follows only refers to the left heart and the activity of the MV and AV.

### Late diastole

Number 1 at the top of Figure 2 correlates with the heart in late diastole. The left ventricle is relaxed with the AV already closed and the MV already open and the left ventricle being filled with left atrial blood. This is the phase during which an S4 would be heard (Walker et al., 1990).

### Fourth heart sound—S4

S4 occurs immediately before S1 and after the P wave on the ECG (Malarvili et al., 2003). It is best heard at the apex of the heart with the bell of the stethoscope and the patient lying supine or left-side lying. This late diastolic sound is made during atrial contraction when blood from the left atrium enters a stiff non-compliant left ventricle. S4 can sound like "belub dup" S4-S1-S2 or a cadence similar to the words "a-stiff-wall" (a=S4, stiff=S1, wall=S2), "Tennessee" (Ten=S4, nes=S1, see=S2), or "Toronto" (Tor=S4, on=S1, to=S2) (Warnica, 2007).

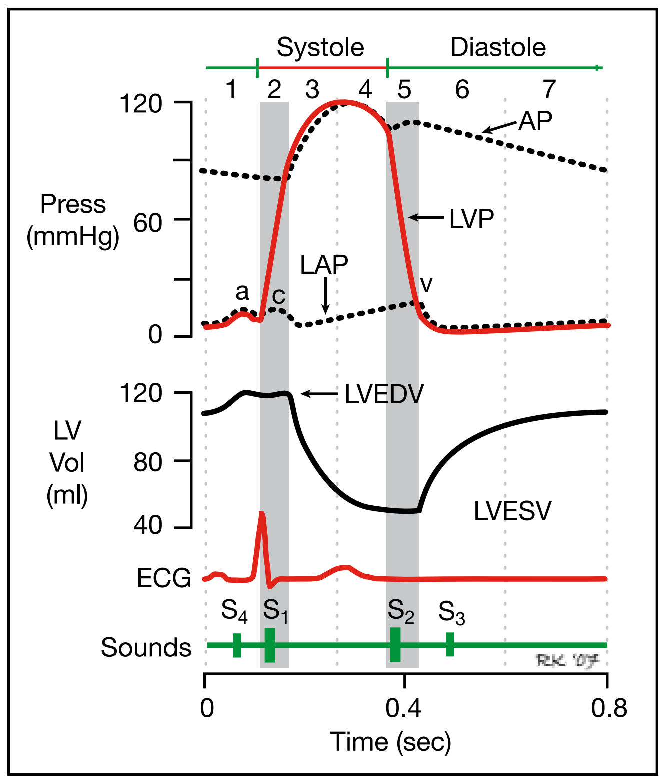


**Figure 2: Heart sounds in relation to the cardiac cycle**
*Klabunde, R.E. (2011). http://cvphysiology.com/Heart%20 Disease/HD002.htm*
*Image used with permission*

**Isovolumetric contraction**

Number 2 at the top of Figure 2 correlates with the period of systole called isovolumetric contraction when the AV remains closed and the MV closes as soon as left ventricular pressure exceeds left atrial pressure. During a brief period of time both the AV and MV are closed and left ventricular pressure continues to rise sharply to overcome aortic pressure. This is the phase during which an S1 would be heard (Walker et al., 1990).

**First heart sound—S1**

The onset of systole is marked with the closure of the MV producing S1 or "lup". Best heard at the apex of the heart with the diaphragm of the stethoscope, this low-pitched sound is of longer duration than S2. It can be distinguished using the ECG as S1 is heard right after the QRS complex (Malarvili et al., 2003).

S1 can also be distinguished using the carotid pulse, as it occurs just before or coincident with the upstroke of the carotid pulse (Walker et al., 1990). The carotid pulse is preferred over peripheral pulses, as there is a palpable delay between ventricular contraction and more distal peripheral pulses.

S1 can also be split as the MV normally closes just before the TV. A split S1 sounds like "lu-lub". A normal split S1 is very brief and often not detected. An abnormal split S1 is prolonged and caused by a right bundle branch block (RBBB) (Walker et al., 1990).

**Systole (ejection phase)**

Numbers 3 and 4 at the top of Figure 2 correlate with the ejection phase of systole. The left ventricle is contracting and when left ventricular pressure exceeds aortic pressure the AV is pushed open. The MV remains closed, which allows the left ventricle to forcefully empty its blood into the aorta. As soon as the volume within the left ventricle decreases, left ventricular pressure immediately falls.

**Isovolumetric relaxation**

Number 5 at the top of Figure 2 correlates with the period of systole called isovolumetric relaxation when the MV remains closed and the AV closes as soon as left ventricular pressure has fallen below aortic pressure. During a brief period of time both the AV and MV are closed as left ventricular pressure continues to fall sharply until it is below LA pressure. This is the phase during which an S2 would be heard (Walker et al., 1990).

**Second heart sound—S2**

The end of systole is marked with the closure of the AV producing S2 or "dub" (Huebner, 2010). Best heard at the base of the heart with the bell of the stethoscope this high-pitched sound is of shorter duration than S1. S2 occurs after the peak or with the downslope of the carotid pulse. If using the ECG to help with timing, S2 occurs at the end of the T wave.

Normally, at the very end of systole, the AV closes just before the PV causing a split S2, which sounds like "du-dub". Physiological splitting is normal and it will fluctuate with the respiratory cycle. During inspiration, PV closure is delayed due to increased venous return to the right side of the heart. The split will widen and become more discernible on inspiration and disappear on expiration. Pathological splitting can be fixed, narrowed, or reversed (paradoxical). Fixed splitting can be caused by an RBBB or an atrial septal defect. Narrowed splitting during inspiration occurs when left ventricular ejection time is increased. Causes include severe aortic stenosis, left ventricular outflow obstruction, left ventricular volume overload, patent ductus arteriosus, left bundle branch block (LBBB), and Wolf Parkinson White Syndrome. Paradoxical or reversed splitting occurs when the AV closes after the PV. Most commonly caused by LBBB, it can also be heard in patients with hypertrophic cardiomyopathy, in the immediate few days after an acute myocardial infarction, or secondary to severe left ventricular dysfunction (Walker et al., 1990).

**Early diastole**

Number 6 and 7 at the top of Figure 2 correlate with the heart in early diastole. The left ventricle is relaxing with the AV closed and the MV open and the left ventricle is beginning to fill with left atrial blood. This is the phase during which an S3 would be heard (Walker et al., 1990).

**Third heart sound—S3**

S3 is best heard at the apex of the heart with the bell of the stethoscope and with the patient lying supine or left side-lying. Although common and innocent in children and young adults it is pathological in older adults often due to left ventricular dysfunction. This early diastolic sound is made when blood from the left atrium slams into an already full left ventricle. S3 can sound like "lub du bub" S1-S2-S3 or a cadence similar to the words "sloshing-in" (slosh=S1, ing=S2, in=S3), "Kentucky" (Ken=S1, tuc=S2, ky=S3), or "Montréal" (Mon=S1, tré=S2, al=S3) (Warnica, 2007).

## Conclusion

This concludes part 1 with the overview of the fundamentals of cardiac auscultation, how cardiac anatomy and physiology relate to heart sounds and the basic heart sounds of S1, S2, S3, and S4. Appreciating these sounds is an essential prerequisite to learning advanced heart sounds, which will be covered in part 2. Remember it takes time, patience, and dedication to create an auditory template in your brain. To help you with this, visit websites like: http://medicine.osu.edu/exam/; http://www.med.ucla.edu/wilkes/intro.html; http://depts.washington.edu/physdx/heart/demo.html; or http://www.cardiosource.com/heartsounds/index.asp. The end result will be worth it, as you will have an important skill to add to your assessment tool kit. ♥

**About the author**

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## New Member Contest Winner!

Congratulations to Caroline Lemay, Université du Québec à Trois-Rivières, winner of the CCCN's 2013 get a new member contest. The prize package includes airfare, two nights' accommodation and conference registration to attend the CCCN Annual General Meeting and Scientific Sessions being held in conjunction with "Vascular 2013" in Montreal, QC, October 17–20, 2013.

Thank you to all of our members who recommended a new CCCN member. **Welcome** to all new CCCN members. Keep watching our e-newsletter and website for additional contests and draws.

## CCCN Dates to Remember

- **4th Thursday of every month:** National Learning Session Webinar
- **May 25, 2013:** CCCN Nursing Conference " Update your Cardiovascular Nursing Toolkit", Sheraton Hotel, St. John's, NL
- **August 31, 2013:** Recognition and Awards Submission Deadline
- **August 31, 2013:** Clinical Improvement and Research Grant Submission Deadline
- **October 17–20, 2013:** Vascular 2013 and CCCN Annual General Meeting and Scientific Sessions, Montreal, QC

## Cardiovascular Nursing Excellence Recognition Program

Do you know a nurse who deserves recognition for her/his accomplishments in and contribution to the field of cardiovascular nursing? A nurse who demonstrates excellence in her/his practice?

CCCN honours cardiovascular nurses each year with awards that celebrate nursing excellence. CCCN is inviting applications for the CCCN Recognition Awards. Awards will be presented at the CCCN Annual General Meeting & Scientific Sessions, October 17–20, 2013, in Montreal. Deadline for application is August 31, 2013. For nomination guidelines and additional information, visit our website at **www.cccn.ca**

Please consider nominating a nurse who you feel exemplifies the best in cardiovascular nursing.

# Clinical Improvement Grant Program

The purpose of this grant is to provide CCCN members with financial support for knowledge dissemination and knowledge utilization projects pertaining to cardiovascular or cerebrovascular nursing in Canada.

This grant is directed to nurses in clinical settings who use results from research to improve their practice, and to research nurses wishing to establish linkages with clinical nurses to facilitate the uptake of research evidence and advance clinical practice.

## Types of clinical projects to be funded

1. Knowledge Dissemination Project (e.g., research/education day, speaker series)
2. Knowledge Utilization Project (e.g., policy development, planning meeting, specialty certification preparation course)

## Range of funding

1. $1,000 to a maximum of $5,000
2. A candidate may only receive one CCCN clinical grant for the same project

## Eligibility

1. Canadian citizens or permanent residents
2. Current members of the CCCN
3. Currently licensed as a nurse in a provincial/territorial professional association
4. The project must include both clinical and research nurses

## Selection criteria

The CCCN National Research Committee reviews grant applications with attention to the relevance of the project. In the event that projects receive equal rating, then preference will be given to the applicant who 1) has not received a funding from CCCN in the past five years, or 2) has contributed the most to CCCN endeavours.

## Closing date for applications

August 31, 2013

For complete details, please visit our website at **www.cccn.ca**

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# Programme de bourse pour l'avancement de la pratique clinique

Le Programme de bourse pour l'avancement de la pratique clinique vise à offrir du soutien financier aux membres du Conseil canadien des infirmières et infirmiers en soins cardiovasculaires (CCIISC) afin de réaliser des projets de diffusion et d'utilisation des connaissances issues de la recherche en soins cardiovasculaires ou cérébrovasculaires au Canada.

La bourse est destinée à la fois aux infirmières œuvrant en milieux cliniques qui utilisent les résultats de la recherche pour améliorer leur pratique, et aux infirmières de recherche qui veulent établir des liens avec les infirmières œuvrant en milieux cliniques pour faciliter l'utilisation des données issues de la recherche et faire avancer la pratique clinique.

## Types de projets cliniques visés

1. Projets de diffusion des connaissances
2. Projets d'utilisation des connaissances

## Éventail des possibilités de financement

1. Entre 1 000 $ et 5 000 $ au maximum
2. Une candidate peut recevoir une seule bourse du CCIISC pour le même projet d'avancement de la pratique clinique.

## Critères d'admissibilité

1. Détenir la citoyenneté canadienne ou le statut de résident permanent
2. Être membre actuelle du CCIISC
3. Être infirmière autorisée actuellement par une association professionnelle provinciale ou territoriale
4. Le projet doit inclure à la fois la participation d'infirmières œuvrant en milieux cliniques et d'infirmières de recherche.

## Critères de sélection

Le Comité national de la recherche du CCIISC examine les demandes de bourse en fonction de la pertinence du projet par rapport au secteur visé. Si plusieurs projets obtiennent une cote scientifique égale, la préférence sera accordée à la candidate 1) n'ayant pas reçu de soutien financier du CCIISC au cours des cinq années précédentes, ou 2) ayant contribué le plus aux entreprises du CCIISC.

## Date de clôture pour la présentation des demandes

31 août de chaque année

Pour plus de détails, veuillez visiter notre site Web à **www.cccn.ca**

# Research Grant Program

The purpose of this grant is to provide funds to CCCN members for research pertaining to cardiovascular or cerebrovascular nursing in Canada. A maximum of $5,000 is available for this competition.

### Types of research to be funded

1. Development of a research proposal that will lead to funding from another granting agency
2. Pilot study, a small project, or instrument development and testing
3. Evaluation of a nursing intervention.

### Range of funding

1. $1,000 to a maximum of $5,000
2. A candidate may only receive one CCCN research grant for the same project.

### Eligibility

1. Canadian citizens or permanent residents
2. Current members of the CCCN
3. Currently licensed as a nurse in a provincial/territorial professional association.

### Selection criteria

The CCCN National Research Committee reviews grant applications with attention to both relevance and scientific merit. In the event that projects receive equal scientific rating, then preference will be given to the applicant who 1) has not received a funding from CCCN in the past five years, or 2) has contributed the most to CCCN endeavours.

### Closing date for applications

August 31, 2013

For complete details, please visit our website at **www.cccn.ca**

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# Programme de bourse de recherche

Le Programme de bourse de recherche vise à offrir du soutien financier aux membres du Conseil canadien des infirmières et infirmiers en soins cardiovasculaires (CCIISC) afin de réaliser de la recherche sur les soins cardiovasculaires ou cérébrovasculaires au Canada. Un somme maximale de 5 000 $ est disponible dans le cadre du concours.

### Types de recherche visés

1. Développement d'une proposition de recherche pouvant attirer du soutien financier d'un autre organisme subventionnaire
2. Étude pilote, petit projet ou développement et mise à l'essai d'un instrument
3. Évaluation d'une intervention infirmière.

### Éventail des possibilités de financement

1. Entre 1 000 $ et 5 000 $ au maximum
2. Une candidate* peut recevoir une seule bourse de recherche du CCIISC pour le même projet.

### Admissibilité

1. Détenir la citoyenneté canadienne ou le statut de résident permanent
2. Être membre actuelle du CCIISC
3. Être infirmière autorisée actuellement par une association professionnelle provinciale ou territoriale.

### Critères de sélection

Le Comité national de la recherche du CCIISC examine les demandes de bourse en tenant compte à la fois de la pertinence et du mérite scientifique du projet. Si plusieurs projets obtiennent une cote scientifique égale, la préférence sera accordée à la candidate 1) n'ayant pas reçu de soutien financier du CCIISC au cours des cinq années précédentes, ou 2) ayant contribué le plus aux entreprises du CCIISC.

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Pour plus détails, veuillez visiter notre site Web à **www.cccn.ca**

## CCCN 40th Anniversary—40 Weeks to Celebrate!

Beginning March 25, 2013, we invite you, our CCCN members, to visit our website at **www.cccn.ca** and participate in our "40 Weeks to Celebrate" Contest. Each week, members can click on the "Weekly Word" and enter to win a $5.00 Tim Hortons gift card. Each member who enters before **Week 20** will have their name entered for a chance to win one "Vascular 2013 Conference Registration" in Montreal. Each member who enters by **Week 40** will have a chance to win one of five "2014 CCCN memberships". Winners' names will be posted on the website every Friday. (Maximum one entry per member, per week).

40 Years

Canadian Council of Cardiovascular Nurses

***1973–2013:*** *Celebrating 40 years as the voice for cardiovascular nursing in Canada*

# World Health Organization Celebrates World Health Day, April 7, 2013—Focusing on Hypertension

Lyne Cloutier, RN, PhD, Dorothy Morris, RN, BScN, MA, CCN(C), Jill Bruneau, RN, MHSc, NP, CCN(C), Donna McLean, RN, NP, PhD, and Norm Campbell, MD, FRCPC

Cloutier, L., Morris, D., Bruneau, J., McLean, D., & Campbell, N. (2013). World Health Organization Celebrates World Health Day, April 7, 2013—Focusing on Hypertension. *Canadian Journal of Cardiovascular Nursing, 23*(2), 9– 11.

Each year on World Health Day, the World Health Organization (WHO) focuses on a major global health issue to celebrate its formation in 1948. In 2013, the WHO selected hypertension as the theme for World Health Day (http://www.who.int/world-health-day/en/). The selection of hypertension is likely based on a recent WHO-sponsored study that found increased blood pressure to play a critical and increasing role in causing death and disability worldwide (Lim et al., 2013).

As blood pressure increases above 115/70 mmHg, blood vessels are damaged throughout the body causing more than one half of all strokes and heart disease worldwide (Perkovic, Huxley, Wu, Prabhakaran, & MacMahon, 2007). Approximately one half of hypertension-related disease occurs in those with increased, but still normal blood pressure and the other half in those with clinical hypertension (Perkovic et al., 2007). The WHO currently estimates that 13% of deaths (9.4 million annually) and 7% of disability globally are caused by increased blood pressure: marked increases over the last estimates in 1990 (Lim et al., 2013). World Health Day is intended to focus global attention on the causes and consequences of hypertension, encouraging people to take up and sustain behaviours to prevent hypertension, to have regular blood pressure checks, and to motivate governments to create healthy environments that would assist in preventing hypertension (http://www.who.int/world-health-day/en/).

Canada is fortunate compared to many countries from a hypertension perspective. The national age-adjusted rate of hypertension in adults is approximately one in five and is relatively constant, while the rate in many countries is more than 30%. Canada has the highest reported national rates of treatment and control of hypertension and the lowest rate of people with undiagnosed hypertension (Kearney, Whelton, Reynolds, Whelton, & He, 2004; Wilkins et al., 2010). Many of the successes in Canada have been attributed to an extensive and innovative interdisciplinary Canadian Hypertension Education Program (CHEP) for health care professionals and the public, strong government and non-governmental organization partnerships focusing on hypertension such as Hypertension Canada, and strong provincial health care systems (Campbell & Sheldon, 2010). Canada has also been aided by a series of national strategic plans and frameworks to help guide hypertension prevention and control efforts (Campbell et al., 2012). A national committee of health care and scientific organizations (Canadian Hypertension Advisory Committee), comprising nursing, physician, pharmacy and other allied professional groups including the Canadian Council of Cardiovascular Nurses (CCCN) has formed to help guide and drive the implementation of the Hypertension Framework.

The Hypertension Framework and recent national surveillance efforts indicate there is much work to be done in Canada. It is expected that more than 90% of Canadians living an average lifespan will develop hypertension and an estimated 7.5 million adult Canadians currently have hypertension (Robitaille et al., 2012; Vasan et al., 2002). Some Aboriginal peoples, several ethnic minorities, people with low incomes and education are more at risk to develop hypertension. About one third of Canadians with hypertension have uncontrolled pressures; mostly systolic blood pressure and lack of control is most common in older women (Campbell, McAlister, & Quan, in press). Lack of awareness of having hypertension is common in the young and more so in young men than women (likely because Canadian workplaces, for the most part, do not provide effective screening or health programs targeting that population) (Campbell et al., in press). This is certainly an area in which nurses working in settings with young men can play an active role. The Hypertension Advisory Committee, acknowledging that much of hypertension is caused by unhealthy diets high in saturated fats, trans-fatty acids, free sugars and sodium (see Table 1), has prioritized the prevention of hypertension through development and advocacy for the implementation of policies that could assist in markedly reducing the prevalence of hypertension, improve hypertension control rates and reduce health care expenses.

Canadians should celebrate the national successes that have been accomplished to reduce the disease burden of hypertension. However, World Health Day also needs to remind us that:

1. hypertension is largely preventable and remains a constant threat to well-being, with concerns becoming increasingly evident that the current generation of children in Canada may live shorter, less healthy lives, compared to previous generations due, for the most part, to lifestyle factors.

2. there are effective policies that could support Canadians making healthy choices, which, if implemented, could largely prevent hypertension from occurring.
3. hypertension is easy to screen for.
4. effective lifestyle and drug treatments are available and could control hypertension in nearly all Canadians.

In every setting and neighborhood across Canada, the hospital, clinic or community, nurses are encouraged to participate in the interdisciplinary efforts to control hypertension. Nurses, advanced practice nurses (APNs) or nurse practitioners (NP) along with family physicians in the clinical setting are ideally suited for chronic disease management. This can be done at all stages of hypertension management. Routine monitoring and consistent follow-up including unique, individualized interdisciplinary care plans developed with the client and family can improve outcomes (Lawson & Robelli, 2011). This can be achieved with baseline physical assessments, proper blood pressure measurements, laboratory assessment, cardiovascular risk estimates, and continued monitoring of progression towards positive outcomes from both pharmacological and non-pharmacological therapies. Teaching accurate techniques in use of home blood pressure devices, validating regularly the technique used and encouraging CHEP-endorsed device acquisition are other good examples.

Furthermore, for APNs and NPs, pharmacological management including adjustments to specific antihypertensive medications, prescribing single combination pills according to the latest clinical practice guidelines help to achieve blood pressure targets recommended by CHEP (<140/90 mmHg or 150/90 mmHg [80 years or older] or <130/80 mmHg clients with diabetes [Daskalopoulou et al., 2012]). The sequential addition of antihypertensive medications is important in assisting the client to achieve these targets, as is advice and monitoring of medication and lifestyle adherence (Daskalopoulou et al., 2012). Systematic efforts to assess and council on adherence to medications and on medication side effects is an integral role for nurses, doctors and pharmacists. Educational counselling should be on the benefits of continuing to take prescribed medications and self-monitoring of BP (Daskalopoulou et al., 2012); and the detrimental effects of non-adherence including renal impairment, congestive heart failure, myocardial infarction, peripheral vascular disease, and blindness (Corrao et al., 2011; World Health Organization in collaboration with the World Heart Federation and the World Stroke Organization, 2011). This is an important role for nurses in hospital, clinic or community settings. Nurses can continuously educate clients and their families on the benefits of optimum treatment of hypertension.

Nurses also play important roles in encouraging and monitoring lifestyle modification practices as therapy. Nurses can provide individualized lifestyle advice to empower the individual to take control and encourage self-management to support the necessary changes in behaviour, as part of the solution to achieve BP targets and reduce the associated morbidity and mortality from cardiovascular diseases.

Other determinants that have been found to affect rates of high blood pressure and the health of the population include education, income, housing, and social support systems. According to the WHO, 2011 Global Atlas on Cardiovascular Prevention and Control, change must occur at the governmental/system level to make significant strides reducing the burden of CVD morbidity and mortality. "Unfair distribution of money, power and resources increases exposure to cardiovascular risk factors" (World Health Organization in collaboration with the World Heart Federation and the World Stroke Organization, 2011, p. 44). Population-wide public health strategies can be effective, but the extent to which one strategy is preferred over another depends on achievable effectiveness, cost effectiveness and resource considerations, (World Health Organization in collaboration with the World Heart Federation and the World Stroke Organization, 2011).

Changes in public policy such as banning the use of tobacco in public places and workplaces in Canada significantly reduced the rates of smoking. Similar healthy public food policies could stipulate warning labels or define maximum limits for foods high in saturated and trans fatty acids, sodium and free sugars, restrictions on marketing unhealthy foods, especially to children, and policies for government to only buy and sell the healthy foods they recommend people eat, especially in publicly funded buildings such as schools and hospitals. Regular consumption of unhealthy food is a cause of obesity, as is evident in Canada today, and is a significant risk factor for hypertension (see Table 1).

In February 2013, the WHO released *Sodium Intake for Adults and Children*, a publication on healthy public policy on a global level intended for leaders at national and local levels to endorse (World Health Organization, 2012). Reviews concerning advice to reduce sodium consumption concluded that intensive behaviour change interventions targeting decreasing sodium intake successfully reduced blood pressure in adults with or without hypertension (He & MacGregor, 2004; Hooper, Bartlett, Smith, & Ebrahim, 2002).

**Table 1: Lifestyle Causes of Increased Blood Pressure ***

| Lifestyle | Attributable risk for hypertension |
|---|---|
| High dietary sodium | 32% |
| Obesity | 32% |
| Low dietary potassium | 17% |
| Low physical activity | 17% |
| High alcohol intake | 3% |

However, the reductions in sodium intake and in blood pressure were modest, and the authors concluded that environmental changes (e.g., reduction of sodium in processed foods) would facilitate a greater reduction in sodium consumption and, therefore, have a greater impact on reducing blood pressure. In Canada, a national strategy to reduce dietary sodium is being advocated by different national health care organizations including the CCCN.

The WHO advocates for "Health in All Policies", which highlights the important links between health and the broader economic and social goals across various government sectors in modern society. "An enabling policy environment is fundamental for modifying and sustaining healthy behaviour" (World Health Organization in collaboration with the World Heart Federation and the World Stroke Organization, 2011).

The WHO selected hypertension as its theme for 2013 World Health Day, April 7, 2013. High blood pressure is both preventable and treatable. The WHO goals are to create greater awareness, healthy behaviours, improved detection, and enabling environments. While acknowledging the successes, we must remain diligent and dedicated to continued efforts in hypertension prevention and management, personally and professionally.

*Data derived from the Institute of Medicine report on hypertension (Committee on Public Health Priorities to Reduce and Control Hypertension in the U.S. Population & Institute of Medicine of the National Academies, 2010) and table used with permission from the Canadian Hypertension Advisory Committee. ♥

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# Effects of an Interdisciplinary Education Program on Hypertension: A Pilot Study

Thérèse A. Lauzière, RN, NP, Nicole Chevarie, RN, MN, Martine Poirier, MSc, Anouk Utzschneider, PhD, and Mathieu Bélanger, PhD

## Abstract

***Background:*** *The goal of this pilot study was to examine the effects of a structured interdisciplinary education program on blood pressure, knowledge, anthropometric measures, medication compliance, behavioural risk factors and quality of life.*

***Method:*** *In this quasi-experimental study, participants were assigned to an intervention (n = 21) or a regular care group (n = 19). The intervention group attended four weekly sessions related to hypertension. Anthropometric measures and blood pressure were recorded at baseline, one, three and six months for all participants. Both groups completed questionnaires on knowledge, health-related behaviours and quality of life at these same intervals.*

***Results:*** *The reduction in systolic blood pressure was greater in the intervention group than in the regular care group (p = 0.05). However, there were no between group differences with regard to the other variables studied.*

***Conclusion:*** *Participation in a structured interdisciplinary education program was associated with a reduction of systolic blood pressure, thus contributing to a risk reduction for cardiovascular disease.*

**Key words:** hypertension, interdisciplinary, education program, lifestyle, medication adherence

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## Background

It has been estimated that 19% of Canadian adults 20 to 79 years of age have hypertension (HTN) and that 35% of these are either unaware of their condition (17%), aware but not treated (4%), or not treated to target (14%) (Wilkins et al., 2010). HTN is linked to a 35%–40% increase in risk of cerebral vascular accidents, as well as an increased risk of dementia, cardiovascular, renal and eye diseases (Duron & Hanon, 2010; National Institutes of Health, 2004). A reduction of blood pressure (BP) by 2 mmHg decreases the risk of stroke by 15% and the risk of coronary artery disease by 6% (Madhur, Maron, Riaz, Dreisback, & Harrison, 2012). It is estimated that there is a 90% lifetime risk for developing HTN among the middle aged and elderly (Vasan et al., 2002).

In addressing cardiovascular disease prevention, experts stress the importance of modifying lifestyle and not relying exclusively on pharmacotherapy (Canadian Cardiovascular Congress, 2006). Adoption of a healthy lifestyle has proven to be highly effective to prevent and treat HTN (Bond Brill, 2010). Risk factors for HTN include modifiable behaviours such as high sodium intake, high alcohol consumption, low levels of physical activity, obesity, and smoking (Public Health Agency of Canada, 2010). In developed countries such as Canada, HTN alone is estimated to account for 10% of health care costs (Gaziano, Bitton, Anand, & Weinstein, 2009). This imposes a substantial burden on the health care system and calls for the identification of viable alternatives to our society's heavy reliance on medications. Konrady, Brodskaya, Soboleva and Polunicheva (2001) suggest that the implementation of educational programs including behavioural change components may provide socioeconomic benefits due to the reduction of costs related to treatments.

Previous studies on the effects of educational programs on HTN have demonstrated a reduction in BP among participants (Drevenhorn, Kjellgren, & Bengtson, 2007; Iso et al., 1996; Miura et al., 2004; Wang & Abbott, 1998). Researchers noted an increase in knowledge related to HTN following a structured education program (Cuspidi et al., 2000; Roca et al., 2003). Zernike and Henderson (1998) found that a structured educational program was more efficient to increase patients' knowledge on HTN than the usual approaches of counselling at the bedside or in the office. A meta-analysis demonstrated that multi-faceted approaches are more effective than single strategies in controlling chronic diseases such as HTN (Weingarten et al., 2002). Similarly, Carter, Rogers, Daly, Zheng, and James (2009) reported that the participation of different health professionals, such as nurses and pharmacists, in the provision of education programs is associated with favourable results, including clinic attendance and a better control of HTN.

Patient non-adherence to treatment is also an important factor contributing to inadequate HTN control (Campbell, McKay, & Tremblay, 2008; Uzun et al., 2009). Compliance can, nevertheless, be improved following education (Hadi &

Rostami Gooran, 2006) and this translates into better HTN management (Konrady et al., 2001; Morgado, Rolo & Castelo-Branco, 2011) and, subsequently, fewer cardiovascular events (Campbell et al., 2009).

Although Konrady et al. (2001) found no significant improvements in lifestyle following education, Iso et al. (1996) and Dickinson et al. (2006) noted reduced salt intake and alcohol consumption among participants in an education program and this resulted in lowering systolic blood pressure (SBP). Svetkey et al. (2009) found that an intensive intervention related to lifestyle resulted in a significant reduction in BP. Others also found that a reduction in salt (Joffres, Campbell, Manns, & Tu, 2007), fat intake and total energy intake (Miura et al., 2004) was associated with a decrease in SBP. In addition, some demonstrated that an increase in energy expenditure through exercise, as well as activities of daily living also contributed to a reduced SBP (Dickinson et al., 2006; Drevenhorn et al., 2007; Miura et al., 2004). Côté, Moisan, Chabot and Grégoire (2005) found an improvement in quality of life among participants, which they attributed to an increase in physical activity and to a lowered BP.

To our knowledge, no research has yet combined BP, knowledge, body mass index (BMI), waist circumference, medication compliance, lifestyle and quality of life as study outcomes. We designed and piloted an interdisciplinary-led education program aimed at improving knowledge related to the importance of complying with medical prescriptions and adhering to physical activity and dietary recommendations.

## Purpose

The purpose of this quasi-experimental study was to investigate changes in systolic and diastolic BP, as they relate to participation in an interdisciplinary-led education program on HTN. Secondary study outcomes included changes in knowledge, BMI, waist circumference, medication compliance, lifestyle and quality of life. Therefore, it was predicted that compared to the regular care group, the group exposed to the interdisciplinary education program would present greater improvements in primary and secondary outcomes over a six-month period.

## Methods

### Study population

This study was based in a predominantly francophone region of south-eastern New Brunswick, Canada. The target population consisted of men and women aged 20 to 70 years with a BP greater than 140/90 mmHg at the doctor's or nurse practitioner's office on four occasions, or BP readings greater than 135/85 mmHg on four occasions in the community. Participants needed to be fluent in French, to have received no education on HTN or its risk factors beyond information given by their primary care provider, and to be capable to participate in an education program. Diabetic patients and those with cardiovascular or renal disease and pregnant women were excluded, as these conditions could inadvertently influence BP control. Treatment with an antihypertensive medication was not an exclusion criterion.

A systematic sampling approach was used to form our intervention and regular care groups. Individuals were assigned numbers in the order they called or were referred to the study research office. No factor is expected to have influenced the order in which patients were listed. The intervention group consisted of patients assigned to odd numbers and those with even numbers formed the regular care group. Data collection occurred between September 2008 and December 2010. Participants were invited through referral from their family practitioner, a local radio station and flyers placed in pharmacies throughout the community. Twenty-four participants were recruited to the intervention group, whereas the regular care group consisted of 23 members. Due to loss of participants, the final intervention and regular care groups consisted of 21 and 19 participants respectively. The Institutional Research Ethics Review Board reviewed and approved this study prior to its initiation.

### Procedures

The intervention consisted of four weekly education sessions of one to two hours duration. At the beginning of the first session, the consent forms were reviewed and signed. Height, weight and BP were measured and BMI was calculated. This session was provided by a nurse practitioner and consisted of an overview of HTN, its risk factors and consequences, and instructions on how to self-monitor BP. In the second session, a dietitian presented Dietary Approaches to Stop Hypertension, otherwise known as the DASH diet (Dietician Canada, 2008). The third session was offered by a physiotherapist who spoke on the benefits of physical activity and provided examples of exercises to be performed. A pharmacist presented the last session, which covered pharmacological options for treating HTN, the potential side effects associated with these medications, and the importance of adhering to pharmacological treatments. All sessions were presented by the same professionals throughout the study. At each session, written materials such as pamphlets and a copy of the visual support for the presentation were provided to the attendees. Participants in the regular care group did not attend education sessions or receive written material during the period of the study, but were offered the sessions and written material at its conclusion.

Sociodemographic information was obtained from all participants at the onset of the study. BP and anthropometric measures (height, weight, waist circumference and BMI) were taken at baseline, one, three and six months of follow-up. The same scale and measuring tape were used throughout the study. BP was measured using a digital BP monitor and the appropriate cuff suited to the individual's arm size. Prior to the BP measurement, subjects were seated for five minutes with both feet on the floor and their left arm resting on a table at heart level.

Three questionnaires were also administered at the same intervals. These included the SF-36 health survey (Version 1.0) to evaluate quality of life, a questionnaire on knowledge related to HTN and its risk factors, and another on lifestyle (diet, physical activity, smoking and alcohol use). The SF-36 has strong psychometrics of reliability and validity (Brazier et al., 1992), and has been shown to be appropriate for hypertensive populations (McHorney, Ware, Lu, & Sherbourne, 1994).

The last two questionnaires were developed for the purpose of this study, based on items found in other validated questionnaires (Barry & Hogan, 2002; Charlton et al., 2007; Aucoin-Gallant, 1998). Five medical experts in the field of HTN were asked to review these, as a means of content validation. The questionnaires were then pre-tested for clarity of items among five lay individuals. More specifically, the questionnaire on knowledge included 20 items with multiple choice answers that covered the definition of HTN (two items), symptoms (two items), treatments (10 items), and risk factors (six items). The questionnaire on lifestyle included 20 multiple choice questions on specific dietary consumption (15 items), frequency of physical activity (one item), tobacco use (one item), alcohol intake (one item) and stress management (two items). Each of these questions was followed by four response options, scored incrementally from 0 to 3 with higher values attributed to healthiest responses. At each encounter, participants were also asked to recall whether they had taken their medications, as prescribed. Data were collected by the same researcher (TL) throughout the study.

**Analyses**

Potential between-group differences at baseline were investigated with t-tests for continuous scores meeting normality assumptions and with Fisher exact test for other variables. We used multivariable linear regressions to assess if there were differences in the rate of change in the continuous outcomes from baseline to six months between participants exposed to the educational intervention and those exposed to regular care. Because physical activity and knowledge scores were better represented as counts, we used multivariable poisson regressions for these outcomes. Similarly, we used polynomial logistic regressions to assess between-group differences in changes in smoking status and alcohol use over the follow-up period. In each of the regressions, the between-group differences were investigated using interaction terms between time and a dichotomous variable indicating exposure or non-exposure to the educational intervention. In the fully adjusted models, we accounted for age, gender, number of years since diagnosis of HTN, level of education, household income, and employment status. Analyses were conducted within the generalized estimating equation framework to account for non-independence of repeated observations within individuals. We used the SAS statistical package version 9.1 GENMOD procedure (SAS Institute Inc, Cary, NC, USA). Missing values were rare (4.7%) and were considered to be a random occurrence. Through the GENMOD procedure, missing values were, therefore, replaced by regression estimates. Power calculations indicated that the inclusion of 20 participants per group would provide 80% power to detect a between-group difference of 10 mmHg in systolic or diastolic BP change with probability of type I error set at 5%.

**Results**

This study included 40 hypertensive participants. The 21 participants in the intervention group had higher systolic and diastolic BPs at the onset of the study than participants in the regular care group, but these differences were not statistically significant (Table 1). In comparison to the regular care group, participants in the intervention group also appeared to be older, to have had their diagnosis of high BP longer, to be heavier, to be less physically active, and to have lower levels of education, but none of these differences were statistically significant. Following statistical adjustments, the baseline between-group difference was only significant for the diastolic BP (Table 2).

**Primary study outcomes**

Improvement in SBP was greater in the intervention group than in the regular care group (see interaction term in Table 2). This difference persisted after adjustments for age, number of years since diagnosis of HTN, gender, level of education, household income, and employment status. At the end of the six-month period, the average SBP reduction in the intervention group was 10.8 mmHg greater than the average reduction observed in the regular care group (estimated from the interaction term: -1.8 mmHg per month x six months). No significant improvements were noted for either group with regard to diastolic BP.

**Secondary study outcomes**

In other linear models, we did not note significant changes in weight, BMI, waist circumference, quality of life, lifestyle, and dietary habits of either group. The physical activity level of both groups appeared to increase throughout the educational program (Poisson regression $\beta$ estimate and 95% confidence interval: 0.9, -0.01 to 0.2). However, this improvement was not significant once we accounted for potential confounders in the fully adjusted model (0.8, -0.03 to 0.2). Although the frequency of drinking more than 14 and nine alcoholic consumptions per week among men and women respectively decreased for both groups, this decrease was not significant in either group. The smoking status reported by participants and their results on the knowledge assessment did not change significantly during the follow-up period.

**Table 1: Baseline characteristics of participants**

| | Participants in the regular care group n = 19 | | Participants in the intervention group n = 21 | | |
|---|---|---|---|---|---|
| | **Mean** | **Std Dev** | **Mean** | **Std Dev** | ***p*-value** |
| Systolic blood pressure (mm Hg) | 131.1 | 14.0 | 139.8 | 15.6 | 0.07 |
| Diastolic blood pressure (mm Hg) | 79.1 | 9.4 | 84.4 | 8.9 | 0.07 |
| Age (years) | 51.7 | 9.4 | 56.6 | 8.5 | 0.1 |
| Years since hypertension diagnosis (number) | 4.6 | 4.2 | 8.0 | 6.7 | 0.08 |
| Weight (lbs) | 170.7 | 34.1 | 179.8 | 42.4 | 0.5 |
| Height (cm) | 164.4 | 7.8 | 164.2 | 9.8 | 0.9 |
| Body mass index (kg/m$^2$) | 28.8 | 5.9 | 30.4 | 5.8 | 0.4 |
| Waist circumference (cm) | 96.8 | 13.1 | 101.6 | 13.4 | 0.3 |
| Quality of life (SF36 score range 0–100) | 72.3 | 17.4 | 77.3 | 15.4 | 0.3 |
| Lifestyle (score range: 0–60) | 41.9 | 5.9 | 41.0 | 6.0 | 0.6 |
| Dietary habits (score range: 0–45) | 32.4 | 5.0 | 31.6 | 4.7 | 0.6 |
| | **n** | **%** | **n** | **%** | |
| **Physical activity (30 minutes/day)** | | | | | 0.4 |
| Always | 5 | 26.3 | 3 | 14.3 | |
| Often | 9 | 47.4 | 7 | 33.3 | |
| Sometimes | 3 | 15.8 | 8 | 38.1 | |
| Never | 2 | 10.5 | 3 | 14.3 | |
| **Smoking tobacco** | | | | | 0.3 |
| Every day | 2 | 10.5 | 0 | 0 | |
| Often | 0 | 0 | 0 | 0 | |
| Sometimes | 2 | 10.5 | 1 | 4.8 | |
| Never | 15 | 79.0 | 20 | 95.2 | |
| **Alcohol (> 14 drinks/week for men and > 9/week for women)** | | | | | 0.9 |
| Always | 1 | 5.3 | 1 | 4.8 | |
| Often | 4 | 21.1 | 4 | 19.1 | |
| Sometimes | 6 | 31.6 | 8 | 38.1 | |
| Never | 8 | 42.1 | 8 | 38.1 | |
| **Knowledge on hypertension (score range: 0–20)** | | | | | 0.6 |
| < 15 | 0 | 0 | 0 | 0 | |
| 15 | 2 | 10.5 | 0 | 0 | |
| 16 | 0 | 0 | 1 | 4.8 | |
| 17 | 1 | 5.3 | 2 | 9.5 | |
| 18 | 4 | 21.1 | 7 | 33.3 | |
| 19 | 5 | 26.3 | 6 | 28.6 | |
| 20 | 7 | 36.8 | 5 | 23.8 | |
| Sex (# women) | 13 | 68 | 14 | 67 | 1.0 |
| Marital status (# single) | 2 | 10 | 4 | 20 | 0.3 |
| Race (# caucasian) | 19 | 100 | 21 | 100 | 1.0 |
| **Education (highest degree obtained)** | | | | | 0.2 |
| High school | 3 | 16 | 4 | 19 | |
| College | 5 | 26 | 11 | 52 | |
| University | 11 | 58 | 6 | 29 | |
| **Household income** | | | | | 0.1 |
| < $20,000 | 0 | 0 | 3 | 17 | |
| $20,000–$49,999 | 4 | 21 | 1 | 6 | |
| $50,000–$69,999 | 3 | 16 | 6 | 33 | |
| ≥ 70 000$ | 12 | 63 | 8 | 44 | |
| **Employment** | | | | | 0.2 |
| Unemployed | 0 | 0 | 2 | 10 | |
| Part time | 1 | 5 | 4 | 19 | |
| Retired | 3 | 16 | 6 | 29 | |
| Full time | 15 | 79 | 9 | 43 | |

**Table 2. Beta coefficients[a] and 95% confidence intervals estimated in multiple linear regressions for differences before and during an interdisciplinary educational program on HTN**

| | Partially adjusted models β (95% CI) | p | Fully adjusted models β (95% CI) | p |
|---|---|---|---|---|
| **Systolic blood pressure (mm Hg)** | | | | |
| Difference between groups at baseline | -9.3 (-17.2, -1.3) | 0.5 | -6.4 (-15.9, 3.0) | 0.2 |
| Time (1 month) | 0.9 (-1.5, 3.3) | 0.02 | 0.7 (-2.0, 3.5) | 0.6 |
| Time x Group interaction | -2.0 (-3.6, -0.4) | 0.01 | -1.8 (-3.5, 0.0) | 0.05 |
| **Diastolic blood pressure (mm Hg)** | | | | |
| Difference between groups at baseline | -5.0 (-10.1, 0.1) | 0.05 | -5.6 (-10.2, -0.1) | 0.02 |
| Time (1 month) | -0.6 (-2.2, 1.0) | 0.5 | -1.0 (-2.9, 0.7) | 0.2 |
| Time x Group interaction | -0.3 (-1.3, 0.6) | 0.5 | -0.06 (-1.1, 1.0) | 0.9 |
| **Weight (kg)** | | | | |
| Difference between groups at baseline | -9.3 (-32.2, 13.6) | 0.4 | 8.5 (-8.3, 25.4) | 0.3 |
| Time (1 month) | -0.07 (-1.2, 1.0) | 0.9 | 0.01 (-1.3, 1.3) | 1.0 |
| Time x Group interaction | -0.08 (-0.8, 0.6) | 0.8 | -0.1 (-0.9, 0.7) | 0.7 |
| **Body mass index (kg/m2)** | | | | |
| Difference between groups at baseline | -1.6 (-5.1, 1.9) | 0.4 | 0.6 (-2.2, 3.3) | 0.7 |
| Time (1 month) | -0.08 (-0.3, 0.1) | 0.5 | -0.06 (-0.3, 0.2) | 0.6 |
| Time x Group interaction | 0.03 (-0.1, 0.2) | 0.6 | 0.02 (-0.1, 0.2) | 0.8 |
| **Waist circumference (cm)** | | | | |
| Difference between groups at baseline | -4.4 (-12.4, 3.6) | 0.3 | 2.0 (-4.5, 8.6) | 0.5 |
| Time (1 month) | -0.4 (-1.2, 0.3) | 0.2 | -0.5 (-1.3, 0.4) | 0.3 |
| Time x Group interaction | 0.2 (-0.2, 0.7) | 0.3 | 0.3 (-0.2, 0.8) | 0.3 |
| **Lifestyle** | | | | |
| Difference between groups at baseline | -0.3 (-3.8, 3.1) | 0.8 | -0.7 (-4.3, 2.8) | 0.6 |
| Time (1 month) | 0.1 (-0.3, 0.6) | 0.6 | 0.1 (-0.4, 0.6) | 0.6 |
| Time x Group interaction | 0.1 (-0.1, 0.4) | 0.3 | 0.1 (-0.2, 0.5) | 0.4 |
| **Quality of life (SF-36)** | | | | |
| Difference between groups at baseline | -4.6 (-13.4, 4.3) | 0.3 | -5.5 (-14.7, 3.8) | 0.2 |
| Time (1 month) | 2.0 (-0.2, 4.1) | 0.07 | 2.4 (0.09, 4.7) | 0.04 |
| Time x Group interaction | -0.7 (-2.1, 0.7) | 0.3 | -0.9 (-2.4, 0.6) | 0.2 |
| **Dietary habits** | | | | |
| Difference between groups at baseline | -0.2 (-3.0, 2.5) | 0.9 | -0.6 (-3.4, 2.2) | 0.7 |
| Time (1 month) | 0.01 (-0.4, 0.4) | 1.0 | -0.05 (-0.5, 0.4) | 0.8 |
| Time x Group interaction | 0.1 (-0.1, 0.4) | 0.3 | 0.1 (-0.1, 0.4) | 0.3 |

β, regression coefficient; CI, confidence interval; [a]The regression coefficient represents the estimated adjusted difference in the value of the dependent variable (the group receiving regular care is the reference; this group presents higher scores at baseline for all outcomes in the table). In partially adjusted models, independent variables include the baseline value of the outcome, time, and the time-group interaction. Covariates in fully adjusted models additionally include age, sex, number of years since diagnosis of HTN, level of education, household income category, and employment status. The interaction terms present by how much the effect of time differed for the group that received the educational intervention.

Throughout the study, participants from both groups generally reported good compliance with their pharmacological therapy. Reports of missing more than two doses of medication in the past month occurred in only two participants in the regular care group at baseline, one participant in the regular care group at one month, and one participant in the intervention group at six months.

## Discussion

In this study, participation in an interdisciplinary educational program was associated with a reduction of SBP. This is in agreement with other studies that showed improvement in BP following structured educational programs (Carter et al., 2009; Drevenhorn et al., 2007; Konrady et al., 2001, Svetkey et al., 2009). In their systematic review, Walsh et al. (2006) examined quality improvement strategies and found that interdisciplinary, team-based care was the only strategy that improved HTN significantly. Several other studies also indicate that educational interventions offered by health care providers from various disciplines result in improved BP control (Carter et al., 2009; Glynn, Murphy, Smith, Schroeder, & Fahey, 2010a; Morgado et al., 2011; Odedosu, Schoenthaler, Vieira, Agyemang, & Ogedegbe, 2012). In Glynn et al.'s review (2010a), it was observed that better BP control was obtained when interventions were directed toward patients rather than toward the physicians.

Participation in the education program was not associated with a demonstrated improvement in HTN-related knowledge. The majority of participants in this study were well educated, thus the questionnaire assessing knowledge about HTN may have been too easy for this group, possibly resulting in an under-estimation of the effect for knowledge improvement. It is also possible that repeating the same questions at every evaluation period led participants in the regular care group to seek answers from external sources. It has been documented that people learn by repetition when completing the same questionnaire on several occasions. This concept of maturation must be acknowledged when considering results of education-based interventions (Boswell & Cannon, 2007). Although we could not find recent studies that examined HTN-related knowledge, Martinez-Amenos, Fernandez Ferre, Mota Vidal, and Alcina Rocasalbas (1990) demonstrated an increase in patient knowledge following an HTN-related education program.

It is well established that a healthy lifestyle, including healthy eating (Svetkey et al., 2009), regular physical activity, moderate alcohol consumption, low sodium intake (Joffres et al., 2007), a smoke-free environment and stress reduction contribute to a reduction in BP and cardiovascular risks (Campbell & Kwong, 2010). Although, in our study, there were no between-group differences at six months, both groups improved their level of physical activity over the follow-up period. Drevenhorn et al. (2007) found that weight reduction and decreased BP were associated with increased exercise. As reported previously, improvements in physical activity can lower SBP by 4 mmHg to 9 mmHg (Madhur et al., 2012) independently of changes in anthropometric measurements (National Institutes of Health, 2004). Despite the lack of structured education, participants in the regular care group did return for regular visits with the nurse practitioner, to have their BP and anthropometric measures evaluated. This heightened attention may have had an impact on the participants' desire and effort to improve their lifestyle. The reported improvements in lifestyles were, nevertheless, not associated with changes in weight, BMI and waist circumference. Longer follow-up and an intervention directed toward weight loss may have led to greater improvements in BP since previous studies show that BP reductions of 5 mmHg–20 mmHg can be expected for every 10 kg of weight loss among overweight patients (Madhur et al., 2012).

Although our study did not demonstrate an improvement in medication adherence, participants reported a high level of compliance with pharmacotherapy throughout the study period. Others have demonstrated that education programs may result in high adherence to antihypertensive treatment, which is associated with better BP control (Morgado et al., 2011) and with a reduction in cardiovascular events (Mazzaglia et al., 2009). Campbell and Kwong (2010) also showed that non-adherence to pharmacotherapy can be prevented and adherence improved through health care professional interventions.

### Limitations

Although participants were not allocated randomly to their respective group, the distribution of subjects was the result of chance alone. This said, it is likely that the between-group difference in change in SBP was the result of exposure to the education program (Loiselle & Profetto-McGrath, 2011). Limitations of this study, nevertheless, include the self-report for several of the other components under study. Self-reporting is subject to problems of recall and social desirability bias. However, it is unlikely that either group would have been subject to more of these reporting issues than the other. It should also be noted that the reliability of some of the measure instruments with which no significant change were observed had not been tested. The lack of between-group differences for some outcomes may, therefore, be the result of measures that were not sufficiently sensitive to change. Although unlikely, a potential bias was also introduced because the data collector was not blinded to study group allocation. Finally, although the relatively small sample included in this study provided sufficient statistical power and appropriately served the purpose of pilot-testing the program, it limits the generalizability of the results.

### Conclusion

In this study, a simple interdisciplinary education program resulted in a significant reduction in SBP. It is, nevertheless, unclear how the education program led to an improvement in BP, given the potential mediators studied were not associated with significant between-group differences. It is possible that improvements in SBP were the result of an accumulation of small, but non-statistically significant improvements in several mediators. Others have indicated that it is difficult to determine which components of complex interventions affect changes in BP (Glynn, Murphy, Smith, Schroeder, & Fahey, 2010b). In conclusion, these results suggest that using an interdisciplinary approach to educate patients about HTN may be an effective method to reduce their BP, thus contributing to risk-reduction for cardiovascular disease. Further research is needed to understand what mediates such improvements. ♥

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**DID YOU KNOW…**

# More than 85 medications are known or predicted to interact with grapefruit?

Paula Price RN, PhD

More than 85 medications have the possibility of interacting with grapefruit; 43 of these can result in serious adverse effects (Bailey, Dresser, & Arnold, 2012). Many individuals are aware that grapefruit interacts with statin medications, but how many know what other medications interact with grapefruit, why the interaction occurs, and the possible adverse effects? Medications that interact with grapefruit have the following characteristics: they are administered orally, have very low to intermediate bioavailability (meaning the percentage of the medication absorbed that is unchanged/not metabolized), and are metabolized by cytochrome P450 3A4 (Bailey et al., 2012).

The interaction between grapefruit and some medications causes an increased drug concentration because of impaired drug metabolism (Bailey et al., 2012). Systemic drug concentration increases because grapefruit diminishes the activity of cytochrome P450 3A4 (CYP3A4), an enzyme located in epithelial cells lining the small intestines and colon that is responsible for metabolizing medications. The chemicals in grapefruit that cause this interaction are called furanocoumarins.

One grapefruit or 200 mL of grapefruit juice may cause clinically relevant adverse effects (Bailey et al., 2000; Edgar, Bailey, Bergstrand, Johnsson, & Regardh, 1992). The adverse effects can include torsades de pointes, rhabdomyolysis, myelotoxicity, respiratory depression, gastrointestinal bleeding, nephrotoxicity, and breast cancer (Bailey et al., 2012).

Many of the medications that interact with grapefruit are frequently prescribed in Canada. While patient susceptibility is unknown, people older than 45 years are the usual purchasers of grapefruit and also receive the most prescriptions (Johannot & Somerset, 2006). Furthermore, the pharmacokinetic interaction has been shown to occur more frequently in persons older than 70 years (Dresser, Bailey, & Carruthers, 2000). Other citrus fruits may have similar consequences such as seville oranges, limes and pomelos (Bailey, Dresser, & Bend, 2003; Guo et al., 2007; Malhotra, Bailey, Paine, & Watkins, 2001), but grapefruit has been the most studied.

To see the list of medications involved, see Bailey et al. (2012). ♥

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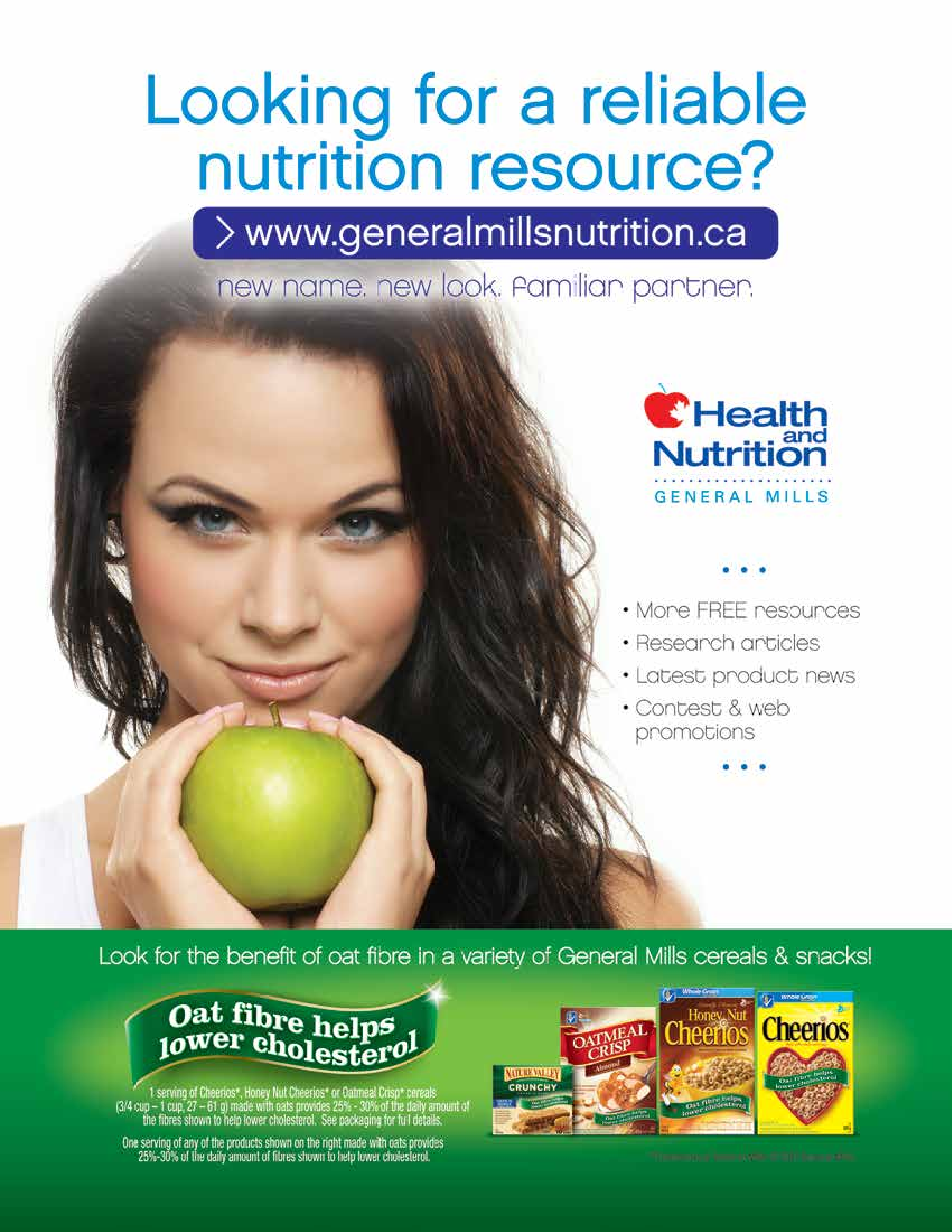
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1 serving of Cheerios*, Honey Nut Cheerios* or Oatmeal Crisp* cereals (3/4 cup – 1 cup, 27 – 61 g) made with oats provides 25% - 30% of the daily amount of the fibres shown to help lower cholesterol. See packaging for full details.
One serving of any of the products shown on the right made with oats provides 25%-30% of the daily amount of fibres shown to help lower cholesterol.
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