Canadian Journal of Cardiology 31 (2015) 314–319

## Clinical Research

# Cost Implication of an Early Invasive Strategy on Weekdays and Weekends in Patients With Acute Coronary Syndromes

Andre Lamy, MD, MHSc,[a,b,c,d] Wesley R. Tong, BSc,[a,b] Kevin Bainey, MD, MSc,[e] Amiram Gafni, PhD,[d,f] Purnima Rao-Melacini, MSc,[a] and Shamir R. Mehta, MD, Msc[a,g]

[a] *Population Health Research Institute, McMaster University, Hamilton, Ontario, Canada*

[b] *CADENCE Research Group, Hamilton Health Sciences, Hamilton, Ontario, Canada*

[c] *Department of Surgery, McMaster University, Hamilton, Ontario, Canada*

[d] *Department of Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, Ontario, Canada*

[e] *Mazankowsi Alberta Heart Institute, University of Alberta, Edmonton, Alberta, Canada*

[f] *Centre for Health Economics and Policy Analysis, McMaster University, Hamilton, Ontario, Canada*

[g] *Department of Medicine, McMaster University, Hamilton, Ontario, Canada*

***See editorial by Rinfret and Potter, pages 250-252 of this issue.***

## ABSTRACT

**Background:** Early invasive intervention is associated with shorter length of stay (LOS) and similar outcomes in a delayed strategy in lower-risk patients with non-ST segment elevation acute coronary syndromes (NSTEACS), but is superior in higher-risk patients. However, early invasive intervention might be constrained by the need to mobilize the on-call team on weekends. We evaluated costs associated with an early vs delayed invasive intervention strategy, including patients who present on weekends.

**Methods:** Health care utilization was extracted from the **Tim**ing of Intervention in **A**cute **C**oronary **S**yndromes (TIMACS) trial for Canadian patients from case report forms. Only direct costs were considered and only hospitalization events were included. Canadian unit costs were applied to health care resources consumed for all patients. Sensitivity and subgroup analyses were performed.

**Results:** Early invasive intervention reduced LOS costs by $2808 (95% confidence interval [CI], $4,629-$987). Total costs per Canadian patient for early invasive intervention were $16,579 (95% CI, $14,949-$18,209) compared with $19,517 (95% CI, $17,897-$21,136) for the delayed invasive approach. This resulted in a savings of $2938 (95%

## RÉSUMÉ

**Introduction :** L'intervention effractive précoce est associée à une durée de séjour (DS) plus courte et la stratégie d'intervention différée à des résultats similaires chez les patients souffrant de syndromes coronariens aigus (SCA) sans sus-décalage du segment ST exposés à un risque plus faible, mais elle est supérieure chez les patients exposés à un risque plus élevé. Cependant, l'intervention effractive précoce serait limitée par la nécessité de mobiliser l'équipe sur appel durant les fins de semaine. Nous avons évalué les coûts associés à la stratégie d'intervention effractive précoce *vs* la stratégie d'intervention effractive différée, y compris pour les patients qui se présentent les fins de semaine.

**Méthodes :** Les données sur l'utilisation des soins de santé étaient extraites de l'essai TIMACS (**Tim**ing of Intervention in **A**cute **C**oronary **S**yndromes) sur les patients canadiens à partir des formulaires d'exposés de cas. Seuls les coûts directs étaient considérés et seuls les cas d'hospitalisation étaient inclus. Les coûts unitaires canadiens étaient appliqués aux ressources en soins de santé consommées pour les patients. Les analyses de sensibilité et par sous-groupes étaient réalisées.

In patients with non-ST segment elevation acute coronary syndromes (NSTEACS) a routine invasive strategy is superior to a selective invasive strategy in reducing major cardiovascular events over the long-term.[1,2] To identify the optimal timing of invasive intervention, the **Tim**ing of Intervention in **A**cute **C**oronary **S**yndromes (TIMACS) study randomized 3031 patients with NSTEACS to early (within 24 hours) or delayed (after 36 hours) coronary angiography and intervention. It showed that the primary outcome of cardiovascular death, myocardial infarction (MI), or stroke was similar for an early invasive strategy (coronary angiography and intervention within the first 24 hours) and a delayed invasive strategy. However, in patients at higher risk of ischemic events (defined according to a **G**lobal **R**egistry of **A**cute **C**oronary **E**vents [GRACE] score $\geq$ 140), early invasive intervention was superior to a delayed strategy. In addition, the composite secondary outcome of death, MI, or refractory ischemia was reduced in the overall population.

Received for publication October 2, 2014. Accepted November 27, 2014.

Corresponding author: Dr Andre Lamy, General Campus, DBCVSRI C1-112, 237 Barton St E, Hamilton, Ontario L8L 2X2, Canada. Tel.: +1-905-522-0175; fax: +1-905-522-2029.

E-mail: lamya@mcmaster.ca

See page 319 for disclosure information.

http://dx.doi.org/10.1016/j.cjca.2014.11.025

CI, $5236-$640). Findings were confirmed using bootstrap simulation. Sensitivity analyses confirmed savings regardless of proportion of cases done on weekends. All subgroup costs favoured early intervention.

**Conclusions:** Early invasive strategy was cost-saving, even on weekends, for Canadian NSTEACS patients because of significant LOS savings. Because many high-risk NSTEACS patients receive delayed intervention because of weekend catheterization laboratory status, these findings support opening catheterization laboratories on weekends to facilitate the use of early invasive intervention.

**Résultats :** L'intervention effractive précoce réduisait les coûts de la DS de 2808 $ (intervalle de confiance [IC] à 95 %, 4629 $-987 $). Les coûts totaux de l'intervention effractive précoce par patient canadien étaient de 16 579 $ (IC à 95 %, 14 949 $-18 209 $) comparativement à ceux de l'approche effractive différée qui étaient de 19 517 $ (IC à 95 %, 17 897 $-21 136 $). Cela entraînait une réduction de 2938 $ (IC à 95 %, 5236 $-640 $). Les résultats étaient confirmés à l'aide de la simulation d'autoamorçage. Les analyses de sensibilité confirmaient les économies, quelle que soit la proportion de cas les fins de semaine. Tous les coûts des sous-groupes favorisaient l'intervention précoce.

**Conclusions :** La stratégie effractive précoce réduisait les coûts associés aux patients canadiens souffrant de SCA sans sus-décalage du segment ST, même les fins de semaine, en raison des économies importantes sur la DS. Puisque plusieurs patients souffrant de SCA sans sus-décalage du segment ST exposés à un risque élevé subissent une intervention différée en raison de la non-disponibilité des laboratoires de cathétérisme la fin de semaine, ces résultats appuient l'ouverture des laboratoires de cathétérisme les fins de semaine pour faciliter l'utilisation de l'intervention effractive précoce.

The Canadian health care system operates in an environment that must constantly find new ways to make health care delivery more efficient. Because of the inherent shorter length of stay associated with early invasive procedures within 24 hours there will be definite cost savings from an early invasive strategy, but it is possible that use of a catheterization laboratory on days when they are normally not in use (ie, weekends) might negate the savings of early intervention.

In this study, we estimated the costs of early and delayed invasive strategies in the TIMACS trial from a Canadian perspective to investigate whether the savings from a shorter length of stay are worth the additional operating costs for catheterization laboratories. Understanding the cost implications would benefit decision-makers who are in charge of catheterization laboratories that do not operate on weekends.

## Methods

### Clinical trial

The TIMACS trial was a randomized, parallel-group, multicentre study that enrolled 3031 patients from 18 countries. The design and main results of the TIMACS study have been published.[3] Patients who presented to the hospital with unstable angina or MI without ST segment elevation within 24 hours from symptom onset had to have 2 of the 3 following high-risk criteria to be eligible: age 60 years or older, increased cardiac biomarkers above the upper limit of normal, or electrocardiogram changes consistent with ischemia (ST segment depression of $\geq$ 1 mm or transient ST segment elevation or T-wave inversion of $>$ 3 mm).

Of all of the patients who were recruited, 1593 were randomized to the early invasive group in whom coronary angiography was performed within 24 hours (median time of 14 hours). The remaining 1438 patients were randomized to the delayed invasive group in whom coronary angiography was performed at a minimum of 36 hours (median time, 50 hours). Revascularization was attempted in the 2 groups if at least 1 coronary stenosis considered hemodynamically significant was suitable for intervention. Clinical follow-up occurred over 6 months. All patients received conventional therapy regardless of treatment allocation. Treatments included aspirin, adenosine-diphosphate (ADP) receptor antagonists, β-blockers, angiotensin converting enzyme inhibitors, and statin therapy. All cost comparisons were based on an early vs delayed invasive strategy. The clinical results of the TIMACS trial are shown in Table 1. Clinical results for Canadian patients are similar with the direction of the overall TIMACS trial.

### Cost analysis and health care utilization

In this analysis we chose to investigate the results from a Canadian health care system perspective and thus only included patients from Canada. There were 479 patients who met this criteria; 238 in the early strategy group and 241 in the delayed strategy group.

For Canadian patients who participated in the TIMACS trial, we hypothesized an early invasive strategy would be either cost-neutral or cost-saving compared with a delayed approach. Thus the cost analysis was performed in a manner consistent with the underlying assumptions of the trial. Although a perspective that encompassed the effect on society and the health care costs should have been used, we were unable to include societal costs because these data were not collected as part of the trial. However, because it is not unreasonable to assume that a longer length of stay would be associated with higher societal costs, the exclusion of societal costs in our analysis favoured the delayed invasive intervention arm.

Health care utilization for each patient was extracted from the study case report forms. We obtained and assigned Canadian unit costs to health care resources consumed for each hospitalization, procedure, diagnostic procedure, and study percutaneous coronary intervention (PCI) procedures for patients from Canada. Nonstudy drug costs were also included. Unit costs were applied to utilization data of individual patient services to arrive at a cost per patient, and then averaged within each treatment group (early vs delayed).

### Health care utilization

Health care utilization involved documenting the resources that were consumed by patients who received early coronary