



# Immediate Helmet Continuous Positive Airway Pressure to Deal Liver Transplantation in Infants Under 1 Year in Pediatric Intensive Care Unit

Yvonne Valzani<sup>2</sup>, Emanuele Rossetti<sup>1\*</sup>, Francesca Tortora<sup>1</sup>, Rosanna Pariante<sup>1</sup>, Roberto Bianchi<sup>1</sup> and Sergio Picardo<sup>1</sup>

<sup>1</sup>Department of Emergency-Anaesthesia and Intensive Care (DEA-ARCO), Bambino Gesù Children's Hospital, Italy

<sup>2</sup>Department of Intensive Care Unit, University of Modena and Reggio Emilia, Italy

## Abstract

**Purpose:** To analyse the correlation between intraoperative fluid therapy and immediate Helmet CPAP on length of conventional mechanical ventilation and length of stay in paediatric intensive care unit in children less than 1 year submitted to liver transplantation.

**Materials and Methods:** A retrospective, descriptive, single centre chart review analysis. Institutional review board approved the study. Inclusion criteria: 1) Children submitted to liver transplantation from January 2008 to October 2014 in our Department; 2) children over 1 month; 3) children less than 1 year. Exclusion criteria: 1) children submitted to liver-kidney transplantation or to multi-visceral transplantation; 2) Redo liver transplantation. From our medical records, we collected demographic data, indications to liver transplantation, paediatric end-stage liver disease score, intraoperative fluid administration, intraoperative diuresis, intraoperative perspiration, fluid balance at the end of surgery and need for non-invasive ventilation after extubation. We recorded days of conventional mechanical ventilation and length of stay in paediatric intensive care unit. We also recorded need for re-intubation. Statistical analysis was performed using Stata 10 ver. per Windows software. Data are expressed as median (max-min) and average  $\pm$  Standard Deviation. Wilcoxon test was used to compare medians. P value  $<0.05$  was considered as a statistically significant value.

**Results:** The 38 children less than 1 year were submitted to liver transplantation from January 2008 to October 2014. Median age was  $7.8 \pm 3.2$  months. Median weight was  $6.8 \pm 1.9$  Kg. Average paediatric end-stage liver disease score was  $27.2 \pm 16.8$ . Male female ratio was 1.4:1. The most frequent indication to liver transplantation was biliary atresia (34 children less than 1 year). End surgery fluid balance resulted to be inferior for children submitted to orthotopic liver transplantation after December 2011. Children were divided into two groups according to this result. Furthermore, since 2011 early Helmet CPAP support increased progressively. We found that children under 1 year submitted to a restrictive intraoperative fluid management and treated with Helmet CPAP immediately after extubation showed better outcomes in terms of length of conventional mechanical ventilation and length of stay in paediatric intensive care unit.

**Conclusion:** According to our results and considering the limits of a retrospective cohort study, restrictive intraoperative fluid management and early post extubation Helmet CPAP seem to have relevant impact in paediatric liver transplantation postoperative outcome in terms of length of conventional mechanical ventilation and length of stay in paediatric intensive care unit. Further investigations are required to confirm these single centre experience findings.

**Keywords:** Paediatric liver transplantation; Fluid management; Length of stay; Paediatric intensive care unit; Non-invasive ventilation

## Introduction

Over the last decade, continuous surgical, anaesthesiological and immunological management improvements led Paediatric Liver Transplantation (PLT) to longer graft survival [1-2]. Nowadays, PLT is widely considered the treatment of choice for end stage liver disease [3]. End stage liver disease is often a high cardiac output condition with decreased systemic vascular resistance and depleted intravascular volume [4]. During the three phases of transplantation, there are sudden fluid

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### \*Correspondence:

Emanuele Rossetti, Department of Emergency-Anaesthesia and Intensive Care (DEA-ARCO), Bambino Gesù Children's Hospital, IRCCS, piazza S. Onofrio 4, Rome, Italy, Tel: +39 0668592397; +39 066865889; Fax: 0039 3478370026; E-mail: emanuele.rossetti@opbg.net

**Received Date:** 08 Jan 2018

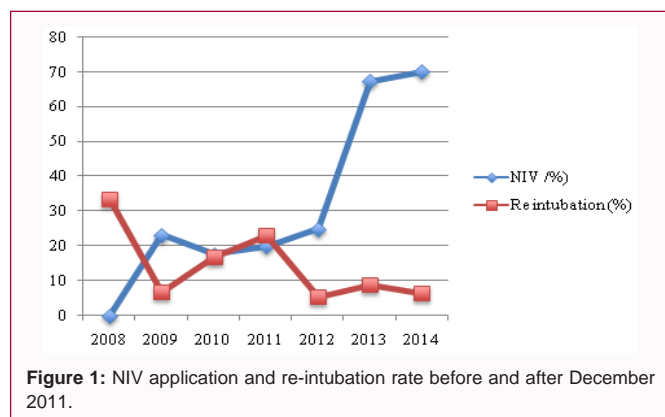
**Accepted Date:** 29 Mar 2018

**Published Date:** 30 Mar 2018

### Citation:

Valzani Y, Rossetti E, Tortora F, Pariante R, Bianchi R, Picardo S. Immediate Helmet Continuous Positive Airway Pressure to Deal Liver Transplantation in Infants Under 1 Year in Pediatric Intensive Care Unit. *Ann Clin Anesth Res.* 2018; 2(1): 1007.

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shifts due to blood loss, inferior cava vein clamping and reperfusion [5]. Intraoperative fluid management in PLT is considered the most complicated and controversial aspect of anaesthesia, especially in children less than 1 year. Anaesthesiologists should strictly monitor intravascular fluid volume status: in our institution we used central venous pressure variations, arterial curve damping and diuresis modifications. The fluid requirement in children submitted to general anaesthesia is estimated according to Holliday and Lindahl's study [6]. It deals with an old method tuned in 1957, to estimate fluid requirement, never reviewed because of ethical implications in leading randomized trials in children. For this reason, no scientific paper is now a day available in matter of fluid management in children less than 1 year submitted to PLT. Murat and Dubois underline that liberal intraoperative fluid management in children can determine respiratory complications and may delay the discharge from Paediatric Intensive Care Unit (PICU) [7]. Bailey et al. [8] suggest applying different fluid management strategies according to the clinical status of children. Mandee et al. [9] led the only available study about restrictive intraoperative fluid regimen in children less than 3 year submitted to general surgery - but not to transplantation - and found no confirmations towards restrictive strategies. Tracheal extubation is a critical step following liver transplantation and time of tracheal extubation is still debated [10]. Currently, only few studies described the use of early or even immediate extubation in the operating room [11]. Early extubation among selected patients as those undergone small amount of blood transfusion, lower Paediatric End-stage Liver Disease (PELD) score, short ischemic time and good status of the graft, may improve early graft function, reducing both Length of Stay (LOS) in PICU and nosocomial infection [12]. Clearly, early extubation is not feasible and safe after PLT in all patients due to coexisting conditions requiring prolonged ventilatory support, or in case of surgical complications (inferior cava vein thrombosis, arterial stenosis, biliary leakage) [13]. Increased intra-thoracic pressure due to invasive mechanical ventilation raises pulmonary vascular resistance and increases right ventricular after load. Furthermore, backward flow into the inferior cava vein and hepatic veins may develop congestion of liver graft. Conversely, spontaneous breathing improves patients' venous return and hepatic blood flow, resulting in better liver graft recovery [14]. Early application of Non Invasive Ventilation (NIV) after extubation improves children outcomes in terms of need for re-intubation and consequently in term of length of Conventional Mechanical Ventilation (CMV). Only few studies describe benefits of NIV in children submitted to PLT: Chin et al. [15] found that early administration of NIV may avoid re-intubation in paediatric patients after solid organ transplantation and improve the

prognosis. Murase et al. [16] evaluated the role of NIV in paediatric patients after liver transplantation and found that the use of NIV immediately after extubation prevented the worsening of atelectasis and stabilized respiratory conditions. In this retrospective analysis, we estimated the impact of restrictive fluid management and early post extubation NIV on mean length of CMV and mean LOS in PICU of children under 1 year undergone PLT.

## Materials and Methods

A single centre retrospective chart review was conducted to determine the role of fluid therapy and early post extubation Helmet CPAP in children less than 1 year submitted to PLT.

### Inclusion criteria

- 1) Children submitted to PLT from January 2008 to October 2014 in our Department
- 2) Children over 1 month
- 3) Children under 1 year

### Exclusion criteria

- 1) Children submitted to liver - kidney transplantation or to multi visceral transplantation
- 2) Redo PLT

From our medical records, we collected demographic data, indications to liver transplantation, PELD score, intraoperative fluid administration, intraoperative diuresis, intraoperative perspiration, fluid balance at the end of surgery and need for NIV after extubation. We recorded days of CMV and LOS in PICU. We also recorded need for re-intubation. Statistical analysis was performed using Stata 10 ver. per Windows software. Data are expressed as median (max-min) and average  $\pm$  Standard Deviation. Wilcoxon test was used to compare medians. P value  $<0.05$  was considered to be significant.

## Results

The 38 children less than 1 year were submitted to PLT from January 2008 to October 2014. Median age was  $7.8 \pm 3.2$  months. Median weight was  $6.8 \pm 1.9$  Kg. Average PELD score was  $27.2 \pm 16.8$ . Male: female ratio was 1.4:1. The most frequent indication to PLT was biliary atresia (34 children under 1 year). End surgery fluid balance resulted to be inferior for children submitted to OLT after December 2011 [Table 1]. Furthermore, since December 2011 immediate post extubation Helmet CPAP application increased progressively (2008: 0%; 2009: 22%; 2010: 18%; 2011: 20%; 2012: 25%; 2013: 68%; 2014: 70%) without increase in need for re-intubation (2008: 0%; 2009: 8%; 2010: 17%; 2011: 21%; 2012: 7%; 2013: 10%; 2014: 8%) (Figure 1). According to these results we divided children into two groups (Group A and Group B): children submitted to PLT before December 2011 belong to group A and children submitted to PLT after December 2011 belong to Group B [17-19]. We found that Group A and B were homogeneous in age, weight, male/female ratio and PELD score [Table 2]. Length of CMV in Group B resulted significantly shorter than length of CMV in Group A. LOS in Group B resulted significantly shorter than LOS in Group A [Table 3].

## Conclusion

Our retrospective study made possible to divide children into two groups comparable in anthropometric features and severity of illness. As it is known randomized trials in paediatric field are complicated

**Table 1:** End surgery fluid balance.

	Pre Dec2011	Post Dec 2011	P
Fluid Balance ml	370 (7 - 1310)	70 (10 - 110)	0.00004

**Table 2:** PLT patients in study before (A) and after (B) December 2011.

	Group A	Group B
Age (months)	7.6 ± 3.1	7.5 ± 2.8
Weight (Kilos)	6.9 ± 1.7	7.1 ± 2.2
Male: Female	1.4 : 1	1.4 : 1
PELD score	28.2 ± 14.8	27.8 ± 15.4

**Table 3:** CMV and LOS statistical differences.

	Group A	Group B	P
CMV (days)	2 (1-6)	1 (1-3)	0.013
LOS (days)	8 (4-16)	5 (4-7)	0.042

to lead because of ethical implications. From data analysis we found that children less than 1 year submitted to PLT after December 2011 presented lower end surgery fluid balance. We also noticed that since December 2011 immediate post extubation Helmet CPAP was most frequently applied. According to these results we divided children into two groups: group A (up to December 2011) and group B (post December 2011). It emerged that children belonging to Group B presented shorter length of CMV and LOS. To date, other authors described monocentric experience on immediate extubation after liver transplantation in selected patients as living-donor transplantation, children less than 1 kg and PELD score lower than our experience. According to our study, considering the limits of a retrospective and cohort evaluation, a restrictive intraoperative fluid regimen and immediate post-extubation Helmet CPAP application may reduce the need for CMV and intensive care requirement. Further investigations are necessary to verify this finding in paediatric population.

**Ethics:** Institutional Review Board (IRB).

**Approval:** Bambino Gesù Children's Hospital IRB, 24/11/2015, 1026\_2015\_OPBG.

**Funding:** The study was funded by departmental resources.

**Disclosures:** Any conflict of interest.

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