Delivery of primary percutaneous coronary intervention for the management of acute ST segment elevation myocardial infarction: Summary of the Cardiac Care Network of Ontario Consensus Report

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M Labinaz, T Swabey, R Watson, et al. Delivery of primary percutaneous coronary intervention for the management of acute ST segment elevation myocardial infarction: Summary of the Cardiac Care Network of Ontario Consensus Report. Can J Cardiol 2006;22(3):243-250.

Tremendous debate has developed over the efficacy of primary percutaneous coronary intervention (PCI) compared with fibrinolysis as the preferred treatment for acute ST segment elevation myocardial infarction (STEMI). In 2002, the Ontario Ministry of Heath and Long-Term Care commissioned the Cardiac Care Network of Ontario to develop consensus recommendations regarding the provincial coordination and provision of urgent PCI for STEMI patients. The panel's work has provided important insights into the acute treatment of STEMI that may be useful to other jurisdictions and may provide a reference for other regions considering the implementation of primary PCI for the management of STEMI patients in their community. In the present report, the evidence for primary PCI is reviewed, the important barriers to implementing this strategy are summarized and several recommendations and models of care for the delivery of primary PCI for STEMI on a wide scale are presented.

Key Words: *Angioplasty; Canadian health system; Myocardial infarction*

La prestation d'une intervention coronaire percutanée primaire dans la prise en charge d'un infarctus du myocarde par surélévation aiguë du segment ST : Sommaire du rapport consensuel du Réseau de soins cardiaques de l'Ontario

Une énorme controverse a été soulevée sur l'efficacité de l'intervention coronaire percutanée (ICP) primaire par rapport à la fibrinolyse comme traitement de choix de l'infarctus du myocarde par surélévation aiguë du segment ST (IMSST). En 2002, le ministère de la Santé et des Soins de longue durée de l'Ontario a demandé au Réseau des soins cardiaques de l'Ontario d'élaborer des recommandations consensuelles quant à la coordination et aux dispositions provinciales en matière d'ICP urgentes pour les patients atteints d'un IMSST. Les travaux du réseau ont donné d'importants aperçus du traitement aigu de l'IMSST qui pourraient être utiles dans d'autres territoires et servir de référence à d'autres régions envisageant l'implantation d'ICP primaires pour prendre en charge les patients atteints d'un IMSST dans leur collectivité. Dans le présent compte rendu, les données justifiant une ICP primaire sont analysées, les principaux obstacles à l'implantation de cette stratégie sont résumés et plusieurs recommandations et modèles de soins à large échelle sont présentés pour la prestation d'ICP primaires en cas d'IMSST.

Tremendous debate has recently developed over the use of primary percutaneous coronary intervention (PCI) compared with fibrinolysis as the preferred treatment for acute ST segment elevation myocardial infarction (STEMI) (1-5). As a result, health care administrators, providers and funders have sought clarification on this important issue. In 2002, the Ontario Ministry of Health and Long-Term Care ('the Ministry') commissioned the Cardiac Care Network (CCN) of Ontario to develop consensus recommendations regarding the provincial coordination and provision of urgent PCI for STEMI patients. A dedicated panel of clinical and administrative staff was created to provide the following key deliverables:

- Perform a literature review of existing guidelines for the interventional component of the treatment of acute myocardial infarction (MI);
- Examine the provision and coordination of urgent PCI in other jurisdictions to determine the applicability and implications for implementation in Ontario;
- Define a model for the provision of urgent PCI in Ontario; and
- Identify resource implications of a coordinated urgent PCI model.

The panel was comprised of interventional cardiologists, general cardiologists from the community, emergency room physicians, hospital administrators, regional cardiac care coordinators, managers and medical directors of emergency ambulance services, and representatives from the CCN and the Ministry (their names are listed in the appendix at the end of the present report). The panel met on numerous

Please note that a complete list of all panel members can be found in the appendix

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Received for publication May 26, 2006. Accepted October 5, 2006.

occasions over a one-year period. Detailed surveys of stakeholders were performed, including all acute care hospitals in Ontario (hospitals with and without on-site cardiac catheterization and interventional facilities), managers of Ontario Emergency Medical Services (EMS) and EMS base hospitals, and other jurisdictions in Canada. Several organizations also provided written submissions of interest. The recommendations underwent extensive secondary review by over 20 individuals from across the country and was ultimately reviewed and approved by the CCN Clinical Services Committee and the Board of Directors.

The panel's work has provided important insights into the acute treatment of STEMI that may be useful to other jurisdictions and may provide a reference for other regions considering the implementation of primary PCI into the management of STEMI patients in their community.

LITERATURE REVIEW

Many detailed literature reviews on the management of STEMI have recently been published, including the American Heart Association/American College of Cardiology guidelines on the treatment of STEMI (6,7). Rather than repeat all of these excellent reviews, the present report focuses on a discussion of the data regarding acute reperfusion therapy for STEMI.

Fibrinolytic therapy significantly decreases the morbidity and mortality of STEMI; however, it has evident limitations, including the lack of timely reperfusion in nearly 40% of patients, as well as hemorrhagic complications, such as intracranial hemorrhaging, recurrent infarction and recurrent ischemia (8-16). PCI is an effective method of treating focal coronary stenosis and has been used to treat acute STEMI for a number of years (17-21). Recent advances in PCI have yielded improved outcomes compared with earlier experiences, and has led to a total of 23 randomized trials comparing primary PCI with fibrinolytic therapy for acute STEMI between 1990 and 2003 (22). Due to the generally small number of patients in each trial, several meta-analyses have been performed. Outcomes with primary PCI have consistently been superior to those achieved with fibrinolytic therapy. For example, primary PCI, when compared with fibrinolytic therapy, was associated with a lower mortality (5% versus 7%, respectively; P=0.0003), lower nonfatal reinfarction (3% versus 7%; P<0.0001), less stroke (1% versus 2%, respectively; P=0.0004), less hemorrhagic stroke (0.05% versus 1%, respectively; P<0.0001), and a lower composite of death, reinfarction and stroke (8% versus 14%, respectively; P<0.0001) at four to six weeks follow-up. The superiority of PCI over fibrinolysis was evident at longer follow-up (six to 18 months), regardless of whether the fibrinolytic agent was streptokinase or fibrin-specific (22). Overall, it is estimated that 23 fewer deaths, 42 fewer nonfatal reinfarctions and 11 fewer strokes per 1000 patients treated would occur with a dominant primary PCI strategy rather than a fibrinolytic strategy.

Another important strategy that has shown promise in treating patients with STEMI is prehospital fibrinolysis (23,24). The Comparison of Angioplasty and Prehospital Thrombolysis in Acute Myocardial Infarction (CAPTIM) trial randomly assigned patients either to prehospital fibrinolysis with accelerated tissue plasminogen activator administered by physicians in the ambulances followed by transfer to a PCI hospital or to immediate transfer for primary PCI (25). A total of 26% of the patients in the fibrinolytic group received rescue PCI, higher than any other published acute reperfusion trial. This study was stopped early and, although no statistical difference in outcomes was observed between the two groups, it was found that patients treated with primary PCI tended to have a lower composite of death, recurrent MI and stroke. Unfortunately, the model of care in the CAPTIM trial is not available in most jurisdictions. Two other recent studies, the Assessment of the Safety and Efficacy of a New Thrombolytic Regimen (ASSENT)-3 PLUS trial (26) and the Early Retavase-Thrombolysis in Myocardial Infarction (ER-TIMI)-19 trial (27), showed that it is feasible to significantly reduce the time to treatment with fibrinolysis by prehospital therapy. Additional studies will be required to determine whether prehospital fibrinolysis is associated with improved clinical outcomes.

A subgroup of patients that may warrant particular attention are those who present very early after symptom onset (ie, less than 2 h). In a meta-analysis of trials comparing fibrinolysis with placebo (28), the greatest reduction in mortality was achieved in patients receiving fibrinolysis within 2 h of symptom onset. A recent subgroup analysis of the CAPTIM trial found lower mortality in patients treated within 2 h with fibrinolysis than in patients treated with primary PCI (2.2% versus 5.7%, respectively; P=0.04) (29). Although this study may suggest that the advantage of PCI during the very early hours after symptom onset is less clear, it must be recognized that this interesting, retrospective, post hoc observation was noted in a relatively small number of selected patients, and additional confirmation by further prospective randomized trials is needed.

Of note, five trials have compared on-site fibrinolytic therapy with emergency hospital transfer for primary PCI, which is of particular relevance because only 10% to 20% of Ontarians present to hospitals with on-site interventional facilities (30-35). Despite the delay inherent in transfer (average of 39 min), these studies found a trend toward lower mortality and a significant reduction in nonfatal MI, total stroke and the combined end points of death, nonfatal reinfarction and stroke, such that 53 deaths, nonfatal reinfarctions or strokes per 1000 patients treated could be prevented if patients were transferred for primary PCI. However, some have criticized the results of the largest of these transfer trials, the Danish Multicenter Randomized Study on Fibrinolytic Therapy versus Acute Coronary Angioplasty in Acute Myocardial Infarction (DANAMI)-2 (32). Some of the issues raised included the following: the fact that only 37% of screened patients were randomly assigned; those considered high risk for transfer were excluded; and the fact that higher heparin doses, readministration of fibrinolytics and inclusion of patients with prior stroke may have marginally increased the incidence of stroke in the group treated with fibrinolytics (36-38).

In addition to the clinically superior outcomes associated with primary PCI compared with on-site fibrinolysis, recent data from a Canadian study showed that the former therapy also resulted in a net cost savings of over $3000 per patient treated (39). The cost savings were derived by avoiding the use of an expensive fibrinolytic agent, as well as shorter hospitalizations and fewer post-MI complications.

The most important prerequisite needed to ensure success with primary PCI is that experienced operators in a large volume institution perform the procedure in a timely fashion. The importance of time was emphasized in an analysis that confirmed that primary PCI is superior to fibrinolysis with respect to mortality when the time differential between the two procedures is less than 62 min, and that primary PCI

TABLE 1
Barriers to access for emergency primary percutaneous coronary intervention (PCI) for acute myocardial infarction (MI)

Category	Description
Provincial policy and standards	Lack of a provincial policy or standard for acute reperfusion therapy in acute MI patients, resulting in considerable variation in practice patterns and patient access to primary PCI among hospitals.
Central coordination and communication	Lack of a coordinated approach to service delivery, including centralized and coordinated communication among referring hospitals, PCI hospitals and emergency medical services.
Patient referral and transfer process	Lack of an organized network and broadly accepted protocols for referral, transfer and repatriation within that network.
	Municipal emergency medical service boundaries create structural barriers for patient transfer across boundaries.
	Variable levels of emergency medical services between municipalities.
	An insufficient number of vehicles and appropriately trained paramedics to support the acute reperfusion care requirements of acute MI patients and their repatriation.
Human resources	Insufficient human resources at PCI hospitals to support a 24 h a day/seven days a week primary PCI policy.
	Insufficient skills/training at some referring hospitals to provide an appropriate level of care for repatriated patients.
Physical resources	Insufficient coronary care unit beds to accommodate extra cases at PCI hospitals and telemetry beds at referring hospitals for repatriated patients.
Geographical and environmental factors	Large travel distances between referring and PCI hospitals.
	Uncontrolled transport delays due to climate and/or geography.

results in less death, nonfatal reinfarction and stroke when this time differential is less than 90 min (40-42). Several studies have highlighted the inverse relationship between hospital and operator volumes and mortality for patients treated with primary PCI (43-45). Canto et al (46) found a 28% mortality difference between hospitals with the highest and lowest primary PCI volume. High-volume hospitals were defined as those hospitals performing more than 35 primary PCI procedures per year. In addition, these investigators observed a 57% relative risk reduction among patients who underwent primary PCI by high-volume operators compared with low-volume operators at these hospitals. Due to the centralization of services in Ontario, these minimum volume standards are easily satisfied. However, these minimum volume standards must be considered before the development of new PCI facilities across the province.

Rescue PCI is also an important treatment strategy for patients who have failed to reperfuse following administration of full dose fibrinolytic therapy. There are no large definitive trials that clearly establish the role of rescue PCI. The first large study, RESCUE-1 (47), found a significantly greater reduction in the composite of death and severe congestive heart failure at 30 days with rescue PCI compared with conservative therapy (16.6% versus 6.4%; P=0.05). Other studies have shown significant reductions in composite end points, including death, reinfarctions, severe congestive heart failure and urgent revascularization (48,49). Therefore, it would appear reasonable to refer patients with a moderate or large MI manifested electrocardiographically or by hemodynamic instability for emergent rescue PCI by an experienced interventional centre. There are much less data for patients with small infarcts or situations where the delay for transfer is prolonged; for these patients, the decision for rescue PCI should be made on a case-by-case basis.

Following detailed review of the available evidence, the panel felt strongly that a strategy of primary PCI performed within appropriate time limits by an experienced team yields reductions in mortality, reinfarctions and stroke, and is likely to be cost effective. The magnitude of the benefits of this strategy support implementation of a provincial strategy.

BARRIERS TO ACCESS

An extensive survey of all hospitals in the province of Ontario, as well as EMS and base hospitals, was conducted. These stakeholders were surveyed with respect to current practice patterns and barriers to access. The panel also reviewed other jurisdictions across Canada. The various surveys can be viewed on the CCN Web site at <www.ccn.on.ca>. All PCI hospitals responded to the survey, as well as 55% of base hospital directors and 58% of all acute care (non-PCI) hospitals. All members of the committee reviewed all responses. Several significant barriers to providing primary PCI for STEMI in Ontario were identified and are summarized in Table 1.

One of the most important identified barriers to providing a primary PCI model was the lack of a provincial standard for acute reperfusion therapy in acute MI patients. It was thought that an explicit policy on primary PCI would help to mobilize the interventional centres, acute care hospitals, municipal EMS and the Ministry to work toward common goals and objectives. The patient referral and transfer process was identified as being complicated and time consuming, and resulted in significant delays. Stakeholders spoke frequently about the need for an organized network and broadly accepted protocols for referrals and transfers within that network; a 'one number to call' system to arrange for transfer was among the most important priorities identified by referring hospitals.

Currently, the availability of ambulances and appropriately trained EMS paramedics is not adequate to support the additional transportation and care requirements of rapidly moving STEMI patients to PCI sites. The issue of repatriation of patients following PCI was identified as an important barrier for receiving hospitals. Many stakeholders identified the lack of available human resources as an important barrier to access. Most of the centres performing PCI identified the need for more catheterization laboratory staff to expand capacity to meet the potential demand for primary PCI and to provide sufficient coverage for off-hours procedures. The largest reported human resource barrier for referring hospitals was the lack of available, trained nurses to accompany the patient during the interfacility transfer. This barrier could be

reduced if EMS was resourced and structured to provide the appropriate level of medical care required for safe patient transportation. Additional coronary care unit (CCU) beds at the PCI hospitals would be required to handle the additional patient load from the communities and the referring hospitals. Financial barriers were also highlighted by many of the hospitals arising from the above-mentioned barriers, and additional funding would be required. Travel distances were identified as an important impediment to the adoption of primary PCI as the dominant strategy for STEMI because only 20% of patients present to hospitals with on-site PCI facilities. In addition, it was recognized that due to the environmental challenges of Ontario's climate, fibrinolytics would still remain an alternative therapy when patient transfer is not possible.

THE RECOMMENDED MODEL OF CARE

The panel developed 17 recommendations for the acute treatment of STEMI based on its extensive review of the literature, survey data, stakeholder consultation and careful deliberation. These recommendations are summarized in Table 2.

The panel believes that to implement a provincial system for the treatment of acute MI, a phased-in approach is required. The first phase requires the development of the supportive infrastructure, while the second phase involves the implementation and development of several integrated service delivery models, which are based on patient presentation. Each model is determined by the location in which a patient presents with acute MI. It is believed that this graduated approach provides an opportunity to fully assess the feasibility and generalizability of the primary PCI model across the different regions of the province.

PHASE I

Regional MI system

As part of the infrastructure development of phase I, a regional MI system should be created similar to the stroke and trauma models in Ontario. Hospitals with PCI capability would serve as regional MI centres, providing primary PCI to hospitals and communities within recommended transfer times, and rescue PCI and cardiogenic shock management for all hospitals within the region. The PCI centres and referring hospitals would work together in the development of common treatment algorithms, care maps and transfer protocols for STEMI. The program should be as comprehensive as possible, spanning from patient education to early diagnosis to acute transfer for revascularization to early post-MI care and cardiac rehabilitation. To ensure a common standard of care for STEMI, standard patient care maps would have to be developed on a provincial level, with local adaptations reflecting the unique circumstances of each community.

EMS

The enhancement of the Ontario EMS is a second critical infrastructure requirement to ensure the timely, reliable and appropriate transportation of the acute MI patient. Improvements in both interfacility transfers and the repatriation process would be required. Additional education of current paramedics, enhancements of protocols and an increased number of units would need to be developed and resourced.

Treatment of STEMI patients at PCI centres 24 h a day/seven days a week

Before implementing a model for primary PCI for referred-in or transferred patients, all PCI sites should be structured and resourced to enable them to provide 100% primary PCI to patients presenting at their hospitals with STEMI on a 24 h a day/seven days a week basis, with a target 'door-to-balloon time' of 90 min or less. The key elements of this model include timely assessment of STEMI, direct notification of the interventional cardiologist and direct patient transfer to the catheterization laboratory without delays imposed by arranging a CCU bed. Ideally, the CCU bed should be de-linked from the availability of the catheterization laboratory by the creation of dedicated and funded 'STEMI beds'.

PHASE II

The majority of patients in Ontario with acute STEMI (approximately 80%) do not present initially to a PCI centre. Therefore, there has been tremendous interest in developing primary PCI algorithms for these patients. Phase II involves the implementation and piloting of two models of patient transfer for primary PCI. Although the pilot studies will provide important preliminary information, local adaptation will be required to address the various diverse issues across the province. The models encompass patients transferred to PCI centres from other acute care hospitals and patients transferred from the community. A comprehensive system to support transferred-in patients must encompass both scenarios. It is important that the receiving PCI hospitals have a functioning 24 h a day/seven days a week primary PCI model in place before implementing a program for transfer patients.

The success of both of these paradigms is contingent on efficient and rapid patient transport, which can be influenced by several factors. An initial prompt assessment of STEMI, the risk of fibrinolytic therapy, and environmental and operational conditions need to be made before the selection of the best reperfusion therapy. In the majority of cases, this will be transfer for primary PCI; however, in the event of anticipated transfer delays, treatment with fibrinolytics should be initiated immediately. It is important to emphasize that fibrinolysis is an effective treatment for STEMI, and that all centres need to maintain their fibrinolytic programs.

Patients transferred from acute care hospitals

Patients presenting with STEMI in an acute care hospital within a 90 min door-to-balloon time of a PCI centre would be considered eligible for transfer for primary PCI. This includes all patients presenting with STEMI to an acute care hospital emergency room or in-patients with acute coronary syndrome that has evolved into an acute STEMI. The critical time element in this model is the total 90 min period, and all partners in the process need to collaborate to ensure that this target is achieved. For planning purposes, the 90 min transfer time can be divided into the following three components, each with their own respective targets: a time from door/medical contact to departure from the sending acute care hospital of 30 min or less; a travel time of 30 min or less; and arrival at the PCI hospital to balloon time of 30 min or less. It is important to note that these are suggested time intervals, and that gains in any one area may allow for a longer time in another element without increasing the overall time.

TABLE 2
Panel recommendations

- Primary PCI should be the preferred therapy for all eligible STEMI patients presenting within 12 h of symptom onset to a hospital with on-site PCI facilities and an experienced interventional team, with a maximum 'door-to-balloon time' of 90 min. Primary PCI should also be used for all eligible patients who can be transferred from an acute care hospital to a primary PCI centre within a door-to-balloon time of 90 min. All patients who have contraindications to fibrinolytic therapy, regardless of distance, as long as the procedure is performed within 12 h of symptom onset, should also be referred for primary PCI.
- All centres providing primary PCI services must maintain an infrastructure that enables them to perform at high standards of safety and efficacy, including the following: a minimum standard of 150 PCI procedures per operator per year; an annual review process to ensure that all operators achieve minimum procedure volumes; and a minimum of 500 diagnostic catheterization procedures per year performed at the centre, as well as 400 interventional procedures per year, of which more than 50 must be primary PCI.
- Fibrinolytics should be administered to STEMI patients who present to hospital within 12 h of symptom onset and to patients who cannot receive primary PCI within the recommended door-to-balloon time, or to whom PCI is contraindicated. Patients who present after 12 h of symptom onset are to be managed on a case-by-case basis.
- Patients presenting within 2 h of symptom onset represent a special subset of STEMI patients who derive particular benefit from early reperfusion therapy. Careful case-by-case consideration of treating these patients with fibrinolytic therapy rather than primary PCI should occur, weighing the risk of fibrinolytic therapy versus the potential delay in performing primary PCI.
- Rescue angioplasty should be performed for patients with acute STEMI who receive fibrinolytic therapy but continue to present with ongoing ischemic symptoms and electrocardiographic changes 90 min following the administration of fibrinolytics.
- Patients younger than 75 years of age who present with cardiogenic shock within 18 h of symptom onset should be transferred immediately to an advanced cardiac centre with on-site cardiac surgery available for immediate angiography and revascularization. Patients older than 75 years of age are to be managed on a case-by-case basis. The use of fibrinolytics has not been proven effective in this setting and its use should be individualized.
- Primary PCI should be performed in centres with on-site cardiac surgical capability or in established stand-alone PCI centres with a demonstrated ability to transport patients to a cardiac surgical centre within 90 min of decision to transport.
- The development of a regional MI system, involving PCI hospitals, referring acute care hospitals and municipal emergency medical services, to provide effective, efficient and quality patient management for STEMI patients from patient assessment through to post-MI care.
- That the Ministry of Health and Long-Term Care support an emergency medical system working group composed of representatives from municipalities, base hospitals and the Ministry to the identify strategies, processes and resources necessary to overcome current emergency medical system transportation barriers and to support the primary PCI model and recommendations described in the present report.
- That the Ministry of Health and Long-Term Care provide sufficient funding for a transportation infrastructure that is capable of providing medically appropriate, reliable and efficient service to allow for optimal utilization of advanced services and regionalized systems.
- That all PCI hospitals begin to implement the following: the development of emergency room care maps that ensure the timely assessment of STEMI and transfer of the patient directly to the catheterization laboratory; the development of direct communication links from the emergency room to the responsible interventionalist; the development of processes/algorithms to accept patients directly to the catheterization laboratory before obtaining a coronary care unit bed (de-linking the coronary care unit from the catheterization laboratory); an early discharge policy for uncomplicated infarcts undergoing PCI; and referral to cardiac rehabilitation (which includes secondary prevention programs).
- That the Ministry of Health and Long-Term Care plans for funding to support the infrastructure and resource requirements of primary PCI on a 24 h a day/seven days a week basis at PCI hospitals.
- The establishment of a pilot project involving several regional MI centres, which includes a PCI hospital, referring acute care hospitals and emergency medical services, to support primary PCI for patients transferred from acute care hospitals to PCI sites.
- That the Ministry of Health and Long-Term Care support a pilot project to evaluate a model of 'First Response' for primary PCI in Ontario, where patients are assessed at the point of presentation of the STEMI and are transferred directly to the closest PCI hospital for primary PCI. The pilot project should involve both urban and nonurban municipalities to appropriately assess the generalizability of the model.
- That the Ministry of Health and Long-Term Care plan for funding to support the infrastructure and resource requirements for the pilot projects.
- That the Ministry of Health and Long-Term Care develop a provincial monitoring system for STEMI in Ontario, which would be used for the following: monitoring the treatment of STEMI in Ontario and the implementation of the proposed models of care; monitoring new changes in the treatment of STEMI as they develop, such as the use of prehospital fibrinolytics and the use of facilitated PCI, and to make recommendations for implementations as appropriate; and monitoring the access, safety and efficacy of the STEMI model in Ontario through the tracking and reporting of data.
- That the Ministry of Health and Long-Term Care fund a centralized working group to support the coordinated implementation of the primary PCI model across Ontario.

MI Myocardial infarction; PCI Percutaneous coronary intervention; STEMI ST segment elevation MI

It was estimated that approximately 55% to 65% of patients with STEMI live within 30 min of a PCI centre (Figure 1). Based on this model (which includes both patients transferred to PCI hospitals and patients presenting directly to PCI hospitals), it is estimated that approximately 4200 patients could receive primary PCI instead of fibrinolytic therapy. By implementing this policy, there would be at least 96 fewer deaths, 176 fewer nonfatal reinfarctions and 46 fewer strokes annually in Ontario.

This model requires the implementation of patient care maps at the referring hospitals, including rapid patient triage, assessment and 12-lead electrocardiography. The use of a prehospital questionnaire completed by paramedics may potentially expedite diagnosis. Direct communication with the PCI centre, while the patient is stabilized for transportation, would allow for expedited transfer. The patient would be received immediately at the PCI hospital without awaiting the availability of a CCU bed. The precatheterization laboratory assessment would

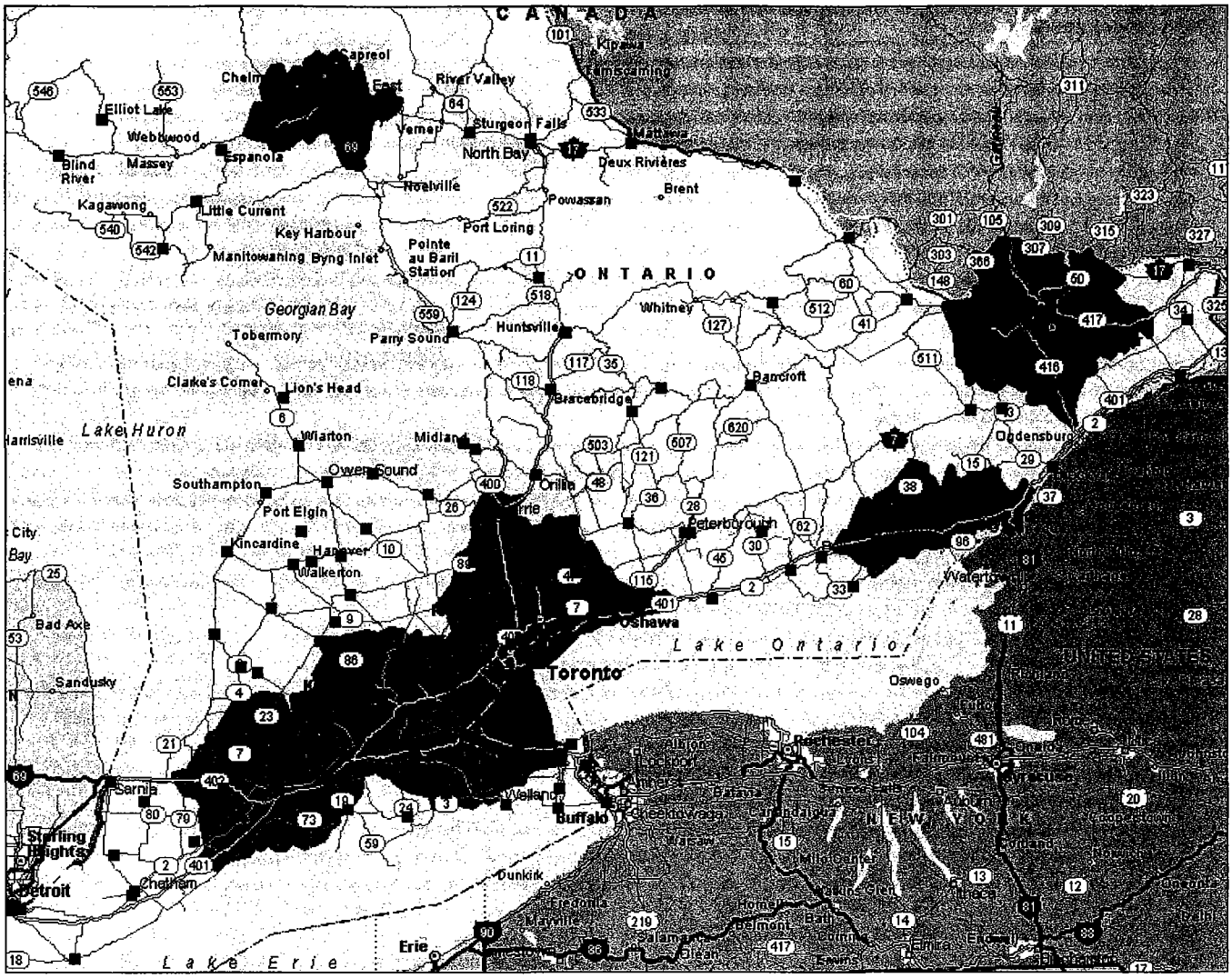

Figure 1) *Acute care hospitals and communities within a 90-min 'door-to-balloon time' of a percutaneous coronary intervention (PCI) hospital. Red squares are PCI hospitals, green squares are acute care hospitals and blue shaded areas are areas within 30±5 min from a PCI hospital*

be focused to allow for direct patient transfer to the catheterization laboratory for immediate angioplasty.

EMS is a critical partner in this model. A high priority transfer code to identify this interfacility transfer as an emergent transfer would need to be developed. Requirements for this priority code potentially could involve the ambulance remaining at the emergency department with the patient for transfer or the quick replacement of this ambulance with an alternative ambulance team with the appropriate level of training. Following successful angioplasty and achievement of patient stability, repatriation of the patient in a timely fashion to the acute referral hospital is an important success factor in this model because the additional volume would quickly occupy all of the available beds at the regional PCI hospital that would be required for the incoming acute cases.

Patients transferred from the community

The final model is referred to as a 'First Response' model. It is thought that this is the most efficient way to provide access to acute reperfusion therapy, whereby patients are assessed by the EMS team in the community and then transferred directly to the most appropriate facility according to a STEMI algorithm. In the majority of cases, this will be the nearest PCI centre and would require other close acute care hospitals to be bypassed en route. Occasionally, clinically unstable patients would require stabilization at the closest acute care hospital before transfer, similar to the Ontario trauma model. The First Response model has been successfully implemented with trauma and is currently being implemented in some municipalities with stroke patients. First Response eliminates the time required to transport and assess patients at the local hospital, thereby reducing the time from symptom onset to intervention, as well as optimizing clinical outcomes for the patient. In addition, the elimination of this intermediate step allows for the expansion of the transportation time component of the total 90 min transfer time, thereby potentially increasing the pool of eligible patients for transfer for primary PCI.

The First Response model requires paramedics to have the necessary skill set to assess patients for STEMI in the field and, in consultation with the base hospital physician, to transfer the potentially unstable patient. According to a prespecified algorithm and in consultation with the base hospital, the paramedic would perform a prehospital electrocardiogram and a direct clinical assessment, including a history and physical examination at the point of patient contact. The electrocardiogram could be electronically transmitted to a base hospital

physician for central interpretation. Once the diagnosis is made, the receiving PCI hospital would be notified of the incoming patient and the appropriate arrangements would be made. Paramedics could also be trained to interpret the electrocardiogram and relay this information to the acute care hospital, which would begin mobilizing the acute MI team.

As part of this model, prehospital pharmacological reperfusion therapy, including fibrinolytic agents administered by paramedics, could also be developed. This program would be particularly useful for those communities that do not have timely access to primary PCI.

Patients not eligible for primary PCI

Although primary PCI is recommended as the dominant reperfusion strategy for STEMI patients, the panel recognizes that this therapy would not be possible for a minority of Ontarians due to the geographical, economic and environmental challenges of the province. Therefore, fibrinolysis will remain an important and acceptable reperfusion strategy. Currently, patients beyond a 90 min door-to-balloon time should be treated with fibrinolysis. As suggested by others and supported by limited data, careful surveillance of these patients is required to ensure successful reperfusion. Patients failing to reperfuse should be transferred to the closest PCI centre for rescue PCI.

Facilitated PCI, which involves the administration of a pharmacological agent, including fibrinolytics, followed by immediate transfer for PCI, is currently being examined in clinical trials and, therefore, no specific recommendations can be made at this time. This strategy could potentially be used in patients anticipated to have poor outcomes, such as patients with large infarcts and patients with impending hemodynamic compromise or cardiogenic shock. The process of facilitation may also allow patients to be transferred from greater distances for PCI.

FUTURE MONITORING AND DATA COLLECTION

Due to the significant changes in health care delivery and EMS infrastructure suggested in the present report, the panel recommends that a provincial monitoring system for STEMI be established. This provincial working group would interface with the regional MI centres and would be responsible for the following: monitoring the treatment of STEMI in Ontario and implementing the proposed models of care; monitoring new changes in the treatment of STEMI as they develop; monitoring changes in clinical needs and indications for treatment; and monitoring the access, safety and efficacy of the STEMI model in Ontario through the tracking and reporting of data. By establishing an ongoing working group, new insights into the treatment of STEMI, such as the results of the Combined Angioplasty and Pharmacological Intervention Versus Thrombolytics Alone in Acute Myocardial Infarction (CAPITAL AMI) (50), ASSIST, WEST and TRANSFER-AMI trials, which have been completed or are currently underway in Canada, could be incorporated into practice patterns more readily (50).

CONCLUSIONS

The tremendous improvements in outcomes in patients with STEMI have been due to progressive, incremental changes. Fibrinolytics were an important step in this process. Due to a number of changes, primary PCI has become the preferred mode of reperfusion if performed by an experienced team in a timely fashion. Significant changes in health care delivery will be required to realize the benefits of primary PCI. The changes proposed in the present report extend beyond the simple application of primary PCI for STEMI. The development of regional and specialized MI centres, an enhanced EMS system and a provincial monitoring system will improve the delivery of many aspects of cardiovascular care.

APPENDIX

Members of the consensus panel of this report included Patricia Daniels, Regional Cardiac Care Coordinator, St Michael's Hospital; Wendy Fucile, Vice President and Chief Nursing Officer, Peterborough Regional Health Centre; Judy Hemming, Angioplasty Coordinator, University Health Network; Dr Marino Labinaz, Cardiologist, University of Ottawa Heart Institute; Dr Christopher Lai, Director of Cardiology, Thunder Bay Regional Hospital; Dr Bruce Lubelsky, Cardiologist, North York General Hospital; Dr Madhu Natarajan, Interventional Cardiologist, Hamilton Health Sciences Corporation; Dr Grama Ravi, Chief of Cardiology, Sudbury Regional Hospital; Dr Bruce Sawadsky, Medical Director, Air Ambulance Base Hospital Program; and Dr Randal Watson, Interventional Cardiologist, Trillium Health Centre. Ex-officio members included Amanda Dean, Dr Kevin Glasgow and Terri Swabey from the CCN; Dennis Brown and Christina Summers from the Emergency Services Branch of the the Ministry of Health and Long-Term Care; Rosalind Tarrant from Priority Programs Hospitals Branch of the Ministry of Health and Long-Term Care; and Marcella Sholdice.

ACKNOWLEDGEMENTS: The authors thank all of the secondary reviewers: Dr Merril Knudston, Dr Paul Armstrong, Terri Burton, Dr Warren Cantor, Dr Eric Cohen, Dr Jack Tu, Dr Sanjay Dhingra, Anthony DiMonte, Pat Doucette, Dr Don Eby, Dr Arvind Koshal, Dennis Merral, Dr Laurie Morrison, Dr George Pink, Dr Brian Schwartz and Nancy Walton.

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