


# The Anesthetic Techniques for Earthquake Victims in Indonesia

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**Introduction:** In Lombok, three-large magnitude earthquakes occurred in July 2018 and caused major losses: 564 victims died, 1684 were injured, 445,343 people became refugees, and 215,628 houses were damaged. It damaged 408 health facilities, consisting of 89 public health centers, 13 hospitals, 174 auxiliary public health centers, 132 village health posts.

**Aim:** The purpose of this study is to describe the anesthetic techniques that were used to treat earthquake victims.

**Methods:** This study was a descriptive cross-sectional study that was conducted by collecting total sampling from all earthquake victims treated in the emergency room (ER) of the regional public hospital (RSUD NTB) on August 6th and 7th, 2018, and all victims who underwent surgery during August 5th–25th, 2018. The data that were collected were surgery type, anesthetic techniques, and anesthesia drugs that were used.

**Results:** The results show that the highest number of patients were treated in the ER during the first seven days after the earthquake and that this number then decreased over several weeks. The majority of patients treated were trauma patients who needed orthopedic surgery. General anesthesia was more widely used than regional anesthesia, but the difference was not significant. The most commonly used regional anesthetic was lidocaine hyperbaric 75–100 mg and clonidine 30–50 mcg combination. Regional anesthesia techniques have better results in cases of lower limb injury, but it is difficult to be applied in earthquake victims who present with complex injuries and limited resources.

**Keywords:** anesthesia, technique, earthquake, victim management, health

## Introduction

Earthquakes are the second most frequent natural Disaster after floods and caused the most significant economic losses in the world during 2007–2016.<sup>1</sup> Indonesia is at the confluence of three active world plates: the India-Australia, Eurasia, and Pacific plates, making it vulnerable to earthquakes.<sup>2</sup> Losses caused by earthquakes depend on the magnitude, the distance from the epicenter, the population density, earthquake preparedness, and mitigation efforts.<sup>3</sup>

From January to April 2017, there were 1426 earthquake events in Indonesia with a magnitude of 1–9.5 on the Richter scale.<sup>4</sup> Usually, a large-magnitude earthquake only occurs once, followed by small-magnitude earthquakes. However, in Lombok in July 2018, a large-magnitude earthquake occurred three times: once on Jul 29th, 2018, Aug 5th, 2018, and Aug 19th, 2018 (Figure 1). In addition, there were 2087 small-magnitude earthquakes, 64 of which could be felt to occur afterward.<sup>5</sup> The repeated large-magnitude earthquakes in Lombok caused major losses: 564 victims died, 1684 were injured, 445,343 became refugees, and 215,628 houses were damaged.<sup>61</sup> In addition, the damaged were 408 health facilities, consisting of 89 Public Health Centers, 13 Hospitals, 174 auxiliary Public Health Centers, 132 Village Health Posts. The situation is made worse by the fact that health workers are also became victims (Figure 1).



Figure 1 Map of districts/cities affected by the earthquake in Lombok, Indonesia.

West Nusa Tenggara (NTB) Province is an archipelagic province consisting of 2 (two) large islands, namely Lombok and Sumbawa, with at least 332 small islands consisting of 7 regencies/cities. Its total population is 3,798,297, with a population density of 246 inhabitants/km<sup>2</sup>. However, only Mataram City has the number of health facilities that meet the minimum standard of availability of health facilities, while other regencies/cities still require additional health facilities (Figure 2). Furthermore, although all regencies/cities affected by the earthquake have not met the minimum standard for the availability of general practitioners and specialist doctors, only Mataram City has met the minimum standard availability of specialists.

In RSUD NTB, there were 11 operating Surgery rooms in the hospital building available. However, after the second earthquake hit, Surgery activities were moved to surgery rooms built from container boxes outside the hospital building with five rooms for safety precautions. In addition, two<sup>2</sup> anesthesiologists were on duty for 2 weeks shift rotation in the hospital.

The main cause of death and injuries is building collapse.<sup>6</sup> Most of these buildings are not designed to withstand earthquakes or were poorly constructed.<sup>7,8</sup> The mode of injury when a building buries victims, the severity of the injury, and the length of time needed to evacuate victims affect the mortality and morbidity rates.<sup>9-12</sup> The roles of physicians, general practitioners, specialist doctors, and nurses are also vital in the first hour after the earthquake to prevent the conditions of victims from worsening (Table 1). In such situations, anesthesiologists and surgeons are the most needed specialists to provide prompt therapy for injured victims.<sup>13</sup> Anesthesia is also an essential component to manage victims' pain before, during, and after surgery.<sup>14</sup>

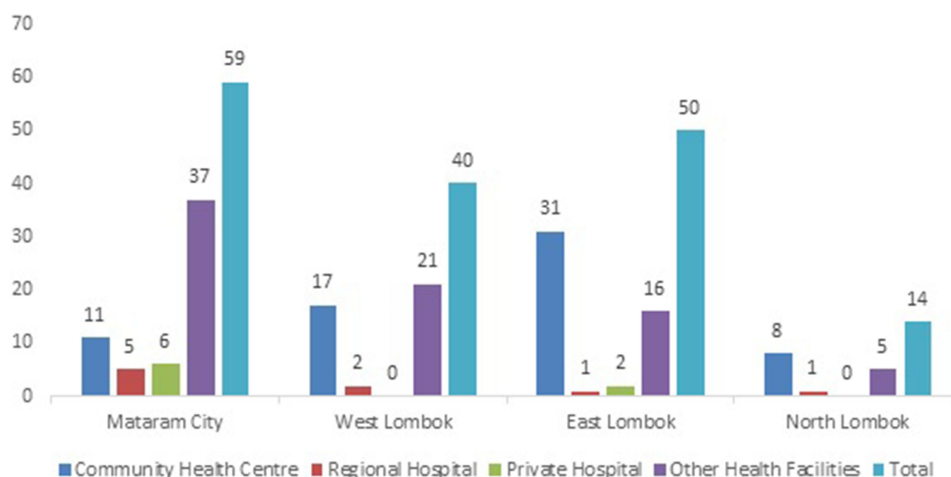


Figure 2 Number of health service facilities of districts/cities affected by the earthquake.

**Table 1** The Number of Casualties by the Earthquake in Lombok, Indonesia

No	District/City	Died	Serious Injuries	Minor Injuries	Refugees
1	Mataram City	9	520	9589	18,894
2	West Lombok	44	116	995	116,453
3	East Lombok	31	381	3071	104,060
4	North Lombok	467	1360	25,092	101,735
5	Central Lombok	2	6	218	13,887
	Total	553	2383	38,965	355,029

Anesthesia techniques that can be applied in earthquake victims include general and regional anesthesia. During the management of the 2015 Nepal earthquake, regional anesthesia techniques were widely used because of several advantages, such as safety in the context of unknown patient history, a shorter period of anesthesia recovery and ICU use, minimized use of oxygen and other postoperative treatments, and the ability to reduce postoperative pain.<sup>15</sup>

This research was conducted to describe the conditions of Lombok earthquake victims managed by the RSUD NTB, especially to describe the anesthetic techniques used to treat the earthquake victims.

## Methods

The current study was a descriptive cross-sectional study. The data were collected from the anesthesia record of all earthquake victims treated at the emergency room (ER) of the RSUD NTB on August 6th and 7th, 2018. In addition, the samples took from all victims who underwent Surgery from August 5th – 25th, 2018. Therefore, the study used total sampling, and the anesthesiologists on duty validated the data during the surgery.

The procedures: first, the patients were brought by the evacuation and triage team from the disaster site to the ER. Patients were examined in the ER to decide which patient would undergo surgery; second, anesthesiologists examined the patient prioritizing ASA 1 or 2 of ASA physical status.<sup>16</sup> Finally, the anesthesiologists decide to exclude patients if they are deemed not visible to have surgery.

The data of drugs were collected from the type of anesthesia techniques and anesthesia drugs that were used. The criteria applied also distinguished based on trauma and non-trauma cases and the type of surgery performed. Since all data were secondary data from anesthesia earthquake victims, then, the informed consent were waived. The recorded data analyzed and presented in descriptive form using frequencies, pie charts, bar diagrams, and tables. Ethical clearance was approved from RSUD NTB (number: 070.1/25.a.KEP/2018).

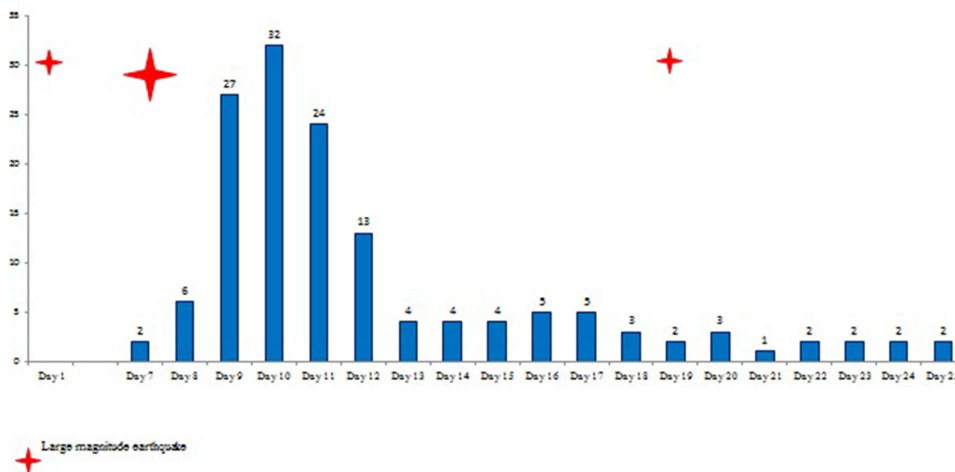
## Results

There were 166 victims treated in the ER of the RSUD NTB on August 6th and 7th, 2018. A total of 133 victims were trauma patients, and 33 others were non-trauma patients. There were also 153 surgeries performed during August 5th – 25th, 2018, as some patients required more than one surgery. No patients were excluded from surgery. Day 1, represents Jul 29th, 2018, when the first large-magnitude earthquake occurred. Day 7, represents Aug 5th, 2018, when the disaster management team started to evacuate victims, shown in [Figure 3](#).

During this period, 79 females (51.6%) and 74 males (48.4%) patients underwent surgery. The youngest patient is 1(one) day old, the oldest patient is 95 years old, and the patients were generally 30 years old. Elderly patients were predominantly women, while children and young adult patients were predominantly men.

Comparison of the selection of general or regional anesthesia shows little difference. Eighty-four of 153 patients received general anesthesia (54.9%), and 69 others received regional anesthesia (45.1%). Similarly, a comparison of the anesthesia techniques used in male and female patients showed no significant difference. In men, 43 (28.1%) patients received general anesthesia, and 30 (19.6%) patients received regional anesthesia. In women, 39 (24.49%) patients received general anesthesia, and 38 (24.84%) patients received regional anesthesia.

The artificial airways used in general anesthesia included intubation, mask, and laryngeal mask airway (LMA). Intubation was the most widely used technique, applied in as many as 62 patients (75%), followed by the use of a mask



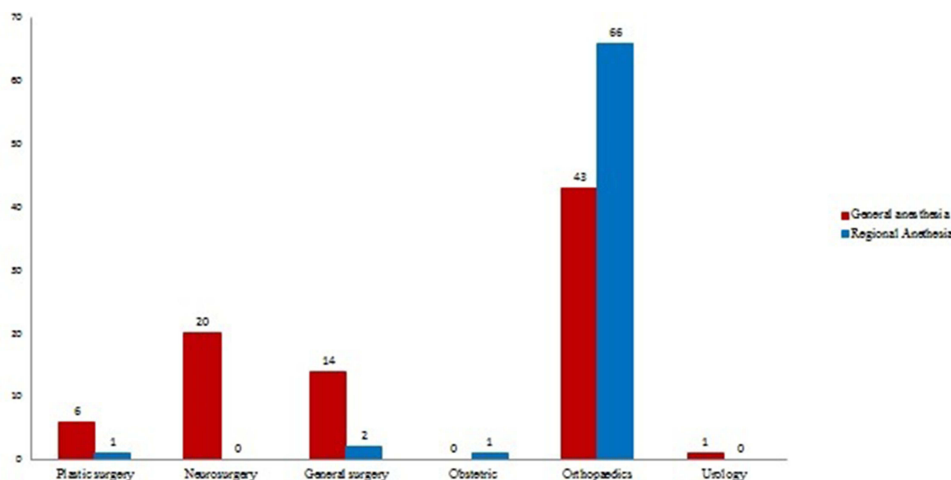
**Figure 3** The number of cases per day during the earthquake.

in 12 patients (14%) and the use of an LMA in 9 patients (11%). The regional techniques used included subarachnoid block (SAB) and peripheral nerve block (PNB), applied in 66 patients (94%) and four patients (6%), respectively.

The regional anesthesia drugs used in this study were lidocaine 2% 20–30 cc, hyperbaric lidocaine 75–100 mg, levobupivacaine 15–20 mg, lidocaine hyperbaric 75–100 mg and Clonidine 30–50 mcg combination, and other drugs, such as Ropivacaine 0.75% 30 mg. The most used drug was hyperbaric lidocaine with Clonidine, at a rate of 49%, followed by lidocaine (20%), hyperbaric lidocaine (14%) levobupivacaine (10%), and other drugs (7%). Commonly, the most surgery type during earthquake management was orthopedic surgery (109 times, 70.8%), followed by neurosurgery (13%), general surgery (10.4%), plastic surgery (4.5%), and obstetric and urological surgery (both 0.6%). An illustration of the selection of anesthesia techniques by surgery type is shown in Figure 4.

Regional anesthesia was mainly used during orthopedic surgery. Based on the operative region, regional anesthesia was primarily used in the rural part (53.62%), followed by the femoral region (26.09%) and pedal region (7.25%).

According to the operative procedure, regional anesthesia was used in as much as 100%, 54.69%, and 59.57% of amputation, debridement, and fixation procedures, respectively. On the other hand, general anesthesia was predominantly used in craniotomy (100%) and other procedures (83.33%). In addition, the other procedures included skin grafting, reconstructive surgery, laparotomy, thoracentesis, and vertebral stabilization procedures.



**Figure 4** The anesthesia options and techniques based on the type of surgery and surgical techniques.

**Table 2** The Number of Health Care Facilities Damaged by the Earthquake in Lombok, Indonesia

No	District/City	CHC 1			Hospital			CHC 2			Poskesdes/Polindes		
		MD 1	MD 2	MD 3	MD 1	MD 2	MD 3	MD 1	MD 2	MD 3	MD 1	MD 2	MD 3
1	Mataram City	9	2	0	3	3	1	8	0	0	10	1	0
2	West Lombok	16	3	0	2	0	0	9	2	11	9	6	5
3	East Lombok	12	4	3	0	0	0	60	8	5	29	2	5
4	North Lombok	2	0	6	0	0	1	0	0	32	10	1	0
5	Central Lombok	8	1	4	0	0	0	0	3	6	9	6	5
	Total	47	10	13	5	3	2	77	13	54	67	16	15

**Abbreviations:** CHC 1, Community Health Centre; CHC 2, Community Health Sub-Centre; MD1, Minor Damaged; MD2, Moderate Damaged; MD3, Major Damaged.

## Discussion

The earthquakes on Lombok Island are different from other earthquakes, as three large-magnitude earthquakes occurred in succession. The largest magnitude earthquake occurred on Aug 5th, 2018, and claimed the most casualties compared to the previous and subsequent major earthquakes. In addition, the earthquake occurred when people were typically asleep inside of their houses, such that they could not escape and look for shelter. This condition also explains why the victims predominantly showed orthopedic traumas and injuries.

In natural disasters such as earthquakes, the third to fifth days after the disaster are the busiest days when victims seek medical help.<sup>17</sup> In this study, the highest number of victims were treated in the ER on the third to fifth day after the first largest magnitude earthquake occurred, or approximately a week after the first earthquake occurred. Thus, the demand for services at local health facilities is very high during the first week after an earthquake<sup>3</sup> (Table 2).

Based on the results, the type of operation during earthquake management was dominated by orthopedic surgery, followed by neurosurgery, general surgery, and plastic surgery. These types of surgery are related to the kind of trauma experienced by the earthquake victims due to building collapse. Therefore, selecting the optimal anesthesia technique will minimize the physical and psychological stress on the patient.<sup>13</sup> Moreover, providing appropriate pain management using anesthesia will prevent physical and psychological sequelae, especially in high-risk victims, such as children and the elderly.<sup>18–21</sup>

The selection of anesthesia techniques must be based on the existing conditions and facilities. In addition, the choice of anesthesia techniques should avoid cardiorespiratory depression and muscle relaxation as much as possible as the postoperative ICU is limited.<sup>22</sup> In this study, general and regional anesthesia selection comparison showed no significant difference, although general anesthesia was used more. The use of general anesthesia is considered more often in disaster areas with minimal human resources. For example, in developing countries such as Indonesia, as stated by MSF (Medecins Sans Frontieres).<sup>23</sup> However, the selection of artificial airways during general anesthesia must also be considered. With more patients undergoing mask artificial airway procedures, more anesthesiologists are needed to stand by for the patient during the operation. On the other hand, the increased usage of intubation and LMA during Surgery with general anesthesia allows anesthesiologists to perform other tasks during the operation.

In another study, the use of general inhalation anesthesia in disaster situations was more limited because of the catastrophic effects that make it impossible to provide facilities for anesthesia machines and inhalation drugs. In addition, most patients who receive general anesthesia have food in their stomach in a disaster condition. Therefore, it is necessary to perform rapid-sequence induction immediately followed by tracheal intubation to prevent gastric acid aspiration.<sup>24</sup>

In this happening and the previous earthquake, most victims experienced trauma to the lower limbs,<sup>25–28</sup> especially fractures of the tibia and fibula. In cases of lower limb trauma, pain management is best performed with regional anesthesia,<sup>29–33</sup> especially with a femoral nerve block.<sup>34</sup> The same result was found in this study, as regional anesthesia was mostly used in cases of lower limb trauma. The high use of regional anesthesia in cases of simple extremity injuries after a disaster was also found in a previous study in which epidural anesthesia (EA) and SAB techniques were used in cases of lower limb injury, and PNB was used in cases of upper extremity injury.<sup>35</sup>

However, the higher frequency of general anesthesia than regional anesthesia in this study could have been caused by the application of regional anesthesia requiring special skills that not all doctors possess.<sup>36–38</sup> For example, the doctor

needs ultrasound facilities and nerve stimulators to perform regional anesthesia, but during the disaster, those apparatus were limited to implementation for regional anesthesia.<sup>20,39,40</sup> Moreover, regional anesthesia is only effective in cases of simple hip or femoral fracture.<sup>36–38</sup> In cases of more complex trauma, general anesthesia could be the better option.<sup>34</sup>

Regarding drugs that can be used in regional anesthesia, MSF has determined anesthesia techniques and drugs that can be applied in situations with limited resources and facilities. These drugs include thiopental and ketamine for general anesthesia without intubation, halothane for general anesthesia with intubation, 0.5% bupivacaine hyperbaric for spinal anesthesia, and levobupivacaine for regional anesthesia.<sup>14</sup> However, it is different from what was found in this study.<sup>41</sup> Drugs mostly used in regional anesthesia were hyperbaric lidocaine combined with clonidine hydrochloride, an alpha-2 agonist drug commonly used in anesthesia. Therefore, lidocaine is a local anesthesia drug commonly used in intravenous regional anesthesia (IVRA) because of its fast-onset and short duration of anesthesia.<sup>42</sup> In addition, it made lidocaine reliable to use in source-limited conditions like earthquake disasters. Hyperbaric (heavy) lidocaine can accumulate in lower space based on gravity. Therefore, it prevents the spread of anesthesia block in the higher spinal segment hypotension and other cardiovascular events.

On the contrary, the different results obtained by other previous studies stated that hyperbaric lidocaine gives a more prolonged onset of anesthesia and a shorter duration of anesthesia than isobaric lidocaine,<sup>43</sup> even Toft et al said those differences were not significant between the two groups.<sup>44</sup> Furthermore, unfortunately, transient neurologic symptom (TNS) occurred more often in hyperbaric lidocaine postoperative than isobaric lidocaine.<sup>45</sup> Even though hyperbaric lidocaine is still worth using because of the limitation on drug availability in the conditions after the earthquake. Clonidine is an alpha-2 agonist commonly used as an adjuvant to regional anesthesia. Clonidine has approximately 1/8 potency of dexmedetomidine. Although adding Clonidine to IVRA gives controversial results in the Kleinschmidt study,<sup>46</sup> Reuben found that Clonidine made postoperative analgesia has better results.<sup>47</sup> Besides, Clonidine as an adjuvant can increase anesthesia duration<sup>48</sup> and prolong analgesia<sup>49</sup> when used with intermediate and long-acting local anesthetics.

According to the operation type, orthopedic surgery was most commonly needed to treat earthquake victims, including amputation, fixation, debridement, and craniotomy. The same result was also found in other studies, in which fixation, debridement, and amputation of the lower limb were the most common procedures.<sup>50–54</sup> Similar to the present study, in previous studies, regional anesthesia was also mostly used during orthopedic surgery.<sup>36–38</sup> In addition, open and closed fractures were the most frequent injuries in a previous study, followed by crush injuries and compartment syndrome.<sup>54,55</sup> The same finding was also presented by MSF, which stated that more than 90,000 surgical procedures in natural disasters are orthopedic but have difficulties related to the limited availability of resources to provide safe anesthesia for patients.<sup>55–57</sup>

This study has several limitations. First, this study did not record data that can help measure the effectiveness of the different anesthesia techniques and anesthesia drugs. However, some measurements could be recorded, like non-operative time (NOT = room turnover time plus anesthesia induction and emergence time),<sup>58</sup> postoperative pain score,<sup>59</sup> and Quality of Recovery Score.<sup>60</sup> Another limitation is that this study only recorded events in Lombok's three-large magnitude earthquakes in July 2018. More extensive data need to be collected from different disaster settings and times to get a broader view and better results that describe the population's conditions.

## Conclusion

The study concluded that the majority used regional anesthesia drugs were hyperbaric lidocaine and Clonidine. The management of earthquake victims on Lombok Island found that the role of anesthesiologists during a disaster is essential in achieving safe and optimal surgical conditions. However, the limited number of anesthesiologists in developing countries should be considered for optimal anesthesia techniques so that disaster preparation and disaster management can proceed well.

## Disclosure

The authors declare that they have no conflicts of interest.

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