使用非侵入呼吸量监测系统对患者风险分级可以提高术后 PACU 阿片类药物使用安全性

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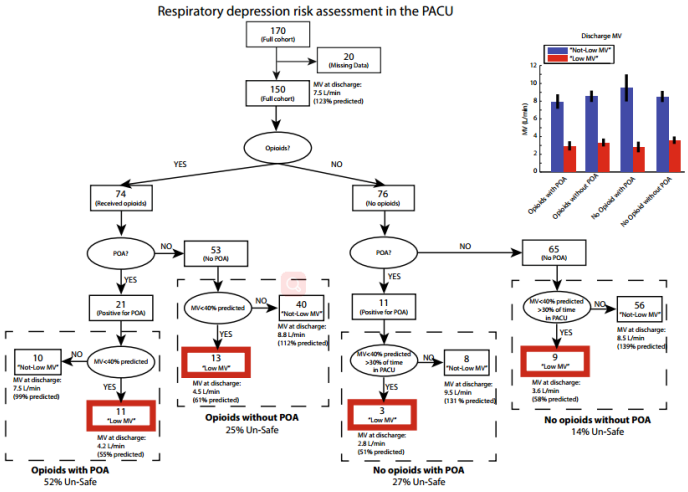
摘要:未及时发现非插管患者呼吸抑制情况会危及患者安全。SpO_2 判定呼吸抑制是滞后的，$EtCO_2$ 在非插管患者中使用证明是不可靠的。每分钟通气量（MV）下降是呼吸抑制最早的征兆。一款非侵入呼吸量监测系统（RVM）能够实时得到 MV 值，从而帮助临床预测和量化呼吸抑制。本实验为观察性研究，操作者不清楚 RVM 测量意义，疼痛管理遵循一般方案。患者依据到达 PACU 时 MV 情况进行分组，分为“有风险组”和“无风险组”，评估每组患者接受阿片类药物后产生“低 MV”的状态。目的是确定是否可以依据到达 PACU 时 MV 情况确定呼吸抑制风险高的患者。预先确定标准阿片药物剂量下呼吸抑制风险较高的患者可以推动疼痛管理的变革并改善病人护理。

收集了 150 名关节置换手术患者在 PACU 的 RVM 和阿片类药物使用数据进行观察性研究。使用标准公式计算每位患者 MV 预测值（MV_{PRED}）和预测值百分比（测量值/预测值×100%）。接受阿片类药物之前，患者分成“无风险组”（$MV \geq 80\%MV_{PRED}$）和“有风险组”（$MV < 80\%MV_{PRED}$）。“低 MV”事件定义为 $MV < 40\%MV_{PRED}$。术后呼吸暂停（POA）定义为在 PACU 停留时，每小时≥5 次 10 秒以上呼吸暂停。研究比较两组单次阿片类药物后“低 MV”事件，POA 和转出时“低 MV”事件的发生率。

在 PACU 中，74/150 名患者接受了阿片类药物，给药 15 分钟内，32%（24/74）位患者发生“低 MV”事件。风险分组预测了其中 22 位患者（92%敏感性）。其中只有 46%患者有 POA，大多数患者发生“低 MV”而没有 POA。转出时，29/150 位患者出现“低 MV”，接受阿片类患者出现“低 MV”的可能性高出 50%（23% vs. 16%）。RVM 可以辨别接受阿片类药物导致呼吸抑制和/或经历 POA 的高风险患者。监测 MV 可以指导阿片类药物给药方案，在整个护理过程中提高患者安全性。



A Risk Stratification Algorithm Using Non-invasive Respiratory Volume Monitoring to Improve Safety when Using Post-Operative Opioids in the PACU

Abstract: Late detection of respiratory depression in non-intubated patients compromises patient safety. SpO_2 is a lagging indicator of respiratory depression and $EtCO_2$ has proven to be unreliable in non-intubated patients. A decline in minute ventilation (MV) is the earliest sign of respiratory depression. A non-invasive respiratory volume monitor (RVM) that provides accurate, continuous MV measurements enables clinicians to predict and quantify respiratory compromise.

For this observational study, practitioners were blinded to the RVM measurements and pain management followed the usual routine. Patients were stratified by their MV on PACU admission and classified as ‘‘At-Risk’’ or ‘‘Not-At-Risk,’’ with progression to ‘‘Low MV’’ status following opioids assessed for each category. The purpose was to determine if stratifying based on MV on PACU arrival could identify patients at higher risk for respiratory depression. Ability to identify in advance patients at higher risk for respiratory depression following standard opioid dosing would drive changes in pain management and improve patient care.

RVM and opioid administration data from 150 PACU patients following elective joint-replacement surgery were collected in an observational study. ‘‘Predicted’’ MV (MV_{PRED}) and ‘‘Percent Predicted’’ ($MV_{MEASURED}/MV_{PRED} \times 100\%$) were calculated for each patient using standard formulas. Prior to opioid administration, patients were classified as either ‘‘Not-At-Risk’’ ($MV \geq 80\%\ MV_{PRED}$) or ‘‘At-Risk’’ ($MV < 80\%\ MV_{PRED}$). ‘‘Low MV’’ was defined as $MV < 40\ \% MV_{PRED}$. Post-operative apnea (POA) was defined as ≥5 ten-second apneas per hour of PACU stay. We compared the incidences of Low MV following a single opioid dose, POA, and Low MV at discharge for both groups.

In the PACU, 74/150 patients received opioids. Within 15 min of opioid administration, 32 % (24/74) developed Low MV. The risk-stratification algorithm identified 22/24 patients (92% sensitivity). Only 46% of them had POA, and the majority had Low MV without POA. At discharge, 29/150 patients had Low MV and those receiving opioids were 50% more likely to display Low MV (23vs. 16%). The RVM can identify patients at-risk for opioid-induced respiratory depression and/or experiencing POA. Monitoring of MV can guide opioid-dosing regimens and may increase patient safety across the continuum of care.