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Original Research

Intra-aortic Balloon Pump-Dependent Patient Transports by Critical Care Paramedics

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A B S T R A C T

Objective: Transport of intra-aortic balloon pump (IABP)-dependent patients between hospitals is increasingly common. The transports are typically time-sensitive and require personnel familiar with IABP operation and management of a potentially unstable patient. This study examined transports performed by specially trained critical care paramedics in a large air medical and land critical care transport service.

Methods: This retrospective, descriptive review prospectively collected data for IABP-dependent patient transports in Ontario, Canada in a 10-year interval beginning September 2003. Call records and patient care reports were reviewed to capture demographic, patient care, adverse events, and transport-related data. Adverse events, including resuscitation medication, procedure, and patient instability, were independently reviewed by 2 investigators.

Results: There were 162 IABP-dependent patients transported. Seventy-one were performed by land critical care transport vehicles, 60 by helicopter, and 31 by fixed wing aircraft. The mean patient age was 63.7 ± 13.8 years; the majority (72.2%) were men. Fifty-nine patients (36.4%) were inotrope or vasopressor dependent, and 46 (28.4%) were intubated and mechanically ventilated. The most common indications for IABP insertion were acute myocardial infarction requiring prompt surgical intervention ($n = 70$), bridge to definitive care ($n = 41$), and cardiogenic shock ($n = 37$). The mean transport time was 92.7 ± 79.4 minutes. There were 48 adverse events in 35 patients, most commonly hypotension (systolic blood pressure < 90 mm Hg, $n = 18$) and tachyarrhythmia requiring therapy ($n = 12$). There were 3 IABP-related events and 3 cases in which the transport vehicle was inoperable resulting in a transport delay. One patient with cardiogenic shock died before departing the sending hospital. Paramedics managed all events without assistance from other health care personnel.

Conclusion: Specially trained critical care flight paramedics can safely transport potentially unstable IABP-dependent patients to definitive cardiac surgical care.

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The intra-aortic balloon pump (IABP) was introduced in 1968¹ to augment cardiac output in hemodynamically unstable patients and serve as a bridge to more advanced treatment options.² IABPs are used in the United States in an estimated 70,000 patients annually,³ and the complication rate for IABP use ranges from 7.6% to 36%.^{4–6}

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Interventional cardiology services, including coronary artery angiography, angioplasty, and intracoronary stenting, are routinely available at hospitals without cardiac surgery backup. The rate of complications after coronary angiography and angioplasty are approximately 1% to 2% and 5%, respectively,^{7–9} and patients who become hemodynamically unstable or suffer a major complication typically require emergent cardiac surgical intervention. This requires interfacility transport if there are no cardiac surgical capabilities locally. The IABP can serve as a bridge in these patients, augmenting coronary perfusion and improving hemodynamic stability until the patient can be transported to a cardiac surgery center.²

Despite evidence suggesting that IABP may have a beneficial effect on patient hemodynamics, the evidence to support IABP use

in infarct-related cardiogenic shock is scarce,¹⁰ and recent studies show it has no benefit in those undergoing early revascularization.¹¹ However, patients experiencing mechanical complications of acute myocardial infarction, such as ventricular septal rupture or acute mitral valve regurgitation, can be bridged with the IABP until emergent surgical repair is undertaken. If these patients experience cardiogenic shock because of the mechanical complication, the IABP improves survival.¹²

The transport of IABP-dependent patients between hospitals is increasingly common and safe.^{13–20} Such transports typically involve a physician, nurse, perfusionist, or other personnel familiar with operation of the IABP and management of a potentially unstable patient. This study documents the experience of an IABP transport program in which specially trained critical care paramedics transport IABP-dependent patients without additional medical escorts.

Study Objective and Design

This retrospective, descriptive review of prospectively collected data evaluated IABP-dependent patient transports performed by specially trained critical care paramedics without additional medical escorts. The study was approved by the research ethics board and conducted in accordance with the confidentiality policies and procedures established by the Sunnybrook Health Sciences Centre and the Ministry of Health and Long-Term Care in Ontario, Canada.

Study Setting and Population

Ontario is Canada's largest province (approximately 424,600 miles²) with a mix of urban, suburban, rural, and remote areas. The health care system is publicly funded and serves a population of approximately 13.5 million. The Cardiac Care Network provides adult interventional cardiac services with 18 centers: 13 providing cardiac catheterization and cardiac surgery services and 5 providing cardiac catheterization services only.

Ornge is the Province's air and land critical care transport service. It uses 8 rotor wing, 10 fixed wing aircraft, and 5 critical care land ambulances and performs approximately 19,000 air medical and land-based critical care transports annually. Dedicated emergency medicine and critical care specialists provide direct medical control via a single, centralized operational control and dispatch center.

One fixed wing aircraft, 1 rotor wing aircraft, and 3 land transport vehicles based in proximity to cardiac center sites with no cardiac surgical capabilities were configured for IABP transports. These vehicles are staffed by critical care paramedics with additional training in IABP use. Each IABP-certified paramedic completed a knowledge- and competency-based critical care training program based on the National Occupational Competency Profile (NOCP).²¹ The NOCP was developed by the Paramedic Association of Canada in conjunction with the Canadian Medical Association and is the national standard for paramedic education in Canada. Each paramedic typically has 5 to 8 years of full-time paramedic experience before beginning their critical care training. The additional IABP-specific training includes precourse self-study modules, didactic lectures, a clinical practicum, and practical testing and was approved by the medical director. IABP training was performed by cardiac perfusionists and specialists in cardiology, critical care, and emergency medicine at designated cardiac care centers. The IABP-certified paramedics also received hands-on instruction in patient movement logistics by aircraft and vehicle engineers to ensure safe transport of IABP equipment. All medical control physicians underwent the same precourse self-study program and didactic lectures. The initial IABP training program for paramedics takes 24 to 32 hours to complete and is comparable with that provided to critical care nursing staff caring for IABP-dependent patients. Paramedics and medical control

physicians receive ongoing training and recertification in IABP use on an annual basis. Paramedics must contact the medical control physician before initiating transport of an IABP-dependent patient and for any adverse or critical event.

This retrospective, descriptive review of prospectively collected data includes all patients transported during a consecutive 10-year interval beginning in September 2003.

Outcome Measures

The primary outcome is rate of adverse or critical events encountered during emergent transport of IABP-dependent patients to definitive cardiac surgical care. Adverse and critical events were defined a priori and are described in Table 1.

Data Collection and Analysis

Paramedics completed a standard ambulance patient care report for all patient transports before being assigned to another response and forwarded them to a central office at the end of each shift. Demographic, patient care, adverse events, and transport-related data were prospectively collected.

The medical director and quality audit staff review each transport and obtain any missing data from the paramedic crews. The quality audit team routinely screens all patient care reports for calls to ensure all IABP-dependent patients' transports are captured. Two investigators independently examined all reports to identify events. Data were entered into and analyzed using a commercially available spreadsheet (Microsoft Excel version 2010; Microsoft Corp, Redmond, WA). Descriptive statistics summarize the continuous variables, and frequencies summarize the categorical variables. The measure of inter-rater agreement on the presence of an adverse event was determined using the kappa statistic.

Results

The critical care paramedics transported 162 IABP-dependent patients during the study period. This represents approximately 1 in 1,200 overall patient transports. The mean age was 63.7 ± 13.8 years (range, 22–94 years), and the majority of patients were male (117/162 [72.2%]). The mean out-of-hospital time was 92.7 ± 79.4 minutes. The majority of patients (156/162 [96.3%]) were transported without additional medical escorts. The 6 patients transported with medical escorts were transported in the first 6 months of the program, when referring physicians were not familiar with the paramedics' capabilities. Tables 2 and 3 summarize the patient and transport characteristics and indications for IABP insertion, respectively.

There were no critical or adverse events in 127 patient transports (78.4%). In the remaining 35 patient transports, there were 48 events while the patient was in care of the paramedics (Table 4). There was 1 event in 26 patients, 2 in 8 patients, and 3 in 2 patients. The 2 investigators independently identified and were in agreement ($\kappa = 1.0$) with all events. The paramedics managed all events independently, even if other medical escorts were present.

During the study period, 1 patient with cardiogenic shock died. The male patient was intubated and mechanically ventilated, hypotensive, vasopressor dependent, and hemodynamically unstable when the paramedics made patient contact at the sending hospital. He had undergone emergent coronary angiography, identifying diffuse multivessel disease. The IABP was inserted as a bridge while preparing for emergent transport to definitive cardiac surgery. The patient died of his underlying disease shortly after transfer of care to the flight paramedics, before departure from the sending hospital.

The program used a single type of IABP (Arrow International Inc, Reading, PA) throughout this study. A new feature ("AutoPilot") was introduced midway through the 10-year interval. This permitted

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