



A mathematical program to predict survival and to support initial therapeutic decisions for trauma patients with long-bone and pelvic fractures

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KEYWORDS

Stochastic analysis and control program;
Outcome prediction;
Therapeutic decision support system;
Noninvasive haemodynamic monitoring;
Thoracic bioimpedance estimation of cardiac output;
Pulse oximetry;
Transcutaneous oxygen and carbon dioxide tensions;
Tissue perfusion

Summary

Aim: To test a mathematical program to monitor early haemodynamic patterns of patients with fractures, predict survival and support initial therapeutic decisions.

Methods: A mathematical search and display program based on non-invasive haemodynamic monitoring was used to study 430 consecutively monitored patients with fractures during the first 48 h after admission to the emergency department of an inner city public hospital. We studied four types of fractures: simple extremity fractures, long-bone fractures, pelvic fractures and fractures incidental to severe trauma. The program continuously displayed haemodynamic patterns and predicted survival probability (SP), which was evaluated by the actual outcome at hospital discharge. The program also assessed the effectiveness of therapies according to haemodynamic responses.

Results: The cardiac index, heart rate, mean arterial pressure, arterial saturation and transcutaneous oxygen tensions at the initial resuscitation were significantly higher in survivors than in non-survivors. After the first 48 h, the haemodynamic patterns were more influenced by fever, sepsis, complications and organ failures. The calculated survival probability averaged $81\% \pm 18\%$ in the first 48 h for survivors and $72\% \pm 20\%$ for non-survivors.

Conclusion: Early continuous non-invasive haemodynamic monitoring using the proposed information system is helpful in predicting outcome and guiding therapy for patients with fractures.

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Introduction

Invasive pulmonary artery (PA) thermodilution (Swan-Ganz) catheters provide the maximum circulatory data at the bedside, but require intensive care unit (ICU) conditions. There was no advantage found for the PA catheter with goal-directed therapy when this invasive monitoring was started late in the course of illness, i.e. >24 h after admission to the Emergency Department (ED), or after onset of an organ failure.^{9,14,11,26,1} Delays in correcting circulatory deficiencies have resulted

in organ failures and death.^{7,21,8,33,15} However, badly injured patients who arrive in severe shock and older patients have survival benefit when managed with a PA catheter.¹³ Although many articles have pointed out the hazards and harmful effects of associated trauma on the patients with pelvic and long-bone injury,^{19,18,31,12} we were unable to find data in the literature on evaluation and decision-making in orthopaedic trauma cases using early haemodynamic monitoring. Since time is crucial in the resuscitation and management of critically ill emergency cases, early non-invasive

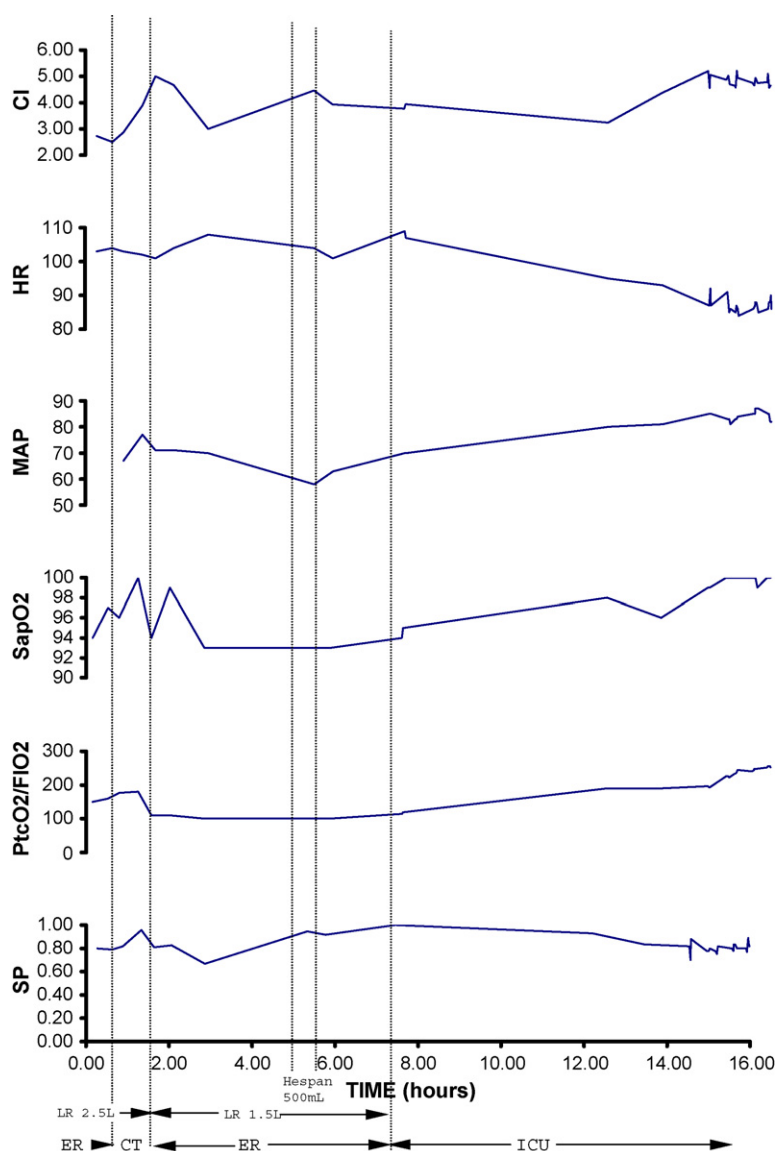


Figure 1 A 40-year-old woman was struck by an automobile and sustained pelvic and tibial/fibular fractures. Top section, cardiac index (CI); second section, heart rate; third section, mean arterial pressure; fourth section, pulse oximetry; fifth section, transcutaneous oxygen tension indexed to the fractional inspired oxygen concentration ($P_{tc}O_2/FiO_2$); lowest section, survival probability. The woman was resuscitated with 2.5 l crystalloids and 7 units packed red cells. CI rose from 2.5 l/min/m² shortly after admission to 5 l/min/m² in the first hour, $P_{tc}O_2/FiO_2$ gradually returned to normal and SP was maintained at 0.80 or above. The woman recovered.

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