THE ROLE OF ANESTHESIOLOGIST AND SELECTION OF EFFECTIVE ANESTHESIA TECHNIQUES IN LOMBOK'S EARTHQUAKE VICTIM'S MANAGEMENT

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ABSTRACT

Lombok earthquake that occurred in July 2018 has three large magnitude earthquakes that caused huge losses; 564 victims died, 1684 injured, 445 343 refugees, and 215 628 houses were damaged. The role of anesthesiology is very important to give prompt therapy for injured victims. This research gave an overview of the important role of Anesthesiologist and the selection of anesthesia techniques during the natural disasters' victims' management. This study was conducted by collecting data of all earthquake victims treated at the emergency room (ER) of RSUD NTB on August 6th and 7th 2018 and all victims operated during August 5 – 25th 2018. All data were recorded, analyzed, and presented in descriptive form using frequency, pie chart, and bar diagrams. The result shown that the highest number of patients treated in ER are during the first seven days after the earthquake and reduced to several weeks. The majority of patients treated are trauma patients who need orthopedic surgery. Since limited number of anesthesiologist should be considered with the right selection of anesthesia techniques, so that the disaster preparedness could be prepared well and the disaster management could run well. General anesthesia was widely used than regional anesthesia, but the different is not significant. The type of regional anesthetic drug usually used is lidodex in combination with catapres. The role of anesthesiologist during disaster is important to handle a safe and optimal surgical condition.

Keywords: effective anesthesia, earthquake, orthopedic, victim's management

INTRODUCTION

Earthquakes are the second most frequent natural disasters after floods and cause the largest economic losses in the world during 2007-2016 (CRED, 2017). Indonesia is at the confluence of three active world plates, namely the India-Australia, Eurasia, and Pacific plates, making it very vulnerable to earthquake occurrence (Marfai et al., 2008). Losses caused by earthquakes depend on the magnitude scale, the distance from the epicenter, population density, earthquake preparedness, and mitigation efforts (Bartels & Rooyen, 2012).

The prevalence of earthquake events in Indonesia during January 2017-April 2017 with a magnitude of 1-9.5 Richter scale is 1426 events (Hamdani & Budi, 2017). Usually, a large magnitude earthquake only occurs once, followed by small magnitude earthquakes afterwards. But not likely in Lombok earthquake that occurred in July 2018 as the large magnitude earthquake occurred three times on July 29th 2018, August 5th 2018, and August 19th 2018. In addition, there were 2087 times small magnitude earthquake with 64 of them can be felt happened afterward (BMKG, 2018). The large magnitude earthquakes occurred repeatedly in Lombok caused huge losses; 564 victims died, 1684 injured, 445 343 refugees, and 215 628 houses were damaged.

The main cause of death and injuries is collapsed building (Noji, 2000). Most of these buildings are not designed to withstand earthquakes or had poor construction (Glass et al., 1977; Noji et al., 1990). The mode of injury when victims were buried with the building, the severity of injuries, and the length of time taken to evacuate victims affect the mortality and morbidity rate (Pointer, 1992; Coburn & Hughes, 1987; Coburn et al., 1987; Better & Stein, 1990). The role of physicians, general practitioners, specialist doctors, and nurses, are also very important in the first hour after the earthquake to prevent the worsen condition. The most needed specialist on this condition includes anesthesiology and surgery to provide prompt therapy for injured victims (Schultz et al., 1996). Anesthesia is also a very important component to manage victims' pain before, during, and after the operation (Centurion et al., 2017).

Anesthetic techniques that can be applied to earthquake victims are general and regional anesthesia. During the Nepal earthquake management 2015, regional anesthesia techniques have been widely used because of several advantages such as safer for unknown patient's history of illness, shorten period of anesthesia recovery and the use of ICU, the minimize use of oxygen and other postoperative treatments, and the ability to minimize postoperative pain (Lehavi et al., 2016).

This research was conducted to describe the condition of Lombok earthquake victims managed by RSUD NTB. This research gave an overview of the important role of Anesthesiologist and the selection of anesthesia techniques during the natural disasters' victims' management.

METHOD

This study was conducted by collecting data of all earthquake victims treated at the emergency room (ER) of RSUD NTB on August 6th and 7th 2018 and all victims operated during August 5 – 25th 2018. Descriptive observational analysis was carried out on the type of anesthesia techniques and drugs used. The data was also differed based on trauma and non-trauma cases and type of surgery performed. All data were recorded, analyzed, and presented in descriptive form using frequency, pie chart, and bar diagrams.

RESULTS

There were 166 victims treated in ER of RSUD NTB on August 6th and 7th 2018. 133 victims were trauma patients and 33 other were non-trauma patients. There were also 153 operations done during August 5th – 25th 2018 as some patients experienced more than one operation procedure (shown in Figure 1). Day 1 shown in Figure 1 was July 29th 2018 where the first large magnitude earthquake happened. Day 7 shown in Figure 1 was August 5th 2018 where the disaster management team started to evacuate victims.

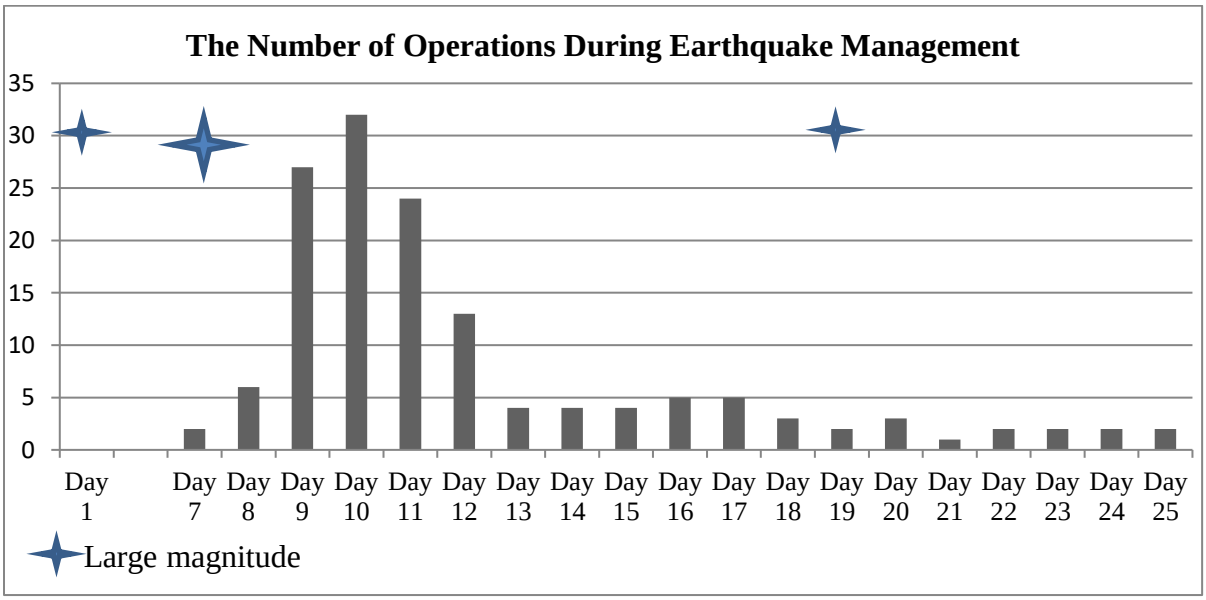

Figure 1 The number of operations during earthquake management

The proportion of patients who underwent surgery during this period was 79 women (51.6%) and 74 men (48.4%). The youngest age was one day old and the oldest age was 95 years old, with the most age of 30 years old. Elder patients were dominated by women, while children and young adult patients were dominated by men.

The comparison of the amount of general and regional anesthesia techniques selection is not much different. 84 among 153 patients received general anesthesia (54.9%) and 69 others received regional anesthesia (45.1%). Similarly, the comparison of anesthesia techniques used in men and women 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 were intubation, mask, and laryngeal mask airway (LMA). The most widely used is intubation techniques as many as 62 patients (75%), followed by the use of masks on 12 patients (14%), and the use of LMA on 9 patients (11%). While, the regional techniques used include subarachnoid blocks (SAB) and peripheral nerve block (PNB) with consecutive number of 66 patients (94%) and 4 patients (6%).

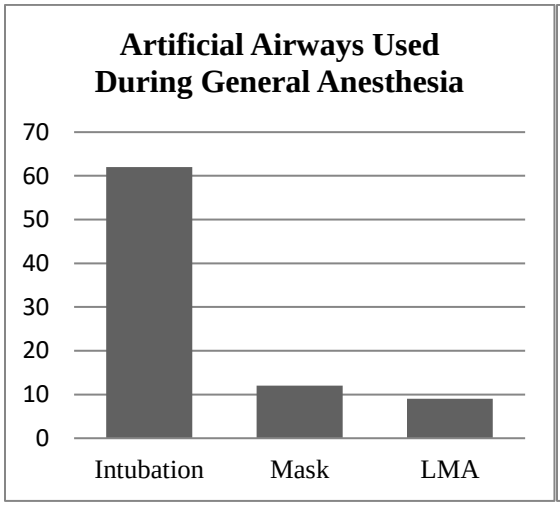

Figure 2 Artificial Airways Distribution

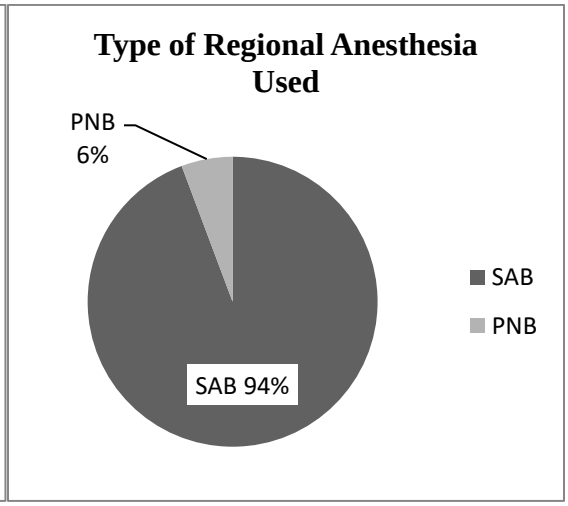

Figure 3 Type of Regional Anesthesia Used

Regional anesthesia drugs used in this study were lidocaine, lidodex, levobupivacaine, lidodex with catapres, and other drugs such as naropine. The most drug used was lidodex with catapres as much as 49%, followed with lidocain (20%), lidodex (14%), levobupivacaine (10%), and other drugs (7%).

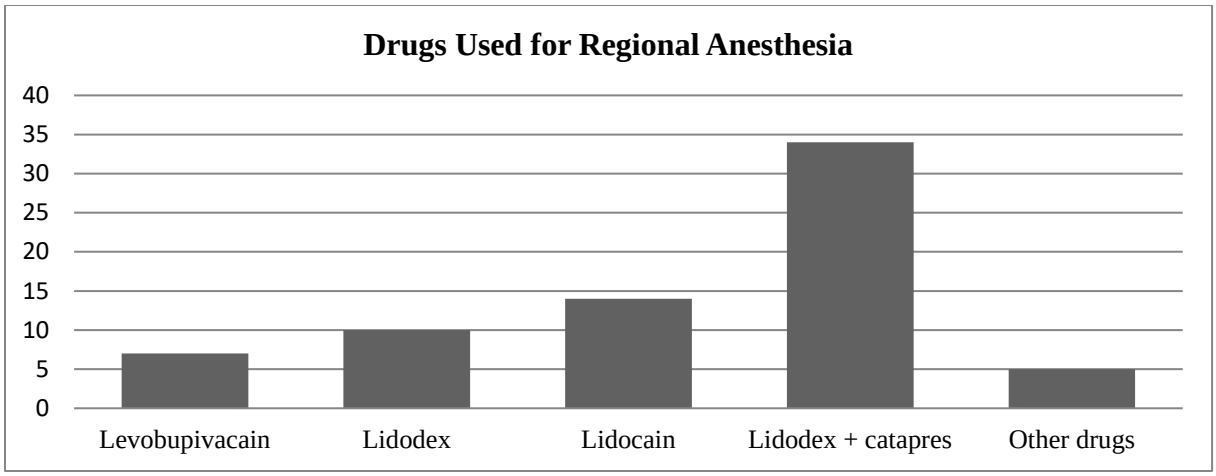

Figure 4 Drugs Used for Regional Anesthesia

The most operation type during the earthquake management was orthopedics with 109 times (70.8%), followed by neurosurgery (13%), general surgery (10.4%), plastic surgery (4.5%), and obstetric and urology with the same percentage of 0.6%. An illustration of the selection of anesthesia techniques in each operation type can be shown by Figure 5.

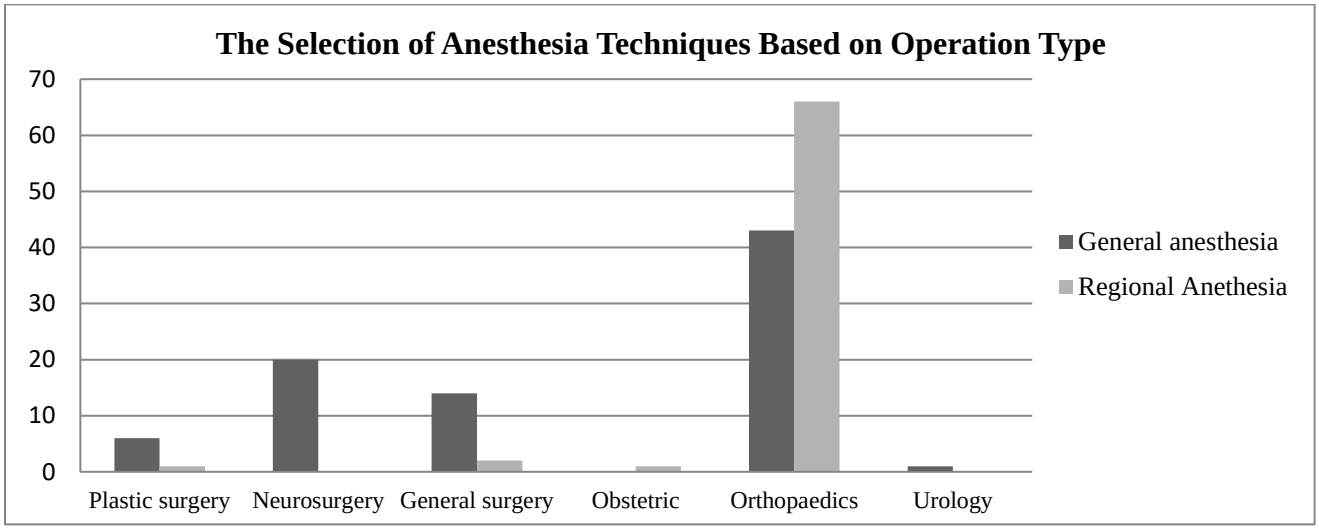

Figure 5 The selection of anesthesia techniques based on operation type

Regional anesthesia was mostly used during the orthopedics. Based on the region, the regional anesthesia was mostly used in cruris region (53.62%), followed by femoral region (26.09%), and pedis (7.25%).

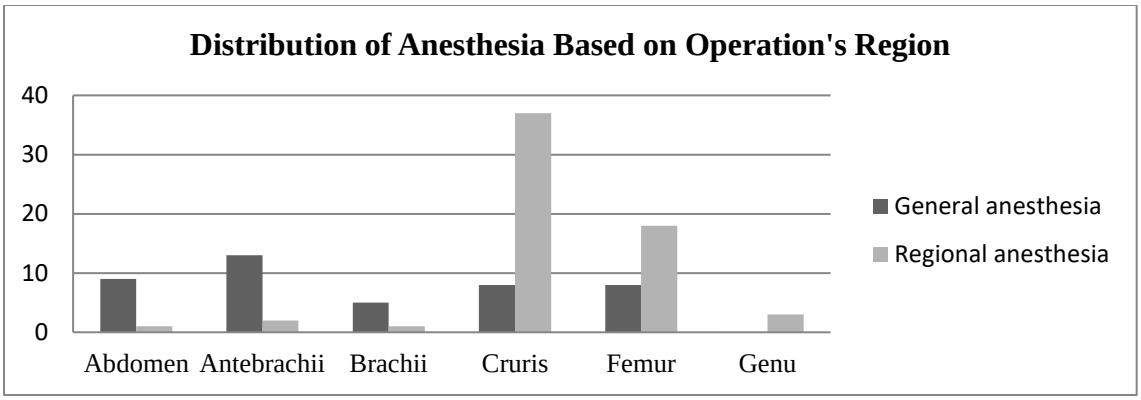

Figure 6 The distribution of anesthesia based on operation's region

Based on the operation procedure, amputation, debridement, and fixation were used regional anesthesia mostly as much as 100%, 54.69%, and 59.57%. On the other hand, craniotomy (100%) and other procedures (83.33%) were dominated with general anesthesia. These other procedures include skin grafting, reconstruction surgery, laparotomy, thoracocentesis, and vertebral stabilization procedure.

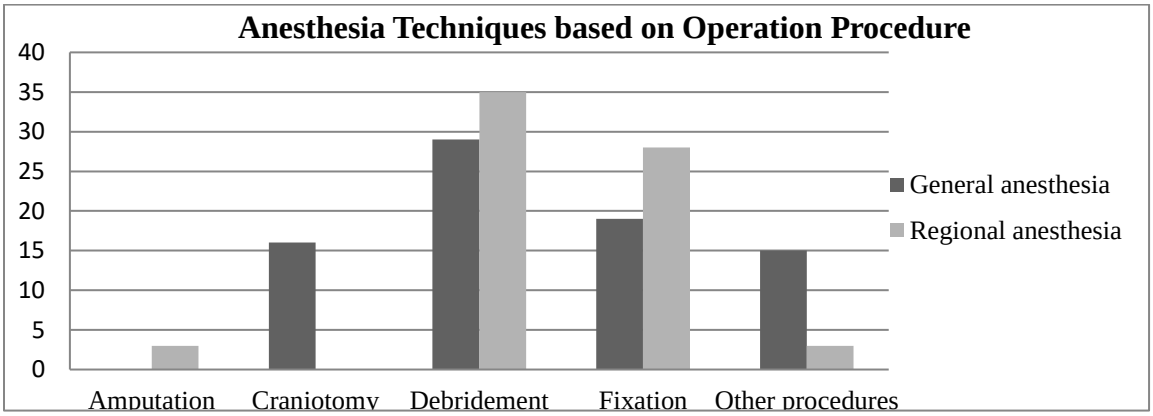

Figure 7 The distribution of anesthesia techniques based on operation procedures

DISCUSSION

The earthquake in Lombok Island was different from other earthquake as the large magnitude earthquake was happened three times. The largest magnitude earthquake was occurred in August 5th 2018 and was claimed as the most casualties than the previous and subsequent major earthquakes. In addition, the time when the earthquake happened was the time when the people asleep inside of the house so that the population couldn't able to escape and look for a shelter. This condition also explained why the victims were dominant with orthopedics traumas and injuries.

In natural disasters like earthquakes, the third to fifth days after the disaster happened is the busiest day where victims start to seek for medical help (Naghii, 2005). In this study, the highest number of victims treated in ER was on the third to fifth day after the first largest magnitude earthquake happened or about a week after the first earthquake happened. Thus, the demand for services at local health facilities is very high during the first week of the earthquake (Bartels & Rooyen, 2012).

As stated in the result, the type of operation during the earthquake management was dominated with orthopedics, followed with neurosurgery, general surgery, and plastic surgery. These types of surgery were related with the type of trauma of the earthquake victims due to collapsed building. The selection of the right anesthesia technique will be able to minimize the physical and psychological stress on patient (Schultz et al., 1996). Moreover, the provision of appropriate pain management using anesthesia will prevent the physical and psychological sequelae, especially in high risk victims such as children and elderly (Chen et al., 2010; Sinatra, 2010; Missair et al., 2010; Lippert et al., 2013).

The selection of anesthesia techniques must be based on the existing conditions and facilities. In addition the selection of anesthesia technique should avoid cardiorespiratory depression and muscle relaxation as much as possible as the postoperative ICU is limited (Adenukanmi, 1999). In this study, the comparison between general and regional anesthesia selection were not significantly different with more general anesthesia given. The use of general anesthesia is more considered in disaster areas with minimal human resources and in developing countries such as Indonesia, as stated by MSF (Medicins Sans Frontieres) (Ariyo et al., 2016). However, the selection of artificial airways during general anesthesia must also be considered. The more mask artificial airways techniques chosen for patients, the more anesthesiologists need to stand by for the patient during operation. On the other hand, the more usage of intubation and LMA during general operation allows anesthesiologists to do another job desk during the operation.

On the other study, the use of general inhalation anesthesia in disaster situations is more limited because of the catastrophic effects that make it impossible to provide facilities for anesthesia machines and inhalation drugs[14]. In addition, in a state of disaster, most patients who received general anesthesia have food-filled stomach. Therefore it is necessary to do a rapid

sequence induction which immediately followed by tracheal intubation to prevent from gastric acid aspiration (Baker, 2016).

In this incident and the previous earthquake, most victims were traumatized in the lower limb (Jacquet et al., 2013; Mulvey et al., 2008; Carlson et al., 2013; Kang et al., 2012), especially fractures of the tibia and fibula. In lower limb trauma, pain management is best done with regional anesthesia (Antonis et al., 2006; Marhofer et al., 1997; Snoeck et al., 2003; McGlone et al., 1987; Tan & Coleman, 2003), especially with the femoral nerve block (Levine et al., 2016). The same result was found in this study, where regional anesthesia was mostly used in lower limb trauma. The high use of regional anesthesia in simple extremities injuries during disaster condition also found in previous study where EA and SAB techniques used in lower limb injuries and PNB in upper extremity injuries (Zheng et al., 2016). This regional anesthesia technique is considered quite safe and efficient in disaster conditions where regional anesthesia only needs minimal medical equipment and drug (Chang & White, 2017).

However, the higher number of general anesthesia chosen than regional anesthesia in this study can be caused by the application procedure where regional anesthesia requires special skills that not all doctors can do (Foss et al., 2007; Beaudoin, et al., 2013; Christos et al., 2010). To do regional anesthesia, the doctor needs ultrasound facilities and nerve stimulators where it become a limitation of the regional anesthesia implementation during the disaster (Missair et al., 2010; Buckenmaier et al., 2003; Stojodinovic et al., 2006). Moreover, regional anesthesia is only effective in simple hip and femoral fractures (Foss et al., 2007; Beaudoin, et al., 2013; Christos et al., 2010). Meanwhile, where the victims experienced more complex trauma, general anesthesia could be better option chosen (Levine et al., 2016).

Regarding drugs that can be used in regional anesthesia, MSF has determined technique and anesthesia drugs that can be applied to 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 (Centurion et al., 2017). This is different from what was found in this study, where drugs that are mostly used in regional anesthesia were lidodex with catapres. This might be caused by the limitation of drugs availability during the earthquake condition.

Based on the operation type, orthopedic surgery was the most needed to treat earthquake victims with the detail of procedures include amputation, fixation, debridement, and craniotomy. The same result was also found in other surgery where the fixation, debridement, and amputation of lower limb were the most undergone procedure (Weiser et al., 2008; Chu et al., 2010; Nickerson et al., 2012; Wong et al., 2015; Alvarado et al., 2015). Regional anesthesia was also mostly used during orthopedics surgery, just like what this study found (Foss et al., 2007; Beaudoin et al., 2013; Christos et al., 2010). On the previous study, open and closed fractures was the most frequent injuries followed by crush injuries, and compartment syndrome (Alvarado et al., 2015; Pierre et al., 2018). The same thing was also stated by MSF which said more than 90 000 operating procedures in natural disasters is orthopedic, but has difficulty with limited resources and availability of safe anesthetic procedures for patients (Pierre et al., 2018; Wong et al., 2015; Chu et al., 2011).

The role of anesthesiologist during disaster is important to handle a safe and optimal surgical condition. However, the limited number of anesthesiologist in developing countries should be considered with the right selection of anesthesia techniques, so that the disaster preparedness could be prepared well and the disaster management could run well.

CONCLUSION

In this study, it was found that the highest number of patients treated in ER during the first seven days after the earthquake and reduced to several weeks. The majority of earthquake victims who received operative actions are the age of 30. The majority of patients treated in the first two days are trauma patients who need orthopedic surgery techniques. The use of regional anesthesia techniques such as SAB gives better results in lower limb injuries, but cannot be applied fully to earthquake victims who experience complex injuries in several parts of the body. In complex injuries, general anesthesia can be performed using rapid sequence induction. The type of regional anesthetic drug that is widely used in the handling of the earthquake in Lombok Island is lidodex in combination with catapres. The role of anesthesiologist during disaster is important to handle a safe and optimal surgical condition. However, the limited number of anesthesiologist in developing countries should be considered with the right selection of anesthesia techniques, so that the disaster preparedness could be prepared well and the disaster management could run well.

REFERENCES

Adenunkanmi A. 1999. 'Where there is no anaesthetist: a study of 282consecutive patients using intravenous, spinal and local infiltration anaesthetic techniques'. *Trop Dr*. vol. (2):56–7

Alvarado, O., Trelles, M., Smith, K.T., Joseph, H., Gesline, R., Wilna, T.E., Omar, M.K.M., Mohammad, N.M.F., Mastaki, J.M., Buhu, R.C., Caluwaerts, Dominguez, & Lynette. 2015. 'Orthopedic surgery in natural disaster and conflict settings: how can quality care be ensured?' *International Orthopedics* (SICOT) vol. (39) pp1901–1908. DOI 10.1007/s00264-015-2781-z

Antonis, M.S., Chandwani, D., & McQuillen, K.2006.'Ultrasound-guided placement of femoral 3-in-1 anesthetic nerve block for hip fractures'. *Academic Emergency Medicine*. 2006; 13: S122-3.

Ariyo, P., Trelles, M., Helmand, R., Amir, Y., Hassani, G.H., Mftavyanka, J., Nzeyimana, Z., Akemani, C., Ntawukiruwabo, I.B., Charles, A., Yana, Y., Moussa, K., Kamal, M., Suma, M.L., Ahmed, M., Abdullahi, M., Wong, E.G., Kushner, A., & Latif, A. 2016. 'Providing Anesthesia Care in Resource-limited Settings: A 6-year Analysis of Anesthesia Services Provided at Médecins Sans Frontières Facilities'. *Anesthesiology*. Vol (124) pp561-9

Bartels, S.A. & Rooyen, M.J.V. 2012. 'Medical complications associated with earthquakes'. *Lancet* 2012.DOI:10.1016/S0140-6736 (11)60887-8

Better, O.S. & Stein, J.H. 1990. 'Early management of shock and prophylaxis of acute renal failure in traumatic rhabdomyolysis'. *N Eng./J Med* vol. (322) pp825-829.

Beaudoin F.L., Haran, J.P., & Liebmann O. 2013.'A comparison of ultrasound-guided three-in-one femoral nerve block versus parenteral opioids alone for analgesia in emergency department patients with hip fractures: a randomized controlled trial'. *Acad Emerg Med Off J Soc Acad Emerg Med*. 2013; 20(6):584–91. 26.

Buckenmaier, C., Lee, E., & Shields, C. 2003. 'Regional anesthesia in austere environments'. *Reg Anesth Pain Med*. Vol (28) pp321–7

BMKG.#Gempabumi7. | BMKG [Internet]. BMKG | Badan Meteorologi, Klimatologi, dan Geofisika. 2018 [cited 18 September 2018]

Carlson, L.C., Hirshon, J.M., Calvello, E.J., & Pollak, A.N. 2013. 'Operative care after the Haiti 2010 earthquake: implications for post-disaster definitive care'. *The American journal of emergency medicine*. Vol. (2):429-431.

Center for Research on the Epidemiology of Disaster (CRED). 2017. *Natural Disasters*. Universite Catholique de Louvain

Centurion, M.T., Den Bergh, R.V., & Gray, H. 2017.'Anesthesia Provision in Disasters and Armed Conflicts'. *Current Anesthesiology Reports*. 7(1): 1–7. Doi: 10.1007/s40140-017-0190-0

Chen, G., Lai, W., & Liu F. 2010. 'The dragon strikes: lessons from the Wenchuan earthquake'. *Anesthesia and analgesia*. Vol (3):908-915

Christos, S.C., Chiampas, G., Offman, R., & Rifenburg, R. 'Ultrasound-guided threein-one nerve block for femur fractures'. *The Western Journal of Emergency Medicine.* 2010; 11(4):310–3

Chu, K.M., Ford, N., & Trelles, M. 2010. 'Operative mortality in resource-limited settings: the experience of Medicines Sans Frontieres in 13 countries'. *Arch Surg* vol. (145) pp721–725. doi:10.1001/archsurg.2010.137

Chu, K., Stokes, C., Trelles, M., & Ford, N. 2011. 'Improving effective surgical delivery in humanitarian disasters: lessons from Haiti*'. PLoS Med*. 8. Vol. (4):1001-25.

Coburn, A.W. & Hughes, R.E. 1987. *Fatalities, injury and rescue in earthquakes. In: 2nd Conference of the Development Studies Association*. Manchester, Eng: University of Manchester.

Coburn, A.W., Murakami, H.O., & Ohta, Y. 1987. 'Factors affecting fatalities and injury. In: Earthquakes: Engineering Seismology and Earthquake'. *Disaster Prevention Planning Internal Report*. Hokkaido University, Hokkaido, Japan, 1987.

Foss, N.B., Kristensen, B.B., Bundgaard, M., Bank, M., Heiring, C., Vickelyst, C., Hougaards, S., & Kehlet, H.2007. 'Fascia iliaca compartment blockade for acute pain control in hip fracture patients: a randomized, placebo-controlled trial'. *Anesthesiology*. 2007; 106(4):773–8. 25.

Glass R.I., Urrutia, J.J., & Sibony S.1977. 'Earthquake injuries related to housing in a Guatemalan village'. *Science* vol. (197) pp638-643.

Hamdani & Budi, S. 2017. 'Pengetahuan Manajemen Resiko Bencana Gempa Bumi Pada Kelompok Lansia Di Desa Lampulo Kecamatan Kuta Alam Kota Banda Aceh'. *Jurnal Ilmiah Mahasiswa Fakultas Keperawatan.* Vol 2, No 3

Jacquet, G.A., Hansoti, B., Vu, A., & Bayram, J.D. 2013.' Earthquake-related injuries in the pediatric population: a systematic review'. *PLoS currents*. pp5. DOI: 10.1371/currents.dis.6d3efba2712560727c0a551f4febac16

Kang, P., Zhang, L., & Liang, W. 2012. 'Medical evacuation management and clinical characteristics of 3,255 inpatients after the 2010 Yushu earthquake in China'. *The journal of trauma and acute care surgery.* Vol. 6) pp1626-1633. Doi: 10.1097/TA.0b013e3182479e07

Levine, A.C., Teicher, C., Aluisio, A.R., Wiskel, T., Valles, P., Trelles; G.B.J., & Grais, R.F. 2016. Regional Anesthesia for Painful Injuries after Disasters (RAPID): study protocol for a randomized controlled trial'. *BioMedCentral Journal* vol (17):542.

Lehavi, A., Meroz, Y., Maryanovsky, M., Merin, O., Blumberg, N., Bar-On, E., & Yitzhak, A. 2016. 'Role of regional anaesthesia in disaster medicine: field hospital experience after the 2015 Nepal Earthquake'. *European Journal of Anaesthesiology* 2016, vol 33 pp312–313.

Lippert, S.C., Nagdev, A., Stone, M.B., Herring, A., & Norris, R. 2013. 'Pain control in disaster settings: a role for ultrasound-guided nerve blocks'. *Annals of emergency medicine*. Vol (6) pp690-696.

Marfai, M.A., King, L., Singh, L.P., Mardiatno, D., Sartohadi, J., Hadmoko, D.S., & Anggraini, D., 2008. 'Natural Hazards in Central Java Province, Indonesia: an overview'. *Environ Geol* 56:335-351

Marhofer, P., Schrogendorfer, K., Koinig, H., Kapral, S., Weinstable, C., & Mayer, N.1997. 'Ultrasoundographic guidance improves sensory block and onset time of three-in-one blocks'. *Anesthesia and Analgesia*. 1997; 85:854-7.

McGlone, R., Sadhra, K., Hamer, D.W., & Pritty, P.E.1987. 'Femoral nerve block in the initial management of femoral shaft fractures'. *Archives of emergency medicine*. Sep 1987; 4(3):163-168.

Missair, A., Gebhard, R., & Pierre, E. 2010. 'Surgery under extreme conditions in the aftermath of the 2010 Haiti earthquake: the importance of regional anesthesia'. *Prehospital and disaster medicine*. Vol (6) pp487-493

Mulvey, J.M., Awan, S.U., Qadri, A.A., & Maqsood, M.A. 2008. 'Profile of injuries arising from the 2005 Kashmir earthquake: the first 72 h'. *Injury*. Vol (5):554-560. DOI: 10.1016/j.injury.2007.07.025

Naghii, M.R.2006. 'Public health impact and medical consequences of earthquakes'. *Rev Panam Salud Publica* 2005; 18: 216–21

Nickerson, J.W., Chackungal, S., Knowlton, L., McQueen, K., Burkle, F.M. 2012.'Surgical care during humanitarian crises: a systematic review of published surgical caseload data from foreign medical teams'. *Prehosp Disaster Med* vol (27) pp184–189. Doi: 10.1017/S1049023X12000556

Noji, E.K. 2000. 'The Public Health Consequences of Disasters. Prehospital and disaster journal'. *Center of Disease Control and Prevention*

Noji, E.K., Kelen, G.D., & Armenian, H.K. 1990. 'The 1988 earthquake in Soviet Armenia: A case study'. *Ann EmergMed* vol (19):891.

Pierre, O., Lovejoy, J.F., Stanton, R., Skupski, R., Previl, H., Bernard, J., Losonczy, L., & Walsh, M. 2018. 'The Use of Emergency Physicians to Deliver Anesthesia for Orthopaedic Surgery in Austere Environments'. *Journal of bone and joint surgery*. Vol (44) pp1-7. doi.org/10.2106/JBJS.16.01481

Pointer, J.E. 1992. 'The 1989 Loma Prieta earthquake: Impact on hospital care'. *AnnEmergMed* vol (2) pp1228-1233.

Schultz, C., Koeng, K., & Noji, E. 1996. 'A Medical Disaster Response to Reduce Immediate Mortality after an Earthquake'. *The New England Journal of Medicine*. Vol 334(7) pp438-444

Sinatra R. 2010. 'Causes and consequences of inadequate management of acute pain'. *Pain medicine*. Vol (12) pp1859-1871.

Snoeck, M.M., Vree, T.B., Gielen, M.J., & Lagerwert, A.J.2003.'Steady state bupivacaine plasma concentrations and safety of a femoral "3-in-1" nerve block with bupivacaine in patients over 80 years of age'. *International Journal of Clinical Pharmacology and Therapeutics.* Vol (41) pp: 107-13.

Stojadinovic, A., Auton, A., Peoples, G., McKnight, G.M., Shields, C., Croll, S.M., Bleckner, L.L., Winkey, J., Maniscalco-Theberge, M.E., & Buckenmaier, C.C. 2006.'Responding to challenges in modern combat casualty care: innovative use of advanced regional anesthesia. *Pain Med*. 7(4): 330–8.

Tan T.T. & Coleman M.M.2003. 'Femoral blockade for fractured neck of femur in the emergency department; *Annals of emergency medicine*. Oct 2003; 42(4):596-597; author reply 597

Wang, Z., Sun, Y., & Wang, Q. 2011. 'Anesthetic management of injuries following the 2008 Wenchuan, China earthquake'. *Eur J Trauma Emerg Surg*. pp37:9–12

Weiser, T.G., Regenbogen, S.E., Thompson, K.D., Haynes, A.B., Lipsitz, S.R., Berry, W.R., & Gawande, A.A. 2008. 'An estimation of the global volume of surgery: a modelling strategy based on available data'. *Lancet* vol (372) pp139–144. Doi: 10.1016/S0140-6736(08)60878-8

Wong, E.G., Gupta, S., Deckelbaum, D.L., Razek, T., Kushner, A.L. 2015. 'Prioritizing injury care: a review of trauma capacity in low and middle-income countries'. *Journal of Surgical Research* vol (193) pp217–222. doi:10.1016/j.jss.2014.08.055

Wong, E.G., Razek, T., Elsharkawi, H., Wren, S.M., Kushner, A.L., Giannou, C., Khwaja, K.A., Beckett, A. & Deckelbaum, D.L. 2015. 'Promoting quality of care in disaster response: a survey of core surgical competencies'. *Surgery* 158 vol (1):78-84.