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REGENERATIVE PAIN MEDICINE/INTERVENTIONAL PAIN MEDICINE (E CORNETT BRADLEY, SECTION EDITOR)

Electronic Health Record Recording of Patient Pain: Challenges and Discrepancies

Yasmeen Kawji[1] · Hanna Almoaswes[1] · Claire Bise[1] · Lena Kawji[2] · Adrienne Murphy[1] · Tanner D. Reed[1] · Rachel J. Klapper[3] · Shahab Ahmadzadeh[4] · Sahar Shekoohi[4] · Elyse M. Cornett[4] · Alan D. Kaye[4,5]

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Abstract

Purpose of Review In the present review, various categories of pain, clinician-observed pain scales, and patient-reported pain scales are evaluated to better understand factors that impact patient pain perceptions. Additionally, the expansion of areas that require further research to determine the optimal way to evaluate pain scale data for treatment and management are discussed.

Recent Findings Electronic health record (EHR) data provides a starting point for evaluating whether patient predictors influence postoperative pain. There are several ways to assess pain and choosing the most effective form of pain treatment. Identifying individuals at high risk for severe postoperative pain enables more effective pain treatment. However, there are discrepancies in patient pain reporting dependent on instruments used to measure pain and their storage in the EHR. Additionally, whether administered by a physician or another healthcare practitioner, differences in patient pain perception occur. While each scale has distinct advantages and limitations, pain scale data is a valuable therapeutic tool for assisting clinicians in providing patients with optimal pain control. Accurate assessment of patient pain perceptions by data extraction from electronic health records provides a potential for pain alleviation improvement.

Summary Predicting high-risk postoperative pain syndromes is a difficult clinical challenge. Numerous studies have been conducted on factors that impact pain prediction. Postoperative pain is significantly predicted by the kind of operation, the existence of prior discomfort, patient anxiety, and age.

Keywords Electronic health record data · Patient pain predictions · Pain management · Chronic pain · Acute pain · Multi-agent systems

Introduction

Prediction of high-risk postoperative pain conditions is a complex and challenging clinical dilemma. Factors that influence pain predictions are well documented. Significant predictors of post-operative pain include the type of surgery, presence of preoperative pain, patient anxiety, and age [1]. Data found in the electronic health records (EHR) is a starting point for determining what specific patient predictors influence postoperative pain. At present, a variety of different methods exist for screening pain and determining appropriate pain management. Identifying patients with high-risk predictors for significant postoperative pain allows for more effective postoperative pain management. Pain remains a significant concern for patients undergoing surgery. Both physiological and psychological factors play a role in pain perception. Adequate pain control following surgical procedures is necessary for patient recovery and better outcomes. Less than half of surgery patients report sufficient pain relief [2•]. Factors contributing to less-than-optimal pain relief include a lack of concrete pain surveillance methods and intervention guidelines [2•]. Adequate pain control following surgical procedures is necessary for patient recovery and better outcomes [3].

Management of pain can be improved using pain instruments that assess the intensity, affect, duration, and onset of pain [4]. Popular scales for rating pain include the FPS-R and the Wong Baker Scale, and both rely on reporting of a face that is meant to reflect the subjective experience of pain [5]. Numeric Rating Scale (NRS-11) is a screening tool to

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evaluate patient pain intensity. Many hospital systems utilize the NRS and record patient survey results in the EHR. While NRS is an easy and reliable method of pain screening, it does not accurately capture the change in pain perception over time [6]. A method to measure pain effect is the McGill Pain Questionnaire, which includes a pain rating index and is considered one of the most comprehensive tools available for measuring affect [7].

Discrepancies exist in patient pain reporting based on instruments utilized for pain assessment and storage in EHR. Differences also occur in patient pain perception when administered by a physician or other healthcare provider [8]. While each scale offers advantages and disadvantages compared to other, pain scale data is a useful clinical tool to assist in providing patients with optimal pain control. Accurate evaluation of patient pain perceptions from extraction of electronic health data represents an opportunity for improved pain relief. To better understand factors influencing patient pain perceptions, we discuss the major types of pain, clinician-observed pain scales, and patient-reported pain scales. We expand on areas that will require more investigation for how to best interpret pain scale data for treatment and management.

Types of Pain

The International Association for the Study of Pain defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage" [9]. Pain is a multidimensional experience encompassing sensory and emotional factors [10]. It can be connected to a physical stimulus and psychological interpretation. Physically, it can be caused by chemical, thermal, or mechanical nociceptors found along the body [11]. Visceral pain is pain that is coming from internal organs and usually feels diffuse and difficult to pinpoint. In contrast, somatic pain comes from receptors on the skin, muscles, or soft tissues eliciting a precise, localizable pain.

Pain can be classified based on duration, either as acute or chronic. Acute pain is transient and associated with a pinpointable disease or injury. On the other hand, chronic pain is classified as a state of pain because it is more permanent [12]. Chronic pain is estimated to affect at least one-sixth of the population [13]. If it is due to a disease or injury, it is considered chronic when the pain outlasts the normal healing time. It may also stem from psychological states that do not have a foreseeable end. Therefore, whereas the treatment of acute pain is more focused on physical nociceptive signaling, treating chronic pain may involve a multidisciplinary approach [14]. The intensity of pain, classified as mild, moderate, or severe, varies from person to person. Using the visual analog scale or VAS to assess pain thresholds, the differences in the actual pain conditions were little and not significantly different between males and females or those with or without current pain [15]. The source, however, can affect how dimensional and long-term the pain may be. Depending on if the source is physical, emotional, or psychological, treatment may require more than one specialty. The different intensities of perceived pain are due to the specific nociceptive afferents, which, depending on the signal, encode different magnitudes of intensity.

Nociceptors are the sensory neurons with receptors that can detect stimuli with the potential to cause pain [16]. Nociceptive pain is pain that continues only when in the presence of a noxious stimulus; therefore, the source is apparent. Examples of nociceptive pain, include fractured or broken bones, arthritis, and even bruises. Neuropathic pain, on the other hand, is considered the "maladaptive response of the nervous system to damage" [17]. A disease, or lesion of the nervous system, causes it. Examples include imbalances between excitatory and inhibitory somatosensory signaling and alterations in ion channels [18]. A few characteristics of neuropathic pain are unexplainable diffuse pain, evidence of a sensory deficit, burning sensation, allodynia, and sudden spontaneous pain attacks [13]. Psychological pain overlaps with pathways in the brain activated during physical pain [10]. Like most pain, psychological pain is subjective; it can manifest as shame, guilt, loneliness, despair, or sadness. It tends to be increased in intensity in those with major depressive disorder or a traumatic stressor. Overall, pain is incredibly relative. Whether nociceptive, neuropathic, or psychological; lasting acutely or chronically; or stemming from visceral or somatic sources, it requires proper assessment and configuration to treat adequately.

Pain Scales: Clinician Observation

Pain measurement is a multivariable process depending on patient age, location of pathophysiological insult, comorbidities, and other factors unique to the patient. It is critical to consider that pain-like behavior should always be interpreted in the context of a patient's documented medical and social history, or lack thereof. Clinician measurement of pain often relies upon interpretation of pain-like behavior. In cases of the nonverbal patient population, the clinician should consider pain-like behavior to be an invaluable indicator of pain, in addition to physiological measurements. Clinical assessment of pain in a neonate is particularly challenging because neonates are nonverbal, and current knowledge in how neonates perceive pain is considered inadequate [19]. There is no single standardized pain scale for neonates; however, one frequently used for children less than one year of age is known as the Neonatal Infant Pain Score (NIPS). This pain scale comprises six behavioral categories: *Facial Expression, Crying, Breathing Patterns, Arms, Legs, and State of Arousal*. Each category is scored as either *0* or *1*,

with *Crying* having an option for a score of *2*, depending on the status of the neonate. The summation of the categorical scores is taken to yield a total score which can be interpreted as absent to mild pain, moderate pain, or severe pain. The scored total can further determine the potential need for medical intervention [20•].

The Face, Legs, Activity, Cry, Consolability (FLACC) Scale is another method that has particular use for nonverbal patients and children between two months and seven years of age [20•]. The FLACC Scale has five criteria: *Face*, *Legs*, *Activity*, *Cry*, and *Consolability*. Each criteria can be scored as *0*, *1*, or *2*. The result from the addition of the scores can be used to estimate the patient's severity of pain as *absent*, *mild*, *moderate*, or *severe*. [21] Similar in methodology to the FLACC scale, the Pain Assessment in Advanced Dementia (PAINAD) scale can be used for patients with dementia. The PAINAD scale differs from the FLACC scale regarding its main criteria: *Breathing*, *Negative Vocalization*, *Facial Expression*, *Body Language*, and *Consolability*. [20•] The COMFORT Scale is another type of pain scale originally developed in 1992 for pediatric patients on ventilators. It can measure the magnitude of sedation, distress, and pain that a patient may be experiencing [22]. When this scale was initially developed, it included six behavioral criteria (*Alertness*, *Calmness/Agitation*, *Respiratory Response* in ventilated patients, *Physical Movement*, *Muscle Tone*, *Facial Tension*) and two physiological criteria (*Heart Rate* and *Blood Pressure*). The behavioral criteria could be scored from *0* to *5*. A lower score indicates less pain, while a higher score indicates more pain [23]. Years later, and after further analysis, the scale was refined to only include the six behavioral criteria as they could decipher most differences among patient scores. This refined COMFORT scale became known as the COMFORT-Behavior Scale [23].

The Nonverbal Pain Scale (NVPS) can be applied to nonverbal adult patients. Potential cases include patients who are critically ill or who have undergone trauma, burns, or surgery [24–27]. The behavioral categories of this scale include modified versions of the *Face* and *Activity* criteria from the FLACC scale while adding a *Guarding* category. Further, there are two physiological categories: *Physiologic I* and *Physiologic II*. *Physiologic I* utilizes the patient's vital signs, and *Physiologic II* involves characteristics of the patient's skin and pupils (pallor, perspiration, flushing, and pupil dilation). Like FLACC, each of the five criteria can be scored as *0*, *1*, or *2*, and the summation of the scores is taken to help decipher pain level. This test has proven to have discriminant validity, but reliability was still in question [28]. The NVPS was later updated to include a *Respiratory* category called NVPS-R (Refined). Studies have shown that NVPS-R is overall better than the original NVPS and possesses consistent reliability and validity [27]. The success of NVPS and NVPS-R application in the palliative care setting is still uncertain and warrants further studies [28].

Pain Scales: Patient Self-Reporting

Self-reporting pain helps identify pain location and quantification of intensity, which can help determine the most appropriate treatment options for patients [29]. There are numerous types of patient self-reporting pain scales in use, and based on various studies, all have shown to be valid, reliable, and appropriate for use [1]. The most commonly used self-reporting pain scales include the Visual Analogue Scale, Numeric Rating Scale, Faces Pain Scale-Revised, and Color Analogue Scale.

The Visual Analogue Scale (VAS) is a 100-mm horizontal line with one end labeled "no pain" and the other end labelled "the worst possible pain." Patients rate their pain intensity as somewhere between those pain extremes [1]. Abstraction and an understanding of magnitude are required for patients to use VAS. VAS has been recommended for use in patients eight years old and older [29]. The Numeric Rating Scale (NRS-11) is a scale from *0* to *10*, in which *0* indicates no pain and *10* represents the worst possible pain. Patients pick a value from that range to rate their pain intensity. Unlike VAS, NRS requires the patient to understand numbers [1]. The Faces Pain Scale-Revised (FPS-R) consists of six faces horizontally lined up, with each face showing a greater pain level than the previous as you go from left to right. Below each face is a score *0*, *2*, *4*, *6*, *8*, or *10* as you go from left to right. The leftmost face has the score of *0* and represents no pain, whereas the rightmost pain has the score of *10* and represents the worst pain. Patients using this scale circle the face that best represents their pain. FPS-R is recommended for use in ages four and above [29]. This scale is useful for children because it does not require patients to understand numbers and magnitude [29]. Color Analogue Scale (CAS) is a wedge-shaped scale with the narrow end being white and gradually changing color to red, the closer to the wider end, you go [29]. The white indicates no pain, and the red indicates the worst pain possible. Patients move the slider along the scale to indicate their pain level. CAS is recommended in patients ages five and older [29].

Management of Patient Pain Predictions and Their Potential Consequences

There is a high prevalence of pain in emergency medical care, as pain is a presenting complaint for up to 70% of emergency department visits [30–32]. However, oligoanalgesia, or the underuse of analgesics, occurs in many emergency department cases [33]. Two critical factors that can feed into oligoanalgesia are shortcomings in acknowledging patients' pain and assessing the pain [32, 34–37].

To enhance pain management in patients, it is thus fundamental for healthcare workers to accurately acknowledge and assess patients' pain level.

Pain scales can serve as valuable, accurate tools to assess patients' pain and guide treatment plans. A 2018 cross-sectional prospective observational study investigated the effects of viewing patient VAS scores on physician's perception of patient pain [38]. The study found that physicians tended to underestimate patient pain [38]. However, when physicians had access to patient self-reported VAS scores in advance, physicians' perception of patient pain increased significantly. The physicians were more likely to prescribe analgesics for the patients [38]. These findings suggest that simply viewing patient VAS scores can influence physician's interpretations of patient pain to be more accurate, which can lead to more successful pain management for patients.

Differences in Patient Reporting

Another important inquiry is whether there are discrepancies in patient pain reporting to different medical staff. A 2018 retrospective cohort study compared patient VAS scores reported to the physician versus the nursing staff [39]. A total of 201 operative foot and ankle patients were preoperatively interviewed and asked to rate their pain by the nursing staff, and then the patients were interviewed and asked again by the surgeon [39]. The study found that 81% of patients reported higher VAS scores to the physician, 8% reported higher scores to the nursing staff, and 11% reported the same pain score to the physician and nursing staff [39]. A 2018 follow-up study with the same research design investigated reporting during encounters with nonoperative patients [40]. It was found that 53% of patients reported higher scores to the physician, 17% reported higher scores to the nursing staff, and 30% reported equal scores to both professions [40].

Furthermore, a 2019 prospective, blinded study investigated the same concept in a postoperative setting using the NRS scores. Ninety postoperative patients were first interviewed by the surgeon, then by the nurse [41]. Fifty-four percent of patients reported the same score to the physician and nurse, and 88% reported scores reported to both professions were within a one-point range [41]. These three studies collectively show the importance of good communication among healthcare professionals caring for the patient and considering the healthcare setting as a possible factor in determining patient reporting consistency. The studies suggest that patients tend to give different pain scores to physicians versus nurses in the preoperative and nonoperative settings (with discrepancy in more encounters in the preoperative setting). In contrast, patients tend to give equal pain scores in postoperative setting encounters [39–41].

Gender Pain Differences

Gender differences in pain perception and treatment is important to stratify to properly treat chronic pain. A meta-analysis study published in 2019 studying sex differences in opioids for pain relief found that men and woman who were prescribed opioids responded differently to pain relief [42]. It is widely studied that a woman's immune system is more robust than men, which accounts for the varied autoimmune disorders that plague women [43]. A study found that chronic neuropathic pain entailed interactions between inflammatory cells, glial cells, and pro and anti-inflammatory cytokines [44, 45]. A study found that chronic pain can be caused by spinal cord activation of glial cells that modulate neuronal synaptic activity [46, 47]. It is known that immune cells such as microglial and T cells are involved in the neuroinflammatory response that differs between sexes. A 2015 study in mice found that pain in mice of different sexes was reversed by different cellular receptors [44]. It was found that microglial toll-like receptors were involved largely in the pain response in men, and inhibition of the T cell response in women drove the neuroinflammatory response to pain [3].

Drug concentrations in the body also play a role in the different sexes. For example, the expression of cytochrome P450 enzymes vary between men and women. This information is important because it affects how effective the drugs for pain relief are in women versus men [48]. Another important element to stratify is how hormonal levels affect pain relief in men and women. Migraines are the most debilitating neurological disorders affecting women. It has been shown that hormones play a crucial role in the pathophysiological mechanism [49, 50]. Specifically, estrogen, progesterone, and androgen hormonal levels are important for changes in pain relief. Menstruating women have changes in their sex hormones that make them more susceptible to migraine attacks [49, 50]. A study found that men who were transitioning into becoming a woman and receiving hormone administration started experiencing headaches similar to women who had migraine attacks. The study also showed that not all participants developed pain. This highlights that sex hormones alone, while contributory to pain sensitivity in different genders, does not fully explain the differences. These findings emphasize the importance of understanding gender roles in pain perception [51, 52].

Racial and Ethnic Barriers that Plague Pain Predictions and Consequences in Minority Patients

Chronic pain affects millions of Americans and costs the medical system billions annually [53•]. The pain burden across racial and ethnic groups is inconsistent in terms of medical management. Much of the research examining this focuses on pain differences in Black, Hispanic, and

Table 1 Patient pain studies and findings

Patient pain studies and findings			
Author (year)	**Groups studied and intervention**	**Results and findings**	**Conclusions**
Cakir et al. (2018)	Physicians were asked to estimate patients' pain either with or without previously viewing patients' VAS scores	Physicians tended to underestimate patients' pain when they did not look at VAS scores. Physicians' perceptions of patients' pain increased when the physicians were allowed to view VAS scores first	VAS and other pain scales can help healthcare workers gain a better understanding of patients' pain
Martin et al. (2018)	A total of operative foot and ankle patients were asked to rate their pain by the nursing staff and physician	Most patients reported higher VAS scores to the physician than the nursing staff	In the preoperative setting, patients tend to complain of more pain to the physician versus the nurse. It is important for the physician and nurse to consistently communicate to reveal any discrepancies in the patient interview and assessment
Martin et al. (2018)	A total of nonoperative foot and ankle patients were asked to rate their pain by the nursing staff and physician	About half the patients reported higher VAS scores to the physician	While there is some discrepancy in patient reporting to the physician versus the nurse in the nonoperative setting, this tends to occur less than during the preoperative setting
Foster et al. (2019)	Ninety postoperative patients were asked to rate their pain to the nursing staff and physician	Most patients reported the same pain score or a score within a narrow range of one another to the physician versus the nurse	In the postoperative setting, patients tend to report agreeing pain scores to the healthcare staff
Casale et al. (2021)	Gender equity and gender differences in pain treatment were examined to understand women's pain perceptions and tolerances	The study found that differences in pain in women are multifactorial, with immunological, physiological, neural, and hormonal aspects contributing to the response of pain and treatment	The review article highlights the importance of pain perspectives in women versus men and how chronic pain conditions mostly affect women. This could be due to underlying immunological responses, which should be addressed in treatment of pain in women
Meints et al. (2019)	Racial and ethnic disparities in pain assessment and treatment were examined	Pain disparities in ethnic and racial minorities patients is influenced by expectations of patients, coping mechanisms, discrimination on part of the healthcare team, and perceived biases of the healthcare team	Much of the literature on racial and ethnic groups focus on Black and Non-Hispanic White patients. However, research is lacking in other minorized groups, such as pain experiences in Asian–Americans, Native Americans, Alaskan Natives, Hawaiian and Pacific Islanders, and Middle-Eastern Americans

non-Hispanic white groups [54]. However, Asian and Native Americans pain differences vary as well. In one study, Asian-Americans endorsed higher pain levels in response to painful knee-osteoarthritis [55]. They also found that they have lower pain tolerances and increased pain sensitivity compared to their white counterparts [55]. Another issue plaguing ethic and racial barriers to pain predictions is disparities in treatment towards minority groups. A review by Anderson and colleagues found that minority patients are more likely to have their pain underestimated by providers and less likely to receive opioids medications to manage their pain [56, 57]. Many factors need to be addressed to work towards understanding the issues plaguing racial and ethnic minority groups in terms of pain management outcomes. The study published in 2019 proposed examining areas such as coping mechanisms, perceived bias and discrimination, patient preferences, and patient expectations [54•]. The study found that understanding these areas can provide insight into the problems that plague minority communities in terms or pain responses [54•]. Research has heavily focused on Black versus White pain preferences and outcomes. However, Hispanic Americans, Asian Americans, and Native Americans populations are steadily rising, and research needs to focus efforts to understand pain predictions in those respective minoritized groups [54•] (see Table 1).

Conclusions

Regardless of the type of pain, pain is often the presenting chief complaint for many patients. Thus, it is important to accurately estimate patients' pain to create the most appropriate, impactful treatment plans for patients. Physicians and other healthcare staff can use their assessment of the patient and use pain scales (NIPS, FLACC scale, PAINAD, COMFORT scale, NVPS) to help them understand the level of pain experienced by the patient. However, referring to pain scales based on patient reporting (VAS, NRS-11, FPS-R, and CAS) can help healthcare workers better understand the patients' pain. Moreover, many of these patient-reported pain scales are quick to complete, so patients can fill them out as they wait to be seen. The staff can also easily incorporate these pain scales into their patient interview and record patient responses.

Furthermore, having these pain scales in use routinely might also enhance patient satisfaction, as this gives patients another opportunity for them to express their feelings. Based on several studies, it was shown that sometimes patients report different pain scale ratings to various members of the healthcare staff, particularly with regard to the physician versus the nurses. Moreover, the setting (nonoperative, preoperative, postoperative) might also affect how patients report their scores to different staff. Such findings emphasize the importance of communication among all healthcare staff members. Good communication and thorough documentation can prevent many faults and shortcomings in the medical field so that everyone involved with patient care can have the same information.

Acknowledging pain differences across different genders is critical, as pain is influenced by many physiological factors. Some conditions primarily affect one gender or may have very different presentations in different genders. Healthcare workers need to constantly be aware of this to avoid dismissing symptoms and missing what could be a life-threatening diagnosis. Similarly, another issue faced in healthcare involves shortcomings in perception of patient pain levels based on the patients' racial and ethnic background. Sometimes, healthcare workers come in with expectations and false beliefs about the patient based on their race, ethnicity, religion, appearance, and family background before they even see the patient. This unconscious bias can lead to major faults in quality of care that stem from differences in patient interviewing, assessment, and treatment plans and decreased patient satisfaction. Thus, healthcare workers need to constantly check for biases to avoid unintentional discrimination towards patients and ensure their patients receive the best quality of care.

Overall, pain management is a substantial aspect of patient care; thus, it is fundamental to accurately assess patient pain levels. The quickness, ease, and accuracy of pain scales make them practical tools to estimate patient pain. Furthermore, the diversity in pain scales allows flexibility in their use across different age groups and situations. By incorporating pain scales into routine healthcare practices, physicians, nurse practitioners, physician assistants, nurses, and other staff members can offer better healthcare to their patients.

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Data Availability Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

Compliance with Ethical Standards

Competing Interests The authors declare no competing interests.

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Authors and Affiliations

Yasmeen Kawji[1] · Hanna Almoaswes[1] · Claire Bise[1] · Lena Kawji[2] · Adrienne Murphy[1] · Tanner D. Reed[1] · Rachel J. Klapper[3] · Shahab Ahmadzadeh[4] · Sahar Shekoohi[4] · Elyse M. Cornett[4] · Alan D. Kaye[4,5]

✉ Sahar Shekoohi
sahar.shekoohi@lsuhs.edu

Yasmeen Kawji
ykawji@lsuhsc.edu

Hanna Almoaswes
halmoa@lsuhsc.edu

Claire Bise
cbise@lsuhsc.edu

Lena Kawji
lka001@lsuhs.edu

Adrienne Murphy
amurp8@lsuhsc.edu

Tanner D. Reed
treed8@lsuhsc.edu

Rachel J. Klapper
rachelkaye278@gmail.com

Shahab Ahmadzadeh
Shahab.ahmadzadeh@lsuhs.edu

Elyse M. Cornett
elyse.bradley@lsuhs.edu

Alan D. Kaye
alan.kaye@lsuhs.edu

[1] School of Medicine, Louisiana State University Health Sciences Center New Orleans, 433 Bolivar Street, New Orleans, LA 70112, USA

[2] Department of Internal Medicine, School of Medicine, Louisiana State University Health Sciences Center at Shreveport, 1501 Kings Highway, Shreveport, LA 71103, USA

[3] Department of Radiology, Louisiana State University Health Sciences Center at Shreveport, 1501 Kings Highway, Shreveport, LA 71103, USA

[4] Present Address: Department of Anesthesiology, Louisiana State University Health Sciences Center at Shreveport, 1501 Kings Highway, Shreveport, LA 71103, USA

[5] Departments of Anesthesiology and Pharmacology, Toxicology, and Neurosciences, Louisiana State University Health Sciences Center at Shreveport, 1501 Kings Highway, Shreveport, LA 71103, USA