Study First to Use Markovian Models for Tracing Postoperative Pain Trajectories

March 19, 2015, NATIONAL HARBOR, Md. – Markovian models show promise for describing postoperative pain states and, eventually, may help guide clinical decisions, a new study found. In a surgical inpatient population, patients early in their postoperative recovery period carry roughly the same probability of transitioning from one pain state to another, regardless of the timing of the assessment, according to preliminary results on view today at the 31st Annual Meeting of the American Academy of Pain Medicine.

“Pain trajectories help us to understand why different patients will hurt for different lengths of time after injury or surgery,” said Patrick Tighe, M.D., who led the team of investigators from the University of Florida in Gainesville, Fla. “Different analgesics each have different pharmacokinetic profiles, and so a better understanding of pain trajectories could help us better match analgesics to patients.“

The use of Markovian models is new in this context. Markovian models and their derivatives have been applied to a range of problems in financial markets, weather patterns, board game development, DNA sequencing and speech recognition. The models use sequential data to help explain how systems that continually change do so in a probabilistic manner, Tighe explained. The behavior of a probabilistic system cannot be predicted exactly, but the probability of certain behaviors is known. Thus, these methods require certain assumptions about a system.

With institutional review board approval through the University of Florida and funding through a grant from the National Institutes of Health, the investigators set out to test whether Markovian models could be used to predict pain trajectories. First, they examined the first five clinically recorded postoperative pain intensity ratings from a mixed surgical cohort of 26,090 patients. They then measured the probability that a patient would transition from a given pain intensity rating to a subsequent pain intensity rating between each of the first four transition steps.

What they found was that the clinically measured pain states were stable, in terms of the probable distribution over the first five assessments following surgery. Thus, if the initial pain rating was 0, which was the most common rating for all ages and both sexes (range 30.7 percent – 74.6 percent), the sequential transition matrices demonstrated a high probability of transition to 0 for all; indeed, the highest probability was observed for 0 to 0 and 10 to 10. All pain states had a high probability of transitioning to 0 as well as to the same pain state.
“This was a bit surprising, given that we had hoped to see an increase in the probability that patients would transition from higher to lower pain states with each sequential transition,” Tighe said.

The potential for Markovian models to assist medical decision making has been described before. In a scientific journal article, Sonnenberg and Beck wrote, “Markov models are useful when a decision problem involves risk that is continuous over time, when the timing of events is important, and when important events may happen more than once. Representing such clinical settings with conventional decision trees is difficult and may require unrealistic simplifying assumptions. Markov models assume that a patient is always in one of a finite number of discrete health states, called Markov states (Med Decis Making 1993;13(4):322-38).”

Tighe said the current results must be validated in other contexts and institutions, then stratified to specific patient populations. Further, these preliminary explorations must be further matured into decision process models that balance short-term gains with long-term outcomes.

“We still have a ways to go,” he said.


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