Feasibility of Computer-Assisted Vasopressor Titration Using Non-Invasive Blood Pressure Monitoring (Clearsight) During Renal Transplant Surgery: A Case Series

Presenting Author: Sean Coeckelenbergh M.D.[1]
Co-Authors: Alexandre Joosten M.D.[1, 2], Ph.D., Luc Van Obbergh M.D.[1], Ph.D., Maxime Cannesson M.D.[3], Ph.D., Joseph Rinehart, M.D.[4]

1. Department of Anesthesiology CUB Erasme, Université Libre de Bruxelles, Belgium
2. Department of Anesthesiology and Intensive Care, Hôpitaux Universitaires Paris-Sud, Université Paris-Sud, Université Paris-Saclay, Hôpital De Bicêtre, Assistance Publique Hôpitaux de Paris, France
3. Department of Anesthesiology & Perioperative Medicine, David Geffen School of Medicine, University of California Los Angeles, California, USA
4. Department of Anesthesiology & Perioperative Care, University of California Irvine, California, USA

Background: Both magnitude and duration of hypotension are associated with cardiovascular[1], renal[2] and neurological[3] adverse events. Anesthesiologists and intensivists frequently use vasopressors, which are either given in sporadic boluses or adjustable infusions with the goal of maintaining adequate arterial pressure for organ perfusion (e.g. mean arterial pressure of >70mmHg). These manual approaches are time-consuming and limited by distractions. This can ultimately lead to poor compliance to the initial goal-directed strategy and consequently hypotension[4]. Using lessons learned in the development and testing of a closed-loop fluid resuscitation algorithm, we developed a mixed proportional-integrative and rule-based closed-loop system that allows automatic titration of norepinephrine infusion to optimize MAP. This system, linked to a minimally invasive hemodynamic monitoring device, has been tested extensively *in silico*[5] and in animal[(under review)] studies.

In this case series, we sought to determine the feasibility of using our novel controller linked to a non-invasive blood pressure monitor. We aimed to maintain normotension in a series of patients undergoing renal transplant surgery.

Methods: Three high-risk renal transplant surgery patients were recruited for this case series. All three were monitored with non-invasive continuous blood pressure monitoring (Clearsight, Edwards Lifesciences, Irvine, USA), which was linked to the closed-loop controller. The controller automatically titrated norepinephrine doses to achieve a predetermined MAP of 70 mmHg in two patients and of 80 mmHg in one patient (target chosen based on patient's baseline MAP). The primary objective was case time spent in hypotension, which was defined as a MAP below 5 mmHg of the target MAP. Secondary objectives were the percentage time spent above the target value with norepinephrine still running (i.e., overtreatment) and the amount of norepinephrine administered to the patients.

Results: The controller maintained MAP within ±5 mmHg of the predefined target MAP for 91.4% [86.6 -94.7]% (median [25-75] percentiles) of the case time. Patients spent 5.7% [3.7-

8.2]% of case time in hypotension and 2.9% [1.7-5.3]% above target with norepinephrine still running. Median case duration was 2.57 hours and norepinephrine was running during 97.3% of the case time (min: 81.4% ; max: 98.1%). The median dose of norepinephrine was 3.74 µg/min and the controller did 189 changes per hour. The target for one patient was increased to 90mmHg following surgical assessment of poor renal graft perfusion. Patients stayed hospitalized 7 to 9 days and no major postoperative complication occurred. One patient was treated for urinary tract infection.

Discussion: Managing blood pressure using a closed-loop vasopressor administration system guided by continuous non-invasive blood pressure monitoring is feasible. Patients maintained MAP within a ±5 mmHg target range for more than 90% of the case time with 5.7% of case time under target and 2.9% above target. This system may become a powerful new tool for preventing hypotension in surgical patients.

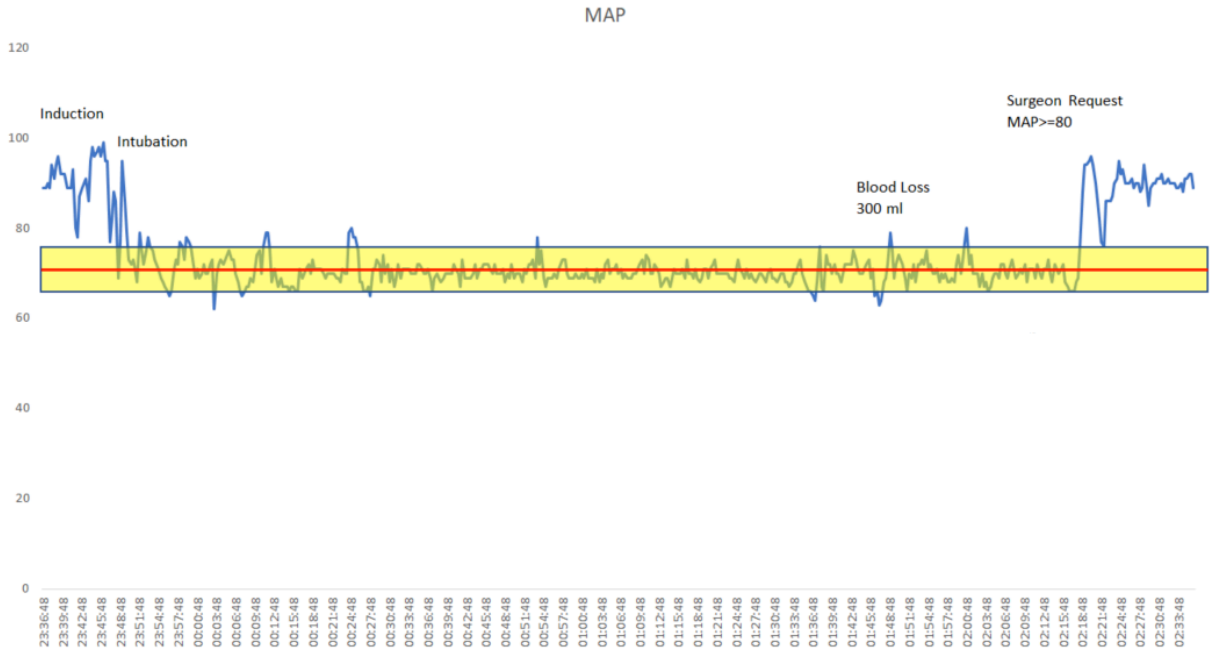

Figure: Intraoperative mean blood pressure (MAP) throughout the intraoperative period in a patient undergoing renal transplantation. The controller automatically titrated norepinephrine to achieve a predetermined MAP of 70 mmHg.

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