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Clinical Paper

Transformation of Heart Attack Care: A Primary Percutaneous Coronary Intervention Service for Northern Ireland

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ABSTRACT Primary percutaneous coronary intervention (primary PCI) is the preferred immediate treatment for patients with acute ST elevation myocardial infarction. It is however, considerably more labour-intensive than the previous standard of care and requires an immediate response from consultant-led teams to deliver best outcomes. We describe the introduction of a comprehensive primary PCI service for Northern Ireland and suggest that the process by which it was designed, piloted, commissioned and benchmarked can serve as a prototype for other high-risk, time-sensitive clinical emergency services.

INTRODUCTION

Acute myocardial infarction (MI) is a common medical emergency with improving clinical outcomes reflecting a wealth of clinical trial evidence. Between the 1980's and the 2000's, 30-day mortality for MI in Denmark fell from 31.4% to 14.8%[1] and in the United Kingdom (UK) and Sweden 30-day mortality fell below 10% by 2010[2].

In this paper, we document the most recent evidence-based change in the management of acute MI in Northern Ireland (NI): a comprehensive primary percutaneous coronary intervention (PCI) service for patients with ST segment elevation MI (STEMI). The service combines pre-hospital diagnosis and clinical stabilisation, then direct transfer to one of two Heart Attack Centres for definitive, consultant-delivered coronary intervention on a 24-hour basis, 365 days a year (24/7/365). Consolidation of early specialised emergency care required the collaboration of all Trusts and is an approach that could benefit patients requiring emergency medical and surgical intervention.

TREATMENT OF MYOCARDIAL INFARCTION

While early forms of MI treatment aimed to limit the sequelae of acute coronary occlusion (heart failure, arrhythmias and reinfarction), a more definitive strategy emerged in the 1980's. Clinical trials proved that early restoration of coronary blood flow reduces mortality and this can be achieved safely by intravenous thrombolytic agents[3]. Thrombolytic therapy followed by rescue PCI for those who fail to reperfuse, or early convalescent coronary intervention for those who successfully reperfuse[4,5] rapidly became part of the standard of care for acute STEMI.

However thrombolytic therapy had many limitations: contraindications, failure to reperfuse, reocclusion after successful reperfusion and haemorrhagic complications including intracranial haemorrhage. These stimulated clinical trials of primarily mechanical as opposed to pharmacological coronary reperfusion. The procedure that evolved, eventually termed primary PCI, was highly effective[6] and in October 2008, the UK National Infarct Audit Project (NIAP) confirmed that it can be delivered safely and effectively beyond clinical trials[7] leading to a new standard of care for acute STEMI management in the UK.

THE BELFAST TRUST PILOT

Following this evidence base, small numbers of cases were undertaken during daylight hours in all PCI centres in NI but no centre had the resources to deliver a service on a 24/7/365 basis. In April 2007, the Review of Public Administration led to the merger of three adult cardiology services in Belfast into a single service within the newly-formed Belfast Health and Social Care Trust (BHSCT). By this time, the European Society of Cardiology (ESC) was recommending primary PCI as the preferred reperfusion option, but only if performed by experienced staff within 90 minutes of first medical contact[8]. The BHSCT merger delivered an interventional cardiology team of sufficient size and experience to deliver 24/7/365 primary PCI for a large number of patients with STEMI.

Following detailed preparation, a pilot project covering the greater Belfast area was undertaken. Planning involved many clinical teams and many logistical considerations (Table 1). The pilot service, launched on December 7 2009, proved that 24/7/365 primary PCI was feasible in NI, and outcomes compared well with appropriate benchmarks (Table 2). Treating several hundred patients over these early years enriched the expertise of many professionals who would form part of the NI-wide service and the annual procedural volume of the BHSCT pilot predicted the likely demand of a region-wide service (Table 3).

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TABLE 1.

Logistical planning considerations prior to launch of the BHSCT primary PCI pilot

Staff	***Clinical protocols***
Daytime staffing arrangements	Inclusion and exclusion criteria
Out-of-hours on call rotas	ECG criteria to be used by NIAS
A primary PCI co-ordinator role	A care pathway
Staff accommodation	ECG transmissions and nurse-led interpretation
Training and CPD	Pharmacotherapy and equipment
Compensatory rest	Expected patient numbers
The patient journey	***Quality***
Direct admissions from NIAS	Clinical governance
Self-presenters at Emergency Departments	Education and research
Facilities for relatives	Benchmarking
Repatriation arrangements (nurse-led)	
	Communications
	Links with other clinical teams
	Public and media relations

A COMPREHENSIVE PRIMARY PCI SERVICE FOR NORTHERN IRELAND

Through the course of the BHSCT pilot, performance and outcome data were shared and a unified view emerged that a region-wide primary PCI service should be commissioned for NI. This consensus led to a formal commitment in the NI Programme for Government (2011-2015) which undertook to:

"*Expand cardiac catheterisation capacity to improve access to diagnostic intervention and treatment and further develop a new primary percutaneous coronary intervention (PPCI) service model to reduce mortality and morbidity arising from myocardial infarction (heart attack).*"

Under the direction of a Regional Cardiac Catheterisation Implementation Group (CCIG), it took less than 5 years to transform from having no systematic primary PCI service to one covering every patient with STEMI in NI with clinical outcomes as good as anywhere in the UK.

Planning and implementation

An early decision was to develop a two-centre regional primary PCI model between the BHSCT (Royal Victoria Hospital) and Western HSC Trust (Altnagelvin Hospital). The boundaries were defined by 60-minute travel times from each centre, following postcode regions to give greatest clarity to NIAS crews (Figure 1). They have required no modification since first drawn.

Fig 1. Postcode-based definition of the boundaries between the Eastern and Western primary PCI services. The use of postcodes ensures clarity for all and especially for NIAS crews

Experience from NIAP, the BHSCT pilot and international publications led to a set of assumptions from which the projected number of primary PCI activations was calculated. Three-quarters of patients with STEMI present outside office hours so most activations involve a team returning to the

TABLE 2.

Selected outcome measures from the Belfast Trust primary PCI service

	Number of primary PCI activations	Percentage admitted directly from NIAS	Median call-to-balloon time (minutes)*	Median door-to-balloon time (minutes)**
2010/11	257	37%	110	45
2011/12	256	47%	89	47
2012/13	279	47%	98	41
2013/14†	508	55%	104	36

*MINAP standard 150 minutes; **MINAP standard 90 minutes
†The BHSCT service extended its catchment area on 30 September 2013

Table 3.

*Projections of how many activations of a primary PCI service were expected across NI. *08.00 – 18.00, Monday to Friday*

Activity estimates								
1131 activations of the primary PCI service (including other causes of ST elevation on the ECG, likely to be 15 to 20%)								
305 in hours*			826 out of hours				**Total**	
			588 before midnight		238 after midnight		Altnagelvin	Belfast
76 Altnagelvin	229 Belfast		147 Altnagelvin	441 Belfast	60 Altnagelvin	178 Belfast	283	848
1.5 per week	4.4 per week		2.8 per week	8.5 per week	1.2 per week	3.4 per week	5.5 per week	16.3 per week

hospital from home. The projected activations are shown in Table 3: in 2015/16 there were 992 activations, indicating that we had overestimated the caseload by 14%.

Professional guidelines were integral to the strategy. In NI, National Institute for Healthcare and Clinical Excellence (NICE) guidance underpins commissioning strategy and funding of service developments. Cardiologists also aim to align with ESC recommendations and British Cardiovascular Intervention Society (BCIS) standards for UK primary PCI (PPCI) centres[9]:

> *All PPCI centres should provide a STEMI service 24 hours a day, 7 days a week, year-round*
>
> *All PPCI centres should undertake a minimum of 150 PPCI cases per year unless there is extreme geographical isolation to justify a lower volume service*
>
> *Services should be configured to achieve "call-to-balloon time" of <150 minutes in ≥ 75% of patients (excluding cardiogenic shock and out-of-hospital arrest)*
>
> *Optimal performance of the in-hospital service can be measured by a "door-to-balloon" time < 60 minutes in ≥ 75% of patients (excluding cardiogenic shock and out-of-hospital arrest)*

The imperative to deliver a seamless 24/7/365 service and the link between higher volume and lower mortality[10], underpinned the consolidation of expertise into the smallest number of centres that could deliver the required call-to-balloon time standards.

PRACTICE INNOVATIONS

Nurse-delivered electrocardiogram (ECG) interpretation was central from the outset. ECGs recorded at first medical contact (often in the patient's home) are sent electronically with a brief clinical description to the appropriate Heart Attack Centre. If defined criteria (Figure 2) are confirmed by the nurse, the interventional team is activated and the patient is transferred directly to the cardiac catheterisation laboratory.

In a recent internal quality improvement (QI) project, the calculated sensitivity, specificity, positive and negative predictive value of nurse-delivered ECG interpretation were 95%, 91%, 85% and 97% respectively, showing that the system inclines towards greater sensitivity to miss as few patients as possible. As a result, inappropriate activations (15%) are tenfold more common than inappropriate turn-downs (1.6%). Similar QI projects have also led to the acceptance of ECGs suggesting acute posterior MI and have strengthened recommendations that local cardiology teams review patients with borderline ECG changes (e.g. left bundle branch block or ST elevation <2 mm in anterior leads) or when a patient has been referred but not accepted for primary PCI (Figure 2). Such patients are often discussed directly with the primary PCI team if there is clinical suspicion of acute coronary occlusion. The purpose of these gradual protocol modifications has been to maximise sensitivity for the detection of acute coronary occlusion, while ensuring

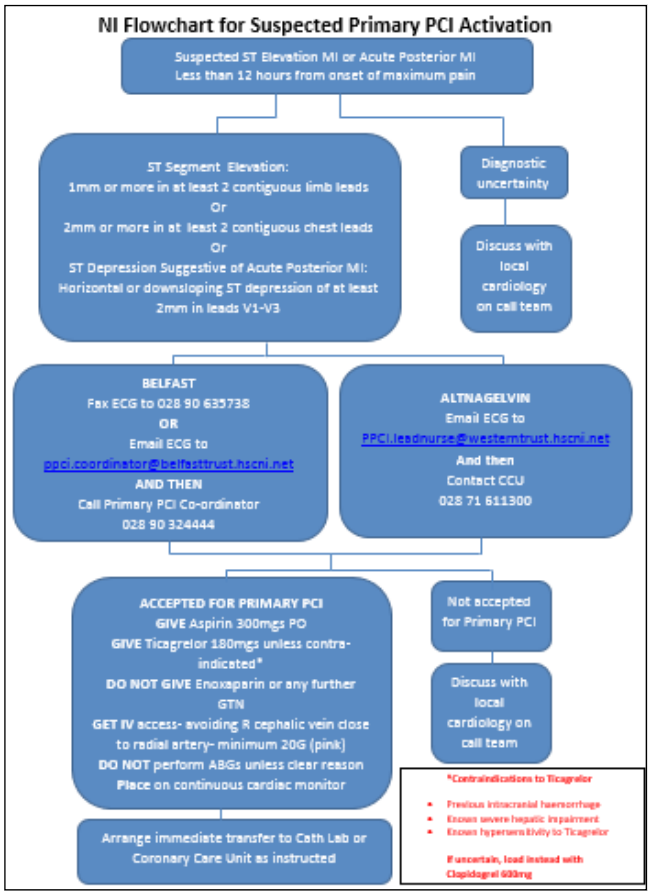

Figure 2. Regionally-agreed protocol for nurse-led primary PCI activation

TABLE 4.

*Key process and clinical outcome measures for the NI Eastern and Western primary PCI (PPCI) services from 2015/16, benchmarked against equivalent national figures from England and Wales (16). *2014 data for all UK – the last year for which 30-day mortality has been published to date*

	Eastern Heart Attack Centre (Belfast)	Western Heart Attack Centre (Altnagelvin)	England	Wales
Number of patients undergoing PPCI	680	168	19 216	1 001
PPCI rate per million population	451		354	323
Percentage of eligible patients undergoing PPCI	99.9%		99.3%	86.0%
Percentage admitted directly to Heart Attack Centre	61%	89%	78%	71%
Median call-to-balloon time (minutes)	109	114	117	127
Eligible patients who received primary PCI within 150 minutes of calling for help (call to balloon) including those admitted directly or transferred to Heart Attack Centre	78%	74%	75%	67%
Median door-to-balloon time (minutes)	34	29	40	41
Percentage of eligible patients who received primary PCI within 90 minutes of arrival at Heart Attack Centre	93.4%	84.7%	89%	87%
30-day mortality	6.2%	6.0%	6.9%*	

that the service remains sustainable by keeping inappropriate activations to a manageable level.

A fundamental component of the primary PCI pathway is a regionally-agreed repatriation protocol with transfer back to a local CCU at 6 hours post-procedure if the patient is stable and it is between the hours of 6am and 10pm. Primary PCI centres cannot deliver a responsive service without clear repatriation arrangements and it is in patients' best interests to have most clinical care and rehabilitation delivered close to home. The system also preserves teaching and training opportunities for staff and students in all CCU's.

Repatriation is managed by CCU nurses using clinical rather than operational criteria. Telephone calls to the host hospital and to NIAS at the time of admission are followed by a second call 6 hours later to confirm transport and to inform the host hospital that the patient is leaving. At no stage is it discussed whether a bed is available. The process shows that collaborative repatriation is achievable for any regionally-centralised service in NI.

The original NIAP report[7] highlighted that patients with STEMI who attend ED's or CCU's experience substantial time delays so the recommended model is pre-hospital diagnosis, then direct transfer to a cardiac catheterisation laboratory in primary PCI-capable hospitals, bypassing all other services. Tables 2 and 4 show that work is required to reduce the number of patients with STEMI attending ED's, particularly in the Eastern region.

The primary PCI service delivers prompt, high quality care for patients with STEMI across NI. The demanding nature of the work, coupled with a finite number of interventional cardiologists with primary PCI experience meant that working across Trust boundaries was essential. Other cross-Trust cardiology service developments, linked to primary PCI have included cardiac imaging, outpatient clinics and wider invasive cardiology services.

The Myocardial Infarction National Audit Project (MINAP) audits and publishes quality of care for patients with STEMI and non STEMI in England, Wales and NI, against NICE standards.[11-13] From their inception, the NI Heart Attack Centres have submitted MINAP data alongside English and Welsh Heart Attack Centres[14]. Performance measures show that both NI centres deliver high levels of performance and a 94% survival to 30 days (Table 4).

LESSONS LEARNED AND WIDER APPLICABILITY

Challenges to the primary PCI implementation project included many stakeholders, initial lack of consensus about the model and a need to balance other elective and urgent needs while transforming emergency care. The service which evolved sets a new standard in quality of care for a large number of patients who are seriously ill at presentation. The factors that we believe contributed to successful implementation are:

- A clear statement that the service change formed part of government policy
- Establishment of a regional Implementation Group with equal representation from all Trusts and a neutral Chair
- A shared, deliverable vision
- A focus on best quality, evidence-based care
- Expectation of cooperation across Trusts
- Sharing information across Trusts, identifying service gaps and examples of good practice
- Recognising the skills of NIAS staff and a lead role for nurses in managing patient pathways

Fig 3. Official launches of the Eastern (upper panel) and Western (lower panel) primary PCI services

- Open feedback in a 'no blame way'

Increasingly patients with high-risk conditions need services that bypass ED's to bring patients directly to a pre-activated specialist area – e.g. major trauma and stroke services. Common components include enhanced assessment skills by paramedics, diagnostic and triage tools and remote access to clinical advice. A supportive culture acknowledges the operational and clinical challenge for ambulance crews undertaking longer journey times with unstable patients. Concentrating specialist skills in fewer sites leads to concerns about clinical skills and staff recruitment; these can be allayed by cross-Trust working. Communication is key with agreed, widely disseminated protocols for incoming and repatriating patients. Finally, there must be willingness to review practice when the system does not work as planned.

The process by which a consolidated regional primary PCI service has been designed, piloted, commissioned, implemented, communicated and benchmarked should serve as a model for how services for other high-risk, time-sensitive clinical emergencies should be developed in NI.

ACKNOWLEDGMENTS

The evolution of the NI primary PCI service represents hundreds of person-years of dedication and hard work by people across the Health Service and its ongoing delivery demands just as much dedication and commitment. The service could not have happened without every one of these people. All involved should be proud of what they have achieved for patients to date, and what they continue to achieve every day

REFERENCES

1. Schmidt M, Jacobsen JB, Lash TL, Bøtker HE, Sørensen HT. 25 year trends in first time hospitalisation for acute myocardial infarction, subsequent short and long term mortality, and the prognostic impact of sex and comorbidity: a Danish nationwide cohort study. *BMJ*. 2012; **344**: e356.
2. Chung S-C, Sundström J, Gale CP, James S, Deanfield J, Wallentin L, *et al*. Comparison of hospital variation in acute myocardial infarction care and outcome between Sweden and United Kingdom: population based cohort study using nationwide clinical registries. *BMJ*. 2015; **351**: h3913.
3. Fibrinolytic Therapy Trialists' (FTT) Collaborative Group. Indications for fibrinolytic therapy in suspected acute myocardial infarction: collaborative overview of early mortality and major morbidity results from all randomised trials of more than 1000 patients. *Lancet*. 1994; **343(8893)**: 311-22.
4. Bonnefoy E, Steg PG, Boutitie F, Dubien PY, Lapostolle F, Roncalli J, *et al*. Comparison of primary angioplasty and pre-hospital fibrinolysis in acute myocardial infarction (CAPTIM) trial: a 5-year follow-up. *Eur Heart J*. 2009;**30(13)**:1598-606.
5. Armstrong PW, Gershlick AH, Goldstein P, Wilcox R, Danays T, Lambert Y, *et al*. Fibrinolysis or primary PCI in ST-segment elevation myocardial infarction. *N Engl J Med*. 2013;**368(15)**:1379-87.
6. Keeley EC, Boura JA, Grines CL. Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomised trials. *Lancet* 2003; **361(9351)**: 13-20.
7. Department of Health Vascular Programme Team. Treatment of Heart Attack National Guidance. Final Report of the National Infarct Angioplasty Project (NIAP). London: Department of Health; 2008.
8. Bassand J-P, Danchin N, Filippatos G *et al*. Implementation of reperfusion therapy in acute myocardial infarction. A policy statement from the European Society of Cardiology. *Eur Heart J* 2005; **26**: 2733–41.
9. MacCarthy PA, Blackman DJ, Hildick-Smith D, Banning AP. Primary percutaneous coronary intervention for ST elevation myocardial infarction. Position statement for facilities and emergency medical staffing. [Internet] London: British Cardiovascular Intervention Society; 2016.
10. Zahn R, M Gottwik M, Hochadel M, Senges J, Zeymer U, Vogt A, *et al*. Volume–outcome relation for contemporary percutaneous coronary interventions (PCI) in daily clinical practice: is it limited to high-risk patients? Results from the Registry of Percutaneous Coronary Interventions of the Arbeitsgemeinschaft Leitende Kardiologische Krankenhausärzte (ALKK). *Heart*. 2008; **94(3)**: 329-35.
11. National Institute for Health and Care Excellence Quality Standard 68. Acute coronary syndrome in adults. NICE 2014. https://www.nice.org.uk/guidance/qs68/resources/acute-coronary-syndromes-in-adults-pdf-2098794360517
12. NICE Clinical Guideline; 172. Myocardial infarction: cardiac rehabilitation and prevention of further cardiovascular disease. [Internet] London: National Institute for Health and Care Excellence Clinical Guideline; 2013. Available from: https://www.nice.org.uk/guidance/cg172 [Accessed September 2018].
13. NICE Clinical Guideline; 167. Myocardial infarction with ST-segment elevation: acute management. [Internet] London: National Institute for Health and Care Excellence Clinical Guideline; 2013. Available from: https://www.nice.org.uk/guidance/cg167 [Accessed September 2018].
14. Weston CF, Reinoga KL, Dubos RF, Demian V. Myocardial Ischaemia National Audit Project. Heart attack in England, Wales and Northern Ireland. Annual Public Report April 2015 – March 2016. [Internet] London: National Centre for Cardiovascular Preention and Outcomes (NICOR); 2017. Available from: http://www.ucl.ac.uk/nicor/audits/minap/documents/annual_reports/minap-2015-16-annualreport. [Accessed September 2018].