Is Screening for Atrial Fibrillation in Canadian Family Practices Cost-Effective in Patients 65 Years and Older?

Jean-Eric Tarride, PhD, a,b,c F. Russell Quinn, MD, PhD, d Gord Blackhouse, MSc, MBA, a,b Roopinder K. Sandhu, MD, MPH, e Natasha Burke, MSc, a,b David J. Gladstone, MD, PhD, f Noah M. Ivers, MD, PhD, g Lisa Dolovich, PharmD, h Andrea Thornton, BSc, i Juliet Nakamya, PhD, j Chinthanie Ramasundarahettige, MSc, i Paul A. Frydrych, MD, j Sam Henein, MD, k Ken Ng, MD, l Valerie Congdon, MD, m Richard V. Birtwhistle, MD, n Richard Ward, MD, o and Jeffrey S. Healey, MSc, MD p

ABSTRACT

We present an economic evaluation of a recently completed cohort study in which 2054 seniors were screened for atrial fibrillation (AF) in 22 Canadian family practices. Using a Markov model, trial and literature data were used to project long-term outcomes and costs associated with 4 AF screening strategies for individuals aged 65 years or older: no screening, screen with 30-second radial manual pulse check (pulse check), screen with a blood pressure machine with AF detection (BP-AF), and screen with a single-lead electrocardiogram (SL-ECG). Costs and outcomes were discounted at 1.5% and the model used a lifetime horizon from a public payer perspective. Compared with no screening, screening for AF in Canadian family practice offices using pulse check or screen with a blood pressure machine with AF detection is the dominant strategy whereas screening with SL-ECG is a highly cost-effective strategy with an incremental cost per quality-adjusted life-year (QALY) gained of CAD$4788. When different screening strategies were compared, screening with pulse check had the lowest lifetime horizon from a public payer perspective. Compared with no screening, screening for AF in Canadian family practice offices using pulse check or screen with a blood pressure machine with AF detection is the dominant strategy whereas screening with SL-ECG is a highly cost-effective strategy with an incremental cost per quality-adjusted life-year (QALY) gained of CAD$4788. When different screening strategies were compared, screening with pulse check had the lowest

RÉSUMÉ

Nous présentons une évaluation économique d’une étude de cohorte récemment effectuée dans laquelle 2054 personnes âgées ont passé un examen de dépistage de la fibrillation auriculaire (FA) dans 22 cabinets de médecine familiale canadiens. À l’aide d’un modèle de Markov, nous avons utilisé les données des essais cliniques et de la littérature médicale pour faire des projections à long terme des résultats et des coûts de quatre stratégies de dépistage de la FA chez les personnes âgées de 65 ans et plus : aucun dépistage, dépistage par vérification manuelle du pouls pendant 30 secondes (vérification du pouls), dépistage à l’aide d’un tensiomètre permettant de détecter la FA, et dépistage par électrocardiogramme à dérivation unique (ECG-DU). Les coûts et les résultats ont été actualisés de 1.5 %, et l’horizon temporel utilisé par le modèle était celui de la vie entière du point de vue d’un payeur public. Comparativement à l’absence de dépistage, le dépistage de la FA dans les cabinets de médecine familiale canadiens par vérification du pouls ou à l’aide d’un tensiomètre permettant de
dépistage. Atrial fibrillation (AF) is one of the leading causes of stroke but is often undiagnosed. Screening programs to identify undiagnosed or undertreated AF might lead to treatment with oral anticoagulation therapy, which can decrease the risk of ischemic stroke. To fill a gap in the literature (see the Supplemental Introduction section of the Supplementary Material) and to inform Canadian decision-makers, physicians, and patients, we
expected costs ($202) and screening with SL-ECG had the highest expected costs ($222). The no-screening arm resulted in the lowest number of QALYs (8.74195) whereas pulse check and SL-ECG resulted in the highest expected QALYs (8.74362). Probabilistic analysis confirmed that pulse check had the highest probability of being cost-effective (63%) assuming a willingness to pay of $50,000 per QALY gained. Screening for AF in seniors during routine appointments with Canadian family physicians is a cost-effective strategy compared with no screening. Screening with a pulse check is likely to be the most cost-effective strategy.

describe an economic evaluation of the recently completed Program for the Identification of “Actionable” Atrial Fibrillation in the Family Practice Setting (PIAAF-FP), a cohort study involving 2054 seniors screened for AF in 22 Canadian family practices using 3 screening strategies.\(^1\) The mean age of the cohort was 73.7 years and 47% were male. Approximately 60% had hypertension and 28% diabetes. There were lower rates of previous stroke/transient ischemic attack/systemic embolism (7%), myocardial infarction (7%), and heart failure (3%). Almost two-thirds (64%) had a Congestive Heart Failure, Hypertension, Age (≥75 years), Diabetes, Stroke/Transien Ischemic Attack, Vascular Disease, Age (65-74 years), Sex (Female) (CHA\(_D\)S\(_2\)-VASc) score ≥ 3. The key findings indicated that 0.7% of participants had undiagnosed or undertreated AF. Single-lead electrocardiogram (SL-ECG) or automated blood pressure device was found to be more specific than a pulse check, with 72% and 48% fewer false positive tests, respectively. The objectives of the economic evaluation were twofold: (1) evaluate the costs and outcomes associated with screening AF in physician practices compared with no screening; and (2) compare several different AF screening strategies in physician offices.

Methods
This economic study evaluated the long-term costs and outcomes of 4 AF screening strategies for individuals aged 65 years or older in the family practice setting: (1) no screening; (2) screen with 30-second radial pulse check (pulse check); (3) screen with a blood pressure machine with AF detection algorithm; and (4) screen with SL-ECG. Data from the PIAAF-FP clinical study\(^1\) were used to determine the AF detection rates and screening costs for the different screening strategies. Information from other published sources was synthesized to project long-term outcomes and costs. As recommended by the Canadian guidelines for the conduct of economic evaluations of health care programs,\(^7\) outcomes were expressed in quality-adjusted life-years (QALYs) to incorporate mortality and morbidity effects of interventions. The reference case was taken from a public payor perspective and used a lifelong time horizon. Costs and QALYs were discounted at a rate of 1.5% annually.\(^2\) Probabilistic analyses (all model inputs are changed simultaneously using Monte Carlo simulations) and deterministic sensitivity analyses (changing the value of a single parameter at the time while holding all the other model inputs constant) were used to test the effect of changes in assumptions on results. Parameter uncertainty around the base case results were expressed using cost-effectiveness acceptability curves, which show the probability that each screening strategy is cost-effective across different willingness-to-pay thresholds. The model builds on a previous methodology developed to evaluate the cost-effectiveness of AF screening in the Canadian pharmacy setting.\(^4\) More information on the study methods are shown in the Supplementary Methods section of the Supplementary Material, Supplemental Figures S1 and S2 and Supplemental Tables S1 and S2.

Results
The results indicate that screening for AF in Canadian family practices is either the dominant strategy or a very cost-effective strategy as shown in Table 1. Screening with pulse check is less costly and produces more QALYs compared with no screening and is therefore dominant. Similarly, screening with a blood pressure machine with an AF detection algorithm is dominant compared with no screening. The incremental cost per QALY gained of SL-ECG compared with no screening is CAD54788 (Supplemental Table S3). These results did not change in various sensitivity analyses (Supplemental Table S4).

When the different strategies were simultaneously compared, screening with pulse check had the lowest lifetime expected costs ($202) whereas screening with SL-ECG had the highest expected costs ($222). The no-screening arm resulted in the lowest number of QALYs (8.74195) whereas pulse check and SL-ECG screening resulted in the highest expected QALYs (8.74362). Because screening with pulse check is the strategy with the lowest cost and has higher or equal effectiveness compared with all other strategies, it is dominant in terms of cost-effectiveness. The second most cost-effective strategy is screening using SL-ECG followed by blood pressure monitoring and no screening. This is illustrated in Figure 1, which...
Table 1. Base case cost-effectiveness analysis (CAD$)

<table>
<thead>
<tr>
<th>No screen</th>
<th>PC</th>
<th>BP-AF</th>
<th>SL-ECG</th>
<th>Incremental costs</th>
<th>Incremental QALYs</th>
</tr>
</thead>
<tbody>
<tr>
<td>$214.2</td>
<td>$202.48</td>
<td>$211.03</td>
<td>$222.18</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>8.74195</td>
<td>8.74362</td>
<td>8.74301</td>
<td>8.74362</td>
<td>$11.73</td>
<td>$3.18</td>
</tr>
<tr>
<td>Reference</td>
<td>0.00166</td>
<td>0.00106</td>
<td>0.00166</td>
<td>$8.92</td>
<td>$9.15</td>
</tr>
</tbody>
</table>

**Cost QALYs Incremental costs Incremental QALYs vs no Screen**

<table>
<thead>
<tr>
<th>No screen</th>
<th>PC</th>
<th>BP-AF</th>
<th>SL-ECG</th>
<th>Reference</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>$214.2</td>
<td>$202.48</td>
<td>$211.03</td>
<td>$222.18</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>8.74195</td>
<td>8.74362</td>
<td>8.74301</td>
<td>8.74362</td>
<td>$11.73</td>
<td>$3.18</td>
</tr>
<tr>
<td>Reference</td>
<td>0.00166</td>
<td>0.00106</td>
<td>0.00166</td>
<td>$8.92</td>
<td>$9.15</td>
</tr>
</tbody>
</table>

* These analyses compare each of the 3 AF screening strategies vs no screening.

$1All strategies are compared simultaneously. Because the no screening strategy is the least expensive and has the lowest number of QALYs it is the reference. If one single strategy had to be chosen among the 4, PC would be the optimal strategy regardless of willingness to pay for a QALY because it dominates all other strategies.

presents the multiple cost-effectiveness acceptability curves for the 4 strategies evaluated when taking into account the uncertainty around the model inputs. If the maximum willingness-to-pay per QALY is $50,000, then screening with pulse check has the highest probability of being the most cost-effective strategy (63%) followed by screening with SL-ECG (25%). In all of the simulations, the no-screening strategy is always the worst alternative, resulting in the highest costs and lowest benefits (ie, QALYs). More results are presented in the Supplemental Results section of the Supplementary Material, and Supplemental Tables S4 and S5 and Supplemental Figure S3.

**Discussion**

Consistent with previous studies, our results indicate that screening for AF in seniors during routine appointments with family physicians is a cost-effective strategy compared with no screening. However, very few economic studies have directly compared different AF screening strategies and none in the Canadian setting (see the Supplemental Discussion section of the Supplementary Material for a comparison of our results with the international literature). In this PIAAF-FP study involving more than 2000 Canadian seniors, pulse check and single lead-ECG had the same detection rate for actionable AF (ie, 0.54%) followed by blood pressure monitor (ie, 0.43%). Considering that pulse check is the least expensive alternative with the highest detection rate, pulse check dominates the other alternatives. This holds true even taking into account the fact that this test is less specific, with more false positive results and hence more confirmatory testing. Our results indicate that that pulse check has the highest probability of being cost-effective followed by single-lead ECG, blood pressure monitoring, and no screening.

Our economic evaluation has a number of limitations, which should be taken into consideration when interpreting these results. First, the extrapolation of detection rates on long-term outcomes were driven by predictions of AF-related events (eg, ischemic strokes) and not on observed data. Additionally, some of the sources used for the extrapolation of outcomes might have had different population characteristics than the current study. For example, the Swedish registry study used for the estimates of stroke and major bleeding focused on AF patients diagnosed in the hospital as opposed to our community-based cohort. However, any differences in the population characteristics should have had a minimal effect on our results because the risk of stroke in our evaluation was adjusted to the CHA2DS2-VASc score observed in the PIAAF-FP study. Although our modelling approach was on the basis of actionable AF detection rates observed in this Canadian study, this PIAAF-FP study has its own limitations. For example, patients in the study were screened at a single time point. Because of this, cases of paroxysmal AF likely were missed, which could have led to an underestimate of actionable AF detection rates for the 3 screening methods. Additionally, because the analysis assumed that screening would occur at a single time point, the economic effect of repeat screenings every year or every 5 years was not incorporated. All of these limitations could affect the estimates of relative cost-effectiveness between different AF screening methods in physicians’ offices. To deal with the uncertainty with the model parameters, sensitivity analyses were conducted and results indicated that the findings were robust to change in assumptions. Because this economic evaluation was on the basis of the FIAAP-FP trial we were not able to evaluate other methods of monitoring such as implantable devices (eg, LINQs [Medtronic, Minneapolis, MN], cardioMEMS [St Jude Medical (now Abbott), St Paul, MN], or ZIO patch [iRhythm Technologies, Inc, San Francisco, CA]) or patient devices (eg, Fitbit [Fitbit, San Francisco, CA] or iWatch [Apple, Cupertino, CA]). This is left for future research.

Figure 1. Cost-effectiveness acceptability curves. AF, atrial fibrillation; BP-AF, blood pressure machine with AF detection algorithms; QALY, quality-adjusted life-year; screen-BP-AF, screen with a blood pressure machine with AF detection algorithm; screen-PC, screen with 30-second radial pulse check; screen-SL-ECG, screen with single-lead electrocardiogram.
Another area of future research is to investigate if pulse check could be expanded to be used by individual patients. It should also be acknowledged that although we used the term, “screening for AF” in our article, we did not screen the general population. Rather, we opportunistically screen seniors who present at their physician offices, a process that has also been referred to as “case finding” (eg, testing of patients who have sought health care for something that might not be related to AF).

In conclusion, from a policy point of view, the results of this Canadian economic evaluation combined with the international literature shows that there is strong evidence to support the implementation of opportunistic AF screening in family practices because it saves money and improves health outcomes.

**Funding Sources**

The PIAAF-FP study was supported by the Canadian Stroke Prevention Intervention Network, Boehringer Ingelheim, and in-kind support from CardioComm and ManthaMed. R.K.S. received a grant from the University Hospital Foundation. J.S.H. has a Personnel Award from the Heart and Stroke Foundation, Ontario Provincial office (MC7450). N.M.I. holds a Canadian Institutes of Health Research New Investigator Award in Community Based Primary Health Care and a Clinician Scientist award from the Department Family and Community Medicine, University of Toronto. This research is supported in part by the University of Toronto Practice-Based Research Network.

**Disclosures**

Dr Quinn reports consulting fees from Boehringer Ingelheim, Servier, and Bayer, and has research grants from Boehringer Ingelheim and Bayer. Dr Birtwhistle reports research funding from Eli Lilly, Shire Pharmaceuticals, Merck, and Pfizer. Dr Healey reports consulting fees from Bayer, Boehringer Ingelheim, Pfizer, Bristol-Myers Squibb, and has research grants from Boehringer Ingelheim, Bayer, Pfizer, and Bristol-Myers Squibb. The remaining authors have no conflicts of interest to disclose.

**References**


**Supplementary Material**

To access the supplementary material accompanying this article, visit the online version of the Canadian Journal of Cardiology at www.onlinejc.ca and at https://doi.org/10.1016/j.cjca.2018.05.016.