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Effects of Isoflurane Exposure to Fertility through Estrogen Gene Expression in Operating Room Nurses

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Abstract Background. Operating room is one of the many workplace hazards. In the operating room nurses and other health personnel at risk of exposure to chemicals. One type of inhalation anesthetic gas that is isoflurane (foran, aeran). Isoflurane a halogenated hydrocarbon compounds volatile ether. Exposure to halogenated anesthetic gases can result in effects on reproductive health. Method. The study design used is Retrospective Cohort, with a sample size of 16 exposed and 16 unexposed. Mechanical sampling random sampling. Data analysis used independent t-test. Results. The results showed that exposure status isoflurane effect on fertility disorder where there are differences in average significantly between hormone gene expression estrogen the exposed group (9.35 ± 1.78) and unexposed (11.65 ± 1.44) with values p = 0.013 (p < 0.05). The tenure of the effect on fertility disorder where there are differences in average significantly between the tenure of the hormone gene expression estrogen namely the working period of 5-9 years (11.84 ± 1.16) and ≥10 years (8.52 ± 0.94) with values p = 0.006 (p < 0.05). Hormone gene expression estrogen effect on fertility disorder where there are differences in average significantly between hormone gene expression estrogen against fertility disorder that nurses are experiencing hormonal changes in gene expression estrogen risk of impaired fertility (8.52 ± 0.94) and that did not change hormone gene expression estrogen not at risk of reduced fertility (11.69 ± 1.33) with values p = < 0.001 (p < 0.05). Conclusion: Based on this it is expected that the Health and Safety at Work Hospital perform periodic monitoring the work environment primarily in the operating room.

Keywords: *exposure status isoflurane, work period, hormone gene expression estrogen and fertility disorders*

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1. Background

Hospitals are labor-intensive workplaces, expert, capital, and technology, but the existence of the Hospital also has a negative impact on the incidence of disease and work-related accidents when the hospital is not carrying out the occupational procedure Health and Safety [1]. One of the many dangers of the workplace that is an operating room. In the operating room nurses and other health personnel at risk of exposure chemical material [2,3,4,5,6]. Inhalation anesthetics are chemicals that are harmful when inhaled by health workers in the long term has a range of health effects, including neurological, kidney, liver disease also decline in mental performance and agility mental [1,4,7]. Chronic effects for operating room personnel is reduced fertility and problems during pregnancy on the health workers [4,7,8,9]. Exposure to anesthetic gases is the medicine in the form of gas or volatile liquid both oral (mouth), inhalation (respiratory system) and absorption (skin) to workers (nurses) anesthesia in the operating room [10,11].

One type of inhalation anesthetic gas that is isoflurane (foran, aeran). Isoflurane that has the chemical name 1-chloro-2,2,2,-trifluoromethyl difluoromethyl ether is compound clear, colorless, volatile and non-flammable used as general anesthesia [5,12,13]. Exposure to halogenated anesthetic gases can result in effects to health [5,13,14]. National Institute For Occupational Safety and Health (NIOSH) set Threshold Limit Value (NAV) of chemical substances time-weighted average (time-weighted average) The aerial work, where there are workers who may be exposed to chemicals every day for no more than 8 hours per day or 40 hours per week. Exposure to more than 8 hours/day cause chronic effects, namely the

occurrence of cancer, impaired fertility, abortion spontaneous and congenital abnormalities [2,15,16].

Management of anesthesia without exposure to potential environmental factors dangerous is impossible. Exposure to anesthetic gases to the atmosphere of the operating room cannot be avoided. A small amount of exhaust gas entering the operating room every time inhalation anesthetics. Research conducted by Khalid AA, and Nafisa ME (2016) states that incident infertility in workers in the operating room was 7.35% compared with 1.4% in health care workers who are not exposed. Also, health care workers who are exposed to undergo abortions as much as 43.3% compared with health care providers who are not disclosed in the amount of 14:29%. Then Khalid AA and Nafisa MEA (2016) also states that health care workers who have exposed isoflurane (duration of exposure) higher risk of impaired fertility [4].

Studies conducted by Xu et al. (2012) states that exposure isoflurane on male rats significantly can result in decreased sperm production, damage testis and sex hormone imbalances including hormones FSH and LH (follicle stimulating hormone and luteinizing hormone). Both these hormones function set and including centralized reproduction hormone (GnRH from the hypothalamus and gonadotropin, luteinizing hormone and follicle stimulating hormone from the pituitary) and peripheral manufactured (estrogen, progesterone, testosterone, and inhibin originating from the gonads) [17,18].

Interference factors ovulation causes fertility disorder that occurs in women by 40%, 40% tubal disorders, uterine disorders by 10% and factor another 10%. Most occurrences of female infertility are caused by problems ovulation; some women do not ovulate sign characterized by periods regular, irregular menstrual cycles can heighten the incidence of fertility disorders. Factors that may affect the prevalence of fertility disorder is also caused health problems are hormonal changes [8,9,19,20].

Anesthetic gas exposure over 2 ppm within more than 2 hours show the effects on reproduction are fertility disorders, miscarriages, damage genetic and cancer nurses [4,15]. Several studies in animals also stated that chronic exposure (prolonged exposure) anesthesia isoflurane and sevoflurane significantly lowered sperm concentration, motility, interfere with the synthesis of enzymes methionine synthetase in the process of DNA synthesis (DNA damage occurs). This situation is dangerous for officers health while in the operating room [19-30].

The levels of anesthetic gases in operating rooms affected by the ventilation system as set out in the Technical Guidelines for the Operation Hospital by Directorate General of Health Services of the Republic of Indonesia. Some risk factors exposure to anesthetic gases is a factor of the tools, time and person of them is not installed exhaust pipe correctly, using the technique of general anesthesia face mask (face mask), PPE use by health workers and tracheal intubation with mechanical ventilation using a semi-open breathing circuit [1,7,31,32,33].

Studies conducted by Hussein et al., 2016 stating that the operating room HEPA filter system uses a lower concentration levels of 65.5% compared to the room Operating without a HEPA filter and still meets the NIOSH standard 1997. The concentration of sevoflurane The three operating rooms is 1:22 ppm, 2.13 ppm and 6:05 ppm. While the concentration in the recovery room at 0544 ppm [34].

Sanabaria et al. (2006) describe in his research that the absorbent as the gas extractor can reduce 94% exposure to the gas but it is limited in the area around anesthesia machines, the results are different when measured in the field of surgery [35].

Nurse anesthesia is a care provider who is authorized and responsibility in assisting the implementation of the act of anesthesia in the operating room. A nurse anesthetist has a duty before and after surgery and contacts the longest in the operating room. So that the competent nurse anesthetist gets occupational risks. Anesthesia management activities starting from preoperative patient preparation, maintenance anesthesia during diagnostic or surgical procedures, the management of postoperative anesthesia until the patient recovers conscious. Based on studies do J. Baek et al. 2009 states that nurses who administer anesthesia affected a higher concentration than other health care workers [36,37].

Publication of research in Indonesia regarding fertility problems due to exposure to gas anesthesia as well as the accompanying diseases is still very limited. Based on observations Researchers are still no policies on reproductive health protection to nurses in the operating room in the form of prevention and control of health exposure especially reproductive fertility disorder. In fact, exposure anesthetic gases isoflurane to officer anesthesia in the operating room and recovery room can potentially cause the risk of fertility disorders.

Anesthetic gas exposure in the form of isoflurane of nurses in the operating room can become one of the risk factors for hormonal changes estrogen. As is hormonal changes experienced by nurses can have an impact on fertility disorder. The type of reproductive disorder that can occur is in the menstrual cycle disorders nursing women, ovulation disorders, polycystic ovarium syndrome, tubal problems, disorders fertility, spontaneous abortion and congenital abnormalities [8,20,25,38,39,40,41].

2. Method

2.1. Type and Design Research

This research is an analytic study using the design retrospective cohort.

2.2. Location and Time Research

The research was conducted in the operating room Hospital Dr. Wahidin Sudirohusodo Makassar, South Sulawesi. Examination of gene expression in hormone estrogen conducted at the Laboratory of Microbiology, Faculty of Medicine Hasanuddin University, Makassar. The research was conducted in January-October 3, 2017.

2.3. Population and Sample

The population in this study were all nurses working in the operating rooms Hospital Dr. Wahidin Sudirohusodo

as many as 32 nurses. The samples in this study are most nurses working in the hospital operating room and qualified the inclusion criteria. With using a sampling technique random sampling. The sample size is obtained a minimum sample size of 16 people for both groups exposed and unexposed.

3. Result

Table 1. Distribution of Age Group Based on Respondent Exposure Status

Age Group (year)	Exposure Status				Total	
	Exposure		Not Exposure			
	n (16)	%	n (16)	%	n (32)	%
25-30	5	50	5	50	10	100
31-35	1	50	1	50	2	100
36-40	6	50	6	50	12	100
41-45	4	50	4	50	8	100

Table 2. Distribution of Gender-Based on Respondent Exposure Status

Gender	Exposure Status				Total	
	Exposure		Exposure			
	n (16)	%	n (16)	%	n (32)	%
Male	8	50	8	50	16	100
Female	8	50	8	50	16	100

Table 3. Distribution of Latest Education Based on Respondent Exposure Status

Last Education	Exposure Status				Total	
	Exposure		Exposure			
	n (16)	%	n (16)	%	n (32)	%
No School	0	0	2	100	2	100
Primary School	0	0	2	100	2	100
Junior High School	0	0	1	100	1	100
Senior High School	0	0	3	100	3	100
Diploma Three	1	100	0	0	1	100
Strata One	15	88	2	11	17	100
Strata Two	0	0	6	100	6	100

Table 4. Distribution of Old Got Child Based on Respondent Exposure Status

Old to Have Children	Exposure Status				Total	
	Exposed		Exposed			
	n (16)	%	n (16)	%	n (32)	%
= > 1 Year	10	76	3	23	13	100
< 1 Year	4	23	13	76	17	100
Not to Have Children	2	100	0	0	2	100

Table 5. Distribution of Miscarriage History Based on Respondent Exposure Status

History Miscarriage	Exposure Status				Total	
	Exposed		Exposed			
	n (16)	%	n (16)	%	n (32)	%
Yes	2	100	0	0	2	100
No	14	46	16	53	30	100

Table 6. Distribution of Respondent by Isoflurane Exposure Status

Isoflurane Exposure Status	(n)	(%)
Exposure	16	50
Unexposure	16	50
Total	**32**	**100**

Table 7, Distribution of Respondents Based on Work Period in Nurse in Operating Room

Work Period	(n)	(%)
5-9 years	6	37
≥10 years	10	63
Total	**16**	**100**

Table 8. Distribution of Respondents Based on Estrogen Hormone Gene Expression On Nurse in Operation Room

Gene Expression Hormone Estrogen	(n)	(%)
Abnormal	6	37
Normal	10	63
Total	**16**	**100**

Table 9. Distribution of Respondents Based on Fertility Disorders in Nurses in Operation Room

Fertility Disorder	(n)	(%)
Yes	9	28
No	23	72
Total	32	100

Table 10 Mean Differential Analysis of Exposure to Estrogen Hormone Gene Expression in Nurse in Operation Room

Exposure Status	Gene Expression Hormone	(n=16)	Mean	Standard Deviation	*p-value*
Exposure	*Estrogen*	8	9.35	1.78	0.013
Unexposure		8	11.65	1.44	

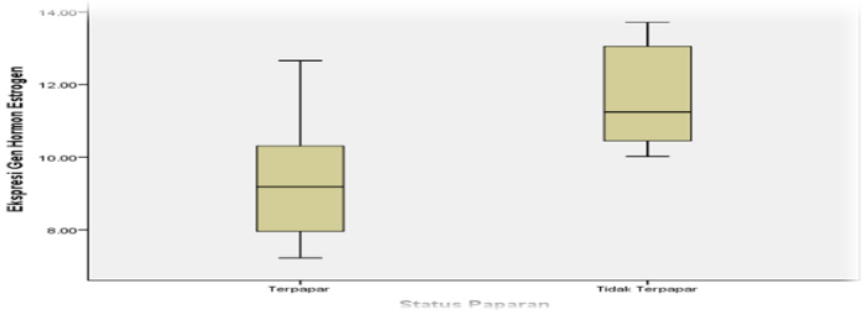

Figure 1. Graph Box Plot Influence Status of Exposure Isofluran against Estrogen Hormone Gene Expression

Table 11. Analysis of the Mean Difference of the Working Period of Estrogen Hormone Gene At The Nurse In The Operation Room

Working Period	Gene Expression Hormone	(n=16)	Mean	Standard Deviation	*p-value*
5-9 years	*Estrogen*	2	11.84	1.16	0.006
≥10 years		6	8.52	0.94	

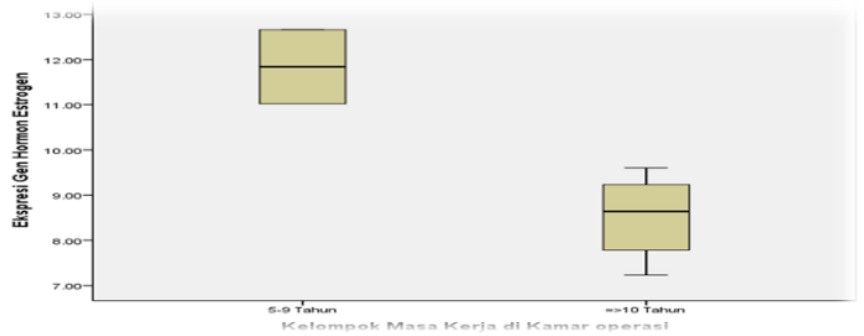

Figure 2. Graph Box Plot Influence Work Period Estrogen Hormone Gene Expression

Table 12. Mean Differential Analysis of Estrogen Hormone Gene Expression on Fertility Disorder in Nurse in Operation Room

Gene Expression Hormone	Fertility Disorders	(n=16)	Mean	Standard Deviation	*p-value*
Estrogen	*Yes*	6	8.52	0.94	<0.001
	No	10	11.69	1.33	

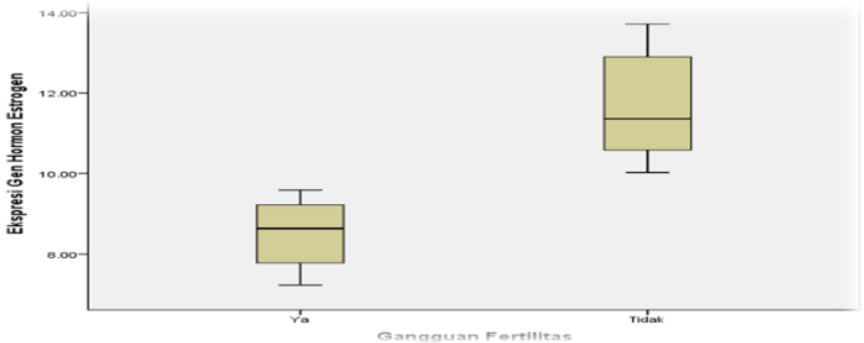

Figure 3. Graph Box Plot Effect of Estrogen Hormone Gene Expression against Fertility Disorders

Table 1 above shows that the majority of respondents both in the exposed group or unexposed in the age group 36-40 years is 6 (50%).

Table 2 above shows that the proportion of male and female both the exposed and unexposed groups together as many eight people (50%).

Table 3 above shows that the majority of respondents' education level in, i.e., an S1 exposed group of 15 people (88%) and the unexposed group, i.e., S2 as many six people (100%).

Table 4 above shows that the majority of respondents by duration has children in the exposed group of => 1 year as many as ten people (76%) and the group unexposed <1 year as many as 13 people (76%).

Table 5 shows that the miscarriage of respondents in the exposed group is 2 (100%), while respondents who are not exposed to the majority never experienced miscarriage 16 (53%).

Table 6 above shows that respondent is exposed, and unexposed groups have the same proportion (50%). The distribution of respondents based on isoflurane exposure status has the same proportion, this is because respondents in the group are unexposed as control or standard of expression of estrogen hormone gene in the exposed group.

Table 7 above shows that the majority of respondents have a working period of ≥10 years (63%). According to Cindyastira et al., (2014) the more extended the work of a person the longer the exposure to the time and type of work performed by workers so that will cause various physical complaints due to work.

Table 8 above shows that six respondents (37%) had abnormal estrogen gene expression and ten respondents (63%) who had normal estrogen hormone expression. Exposure to isoflurane in the long term causes changes in gene expression of estrogen.

Table 9 above shows that there are nine people (28%) of respondents at risk of fertility problems. Exposure to isoflurane in the long term causes changes in gene expression of estrogen. Based on the results of research isoflurane exposure in the long-term risk of fertility problems.

Table 10 above shows that the mean difference test results of the variables of exposure to isoflurane expression of the estrogen hormone gene indicate that there is a significant mean difference between expression of exposed group hormone estrogen (9.35 ± 1.78) and not exposed (control) (11.65 ± 1.44) with a value of p = 0.013 (p <0.05). Seen on the Box Plot graph, the mean expression of the estrogen hormone gene in the exposed group was lower than the unexposed group (control). It can be concluded that the status of exposure affects the expression of estrogen hormone gene. (Figure 1)

Table 11 above shows that the results of the mean difference test of the variable length of work against estrogen gene expression gene indicate that there is significant difference between the average of working time to estrogen hormone gene expression, ie the working period of 5-9 years (11.84 ± 1.16) and ≥10 years (8,52 ± 0,94) with p-value = 0,006 (p <0,05). Seen on the Box Plot chart, the mean expression of estrogen hormone gene in the working group is ten years lower than the working period of 5-9 years. It can be concluded that the working life of ≥10 years affects the expression of estrogen hormone gene. (Figure 2)

Table 12 above shows that the average difference test results of the estrogen hormone gene expression variable on fertility disorder indicates that there is a significant mean difference between the expression of estrogen hormone gene on fertility disorder ie the nurse who undergoes changes in expression of estrogen hormone gene at risk of impaired fertility (8, 52 ± 0.94) and unchanged gene expression of estrogen hormones did not risk fertility problems (11.69 ± 1.33) with p = <0.001 (p <0.05). Seen on the Box Plot graph, the average change in gene expression of estrogen hormone in nurses at risk of impaired fertility compared to that did not change the expression of estrogen hormone gene. It can be concluded that changes in gene expression of estrogen hormone in nurses affect fertility disorder. (Figure 3)

4. Discussion

4.1. Influence of Exposure Status against Estrogen Hormone Gene Expression

From this study, the mean difference test showed that there is significant difference mean hormone gene expression of estrogen hormone expression in the exposed group (9.35 ± 1.78) with unexposed (11.65 ± 1.44) with p = 0.013 (p<0.05). It can be concluded that exposed nurses have lower estrogen gene expression levels than those not disclosed. This means the status of exposure affects the expression of the hormone estrogen.

Nurses exposed to isoflurane are at risk of impaired fertility. This is because the chemicals in the environment can become endocrine disruptors in various ways. The substance may affect the secretion of the endocrine gland, interfere with its elimination and may interfere With the feedback mechanism in the hormonal regulation. Ultimately, it may resemble the hormone by binding to its receptor, so the hormone that physiologically binds to the receptor cannot bind because of a binding endocrine disruptor. In these circumstances, the hormonal function can be disrupted [43].

Research conducted by Mazze RI, 1985 found that exposure to isoflurane in female mice in exposed and unexposed groups experienced a difference [14].

Beilin et al. 1999 found that there was a significant difference between pregnancy and birth of female rats exposed to propofol, nitrous oxide, midazolam and isoflurane in unexposed female mice [28].

Talamanca et al. 2000 found that the dangers of exposure that arise in the workplace affect the people around them and cause reproductive health effects. Hazards caused by exposure to anesthetic gases, use of antineoplastic drugs, radiation, disinfectants [44].

Xu et al. 2012 found that exposure to isoflurane in male rats could significantly result in decreased sperm production, testicular damage and sex hormone imbalance including FSH and LH hormones [17,39,45].

4.2. Effect of Work Period on Estrogen Hormone Gene Expression

Working period is a long time someone has been working since entering the company (Hospital). According to

Cindyastira et al. (2014), the more extended the work of a person the longer the exposure to the time and type of work performed by workers so that will cause various physical complaints due to work.

From this research on average difference test, there was a significant difference of estrogen hormone estrogen expression at work time ≥10 years (8,52 ± 0,94) and 5-9 years (11,84 ± 1,16) with p-value = 0.006 (p <0.05). It can be concluded by the old way of working a long way with lower levels of estrogen gene expression. This means a 10-year working period for estrogen hormone gene expression.

Research Xu et al. (2012) found that long tenure can affect nurse reproductive disorders. Several research studies conducted by Mazze RI, 1985 and 1986 found that there was an effect of prolonged exposure on female mice in the exposed group.

4.3. Result of Estrogen Hormone Gene Expression on Fertility Disorders

From this research, it was found that there was a significant difference of estrogen hormone estrogen genes expression on fertility disorder, i.e., nurses who experienced changes in estrogen hormone expression were at risk of impaired fertility (8.52 ± 0.94) and those with no change in gene expression the estrogen hormone is not at risk of impaired fertility (11.69 ± 1.33) with p = <0.001 (p <0.05).

Nurses exposed to isoflurane over long periods of time are at risk of fertility problems. This is because the chemicals in the environment can become endocrine disruptors in various ways. The substance may affect The secretion of the endocrine gland, interfere with its elimination and may interfere with the feedback mechanism in the hormonal regulation. Ultimately, it may resemble the hormone by binding to its receptor, so the hormone that physiologically binds to the receptor cannot bind because of a binding endocrine disruptor. In these circumstances, the hormonal function can be disrupted so that the risk of impaired fertility [43].

5. Conclusion

The status of exposure to isoflurane affected fertility disorder through the expression of estrogen hormone gene (p=0.013), length of work affecting fertility disorder through estrogen hormone gene expression (p=0.032), and change of estrogen hormone expression effect on fertility disorder (p =<0.001).

References

[1] Kepmenkes RI. Standard of Occupational Health and Safety at RS Directorate of Occupational Health 2010.

[2] NIOSH. Guidelines for Protecting the Safety and Health of Health Care Workers. In: Services HaH, (ed.). Washington: Public Health Services, 1988.

[3] Safaa MH, Rady AA, Aiad AEA and Zahran MA. Occupational hazards to anesthetists and their prevention. *American Science*. 2014; 10: 31-5.

[4] Khalid AA and Mohammed NAE. Occupational Hazards Associated With Exposure to Anesthetic Gases on Reproductive Health in Operating Theatre Staff in Three Hospitals in Khartoum State. Sudan 2016.

[5] D.Miller R and Manuel C.Pardo J. Basics of Anesthesia. In: Larson MD and L.Shafer S, (eds.). *History of Anesthesia, Basic Pharmacologic Principles, Inhaled Anesthetics, Anesthesia Delivery System* Sixth ed. Philadelphia: Elsevier, 1939.

[6] Edling C. Anesthetic gases as an occupational-Hazard A review. *Scandinavian Journal Work Environment & Health*. 2016; 6: 85.

[7] Tankó B, Molnár L, Fülesdi B and Molnár C. Occupational Hazards of Halogenated Volatile Anesthetics and their Prevention: Review of the Literature. *Anesthesia & Clinical Research*. 2014; 5: 2-7.

[8] C.Gupta R. Veterinary Toxicology.

[9] Evans TJ and Ganjam VK. Reproductive Anatomy and Physiology. In: C.Gupta R, (ed.). First ed.: Elsevier, 2011, p. 7.

[10] Gold ABCMdD. Safety and Health In the Use of Chemicals in the Workplace. Geneva: ILO, 1998.

[11] ILO. Occupational Safety and Health Jakarta 2013.

[12] Saber AT and Hougaard KS. *Isoflurane, Sevoflurane, and Desflurane*. Sweden: University of Gothenburg, 2009.

[13] Votava RA. Limiting Exposure to Isoflurane in a Veterinary Occupational Setting. *School of Nursing and Health Professions*. The University of San Francisco: The University of San Francisco, 2015.

[14] Richard I M, M.D, Masahiko Fujinaga MD, Susan A. Rice PD, Stephen B. Harris PD, M SJ and Baden MD. Reproductive and Teratogenic Effects of Nitrous Oxide, Halothane, Isoflurane, and Enflurane in Sprague-Dawley Rats. *Anesthesiology*. 1986; 64: 339-44.

[15] NIOSH. Criteria for a Recommended Standard: Occupational Exposure to Waste Anesthetic Gases and Vapors. In: US and Department of Health E, and Welfare, (eds.). Washington1977.

[16] NIOSH. *The Effects of Workplace Hazards on Female Reproductive Health*. Columbia 1999.

[17] Xu XL, Pana C, Hua J-x, et al. Effects of isoflurane inhalation on the male reproductive system in rats. *Environmental Toxicology and Pharmacology* 2012: 688-93.

[18] Richard I M, M.D, Masahiko Fujinaga MD, Susan A. Rice PD, Stephen B. Harris PD and Jeffery M. Baden MD. Reproductive and Teratogenic Effects of Nitrous Oxide, Fentanyl and Their Combination In Sparague-Dawley Rats *British Journal of Anesthesiology*. 1987; 59: 1291-7.

[19] Ceyhan A, Cincik M, Bedir S, H.Ustun, Dagli G and Kalender H. Effect of Exposure to New Inhalational Anesthetics on Spermatogenesis and Sperm Morphology in Rabbits *Archives of Andrology* 2005; 51: 305-15.

[20] Liua S, Zhang L, Liuc Y, Shend X and Yange L. Isoflurane Inhibits Embryonic Stem Cell Self-Renewal Through Retinoic Acid Receptor. *Elsevier*. 2015; 74.

[21] Lucio LMC, Braz MG, Junior PdN, Braz JRC and Braz LG. Occupational Hazards, DNA Damage, and Oxidative Stress on Exposure to Waste Anesthetic Gases. *Revista Brasileira De Anestesiologia*. 2017.

[22] Karabiyik L, S.Sardas, U.Polat, N.A.Kocabas and A.E.Karakaya. Comparison of genotoxicity of sevoflurane and isoflurane in human lymphocytes studied in vivo using the comet assay. *Elsevier Science*. 2001: 99-107.

[23] Shaker DA, Samir AM, Hagag HA, El-Aal AAA and Afify RA. Cytogenetic Damage in Operating Room Nurses Exposed to Anesthetic Gases. *Med J Cairo Univ*. 2011; 79.

[24] Rosa ACd, Beier SL, Oleskovicz N, et al. Effects of exposure to halothane, isoflurane, and sevoflurane on embryo viability and gestation in female mice. 2015; 36: 871-82.

[25] Araujo TKd, Silva-Grecco RLd, Bisinotto FMB, et al. Genotoxic Effects of Anesthetics in Operating Room Personnel Evaluated by Micronucleus Test. *Anesthesiology & Clinical Science*. 2013.

[26] Jałoszyn´ski P, Kujawski M, Wa¸sowicz M, Szulc R and Szyfter K. Genotoxicity of Inhalation Anesthetics Halothane and Isoflurane in Human Lymphocytes Studied in Vitro Using the Comet Assay. *Mutation Research*. 1999; 439.

[27] Warren JR, Shaw B and Steinkampf MP. Inhibition of Preimplantation Mouse Embryo Development By Isoflurane. *Am J Obstet Gynecol*. 1991.

[28] Beilin Y, Bodian CA, Mukherjee T, et al. The Use of Propofol, Nitrous Oxide, or Isofluran Does Not Affect the Reproductive Success rate Following Gamete Intrafallopian Transfert (GIFT) A Multicenter Pilot Trial/Survey. *Anesthesiology*. 1999; 90: 36-41.

[29] Campion SN, Cappon GD, Chapin RE, Jamon RT, Winton TR and Nowland WS. Isoflurane reduces motile sperm counts in the Sprague-Dawley rat. *Drug and Chemical Toxicology*. 2012; 35: 20-4.

[30] Serkan Y and Calbayram NC. Exposure to Anesthetic Gases Among Operating Room Personnel and Risk of Genotoxicity: A Systematic Review of The Human Biomonitoring Studies. *Clinical Anesthesia* 2016; 35.

[31] Kepmenkes RI. Use of Medical Gas On Health Service Facilities Number: 1439 /Menkes /SK / XI / 2002. Jakarta: Decree of the Minister of Health of the Republic of Indonesia 2002, p. 1-12.

[32] Smith FD. Management of Exposure to Waste Anesthetic Gases. *AORN* 2010; 91.

[33] G.McGregor D. Occupational Exposure to Trace Concentrations of Waste anesthetic Gases. *Mayo Foundation for Medical Education and Research*. 2000; 75: 273-7.

[34] Husein ASF, Pratomo BY and Suryono B. Comparison of Sevoflurane and Nitrous Oxide (N2O) Levels During Anesthesia in the Operating Room With Hepa Filter and No Hepa Filter Anesthesia Complications. 2016; 3.

[35] Sanabria CP, E RP, E JM, et al. Occupational Exposure to Nitrous Oxide and Sevoflurane During Pediatric Anesthesia: Evaluation of an Anesthetic Gas Extractor. 2006.

[36] Baek J, Uhm M, Bae S and Singh KP. Assessing Operating Room Nurses Occupational Exposure to Nitrous Oxide. 2009.

[37] A.Flack L. Nurse Exposure to Waste Anesthetic Gases in a Post Anesthesia Care Unit. *Enviromental and Occupational Health* College of Public Health: University of South Florida, 2006.

[38] Sifakis S, Androutsopoulos VP, Tsatsakis AM and Spandidos DA. Human Exposure to Endocrine Disrupting Chemicals: Effects On The Male And Female Reproductive System. 2017.

[39] Damodaran TV. Genotoxicities and Infertility. In: C.Gupta R, (ed.). First ed.: Elsevier, 2011, p. 923.

[40] Committee TACoOaGCnHCFUWASfRMP. *Exposure to Toxic Enviromental Agents*. The University of California, San Fransisco Program on Reproductive Health and the Enviroment: The American College of Obstetricians and Gynecologist

[41] Tannenbaum TN and Goldberg RJ. Exposure to Anesthetic Gases and Reproductive Outcome. *Occupational Medicine*. 1985; 27.

[42] Sastroasmoro S and Ismail S. *Dasar-dasar Metode Penelitian Klinis*. Sagung Seto, 2010.

[43] Bruner-Tran KL, BS JG, Ding T, MLI DRG, Pensabene V and Osteen KG. Exposure to the Environmental Endocrine Disruptor TCDD and Human Reproductive Dysfunction: Translating Lessons from Murine Models. 2016.

[44] Talamanca FI. Reproductive Problems Among Women Health Care Workers: Epidemiologic Evidence and Preventive Strategies. *Epidemiologic Reviews*. 2000; 22.

[45] Rezk BM and Sikka S. Developmental and Reproductive Disorders: Role of Endocrine Disruptors in Testicular Toxicity. In: C.Gupta R, (ed.). Elsevier, 2011, p. 903.

Effects_of_Isoflurane_Exposure_to_Fertil.pdf

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	sevoflurane in the operating room", Ecotoxicology and Environmental Safety, 2021 Publication	
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16	www.mdpi.com Internet Source	<%1
17	repository.uhamka.ac.id Internet Source	<%1
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2012.
Publication

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