

ORIGINAL RESEARCH

PERIOPERATIVE MEDICINE

Lavender aromatherapy: Its effect on preoperative anxiety and propofol requirement for anesthesia

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ABSTRACT

Background & objective: Preoperative anxiety is a natural human psychology, and the physicians usually prescribe tranquilizers to allay the anxiety of their anxiety. Various other means have also been employed for this purpose. We aimed to investigate the impact of lavender aromatherapy on preoperative anxiety and propofol requirement at induction of anesthesia.

Methodology: A total of 108 female patients were enrolled in the study, and their anxiety levels were evaluated using the Visual Analogue Scale (VAS) at three different time points. Patients were randomly divided into two groups. Group A (Lavender Group) patients were given lavender aromatherapy via a cotton strip infused with two drops of 100% pure lavender essential oil, while the patients in Group B (Control Group) had no aromatherapy.

Results: The results showed that the lavender aromatherapy significantly reduced anxiety in Group A ($P < 0.001$) compared to Group B, and the mean differences of VAS scores for all anxiety assessments were also significantly reduced in Group A ($P < 0.000$). In addition, the mean total amount of propofol required was significantly less in Group A than in Group B (118.46 ± 40.01 vs 140.38 ± 35.29 mg; $P = 0.003$), while the mean duration to reach loss of consciousness was similar in both groups.

Conclusion: The findings of our study suggest that lavender aromatherapy can be a simple, safe, and cost-effective way to reduce preoperative anxiety and decrease the amount of propofol required for the induction of anesthesia. Therefore, the use of lavender aromatherapy may be a valuable addition to the preoperative care of patients undergoing elective surgeries.

Abbreviations: APAIS- Amsterdam Preoperative and Information Scale; LOC- Loss of Consciousness; OT- Operation Theatre; OR- Operating Room; STAI- State-Trait Anxiety Inventory; VAS- Visual Analogue Scale

Key words: Aromatherapy; Benzodiazepines; Lavender; Anxiety, Preoperative; Propofol; Anxiety / therapy; Anxiety Disorders

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1. INTRODUCTION

Preoperative anxiety occurs when a patient is told of the need for surgery and admission to the hospital may further aggravate anxiety due to unfamiliar environment and loss of self-autonomy.¹ Studies have shown that preoperative anxiety is more prevalent in women,^{2,3} and among those having surgery for the first time.⁴ It also has been shown to increase the requirement of intravenous propofol at induction of anesthesia.⁵⁻⁷

Measures to alleviate preoperative anxiety have been practised with pharmacological therapy such as benzodiazepines.⁸ However, benzodiazepines as anxiolysis may cause adverse effects and physical dependence, especially in the elderly.⁹ Adjuvant therapy such as music,¹⁰ acupuncture,¹¹ massage with essential oils¹² and aromatherapy are taking precedence to eliminate the need for pharmacologic agents to reduce anxiety. Aromatherapy has been shown to be a promising alternative in managing anxiety as it is inexpensive, convenient and has a low side effect profiling.¹²⁻¹⁴

The essential oil of lavender, an extract from the flowers of *Lavandula angustifolia* has been tested clinically in various preparations such as aromatherapy, massage oils and oral preparations for the treatment of anxiety-related disorders.^{15,16} Lavender aromatherapy has been shown to reduce the blood pressure and heart rate of postoperative patients in the intensive care unit.¹⁷ It is also able to reduce levels of preoperative anxiety in patients.^{18,19}

Spielberger's State-Trait Anxiety Inventory – STAI, Amsterdam Preoperative and Information Scale – APAIS and the Visual Analogue Scale - VAS has been used in various studies to measure perioperative anxiety.^{20,21} Of the methods above, VAS-assessment for anxiety is simple, less time-consuming and as effective as the STAI in predicting preoperative anxiety.²¹

This study, aimed to evaluate the effect of lavender aromatherapy as an adjuvant treatment to reduce preoperative anxiety and its effect on the requirement of propofol for induction for patients undergoing elective surgeries under general anesthesia.

2. METHODOLOGY

The study was approved (FF-2018-050) by the Ethics Review Board of the Faculty of Medicine, Universiti Kebangsaan Malaysia. Consecutively, this study was

registered at the ClinicalTrials.gov website (under the USA National Institutes of Health, NCT03460145). Upon approval, this clinical trial was conducted in UKMMC.

This study used the lavender essential oil (*L. angustifolia*) produced by New Directions Australia™ and distributed under Claire Organics outlets. The Gas Chromatography and Mass Spectrometry (GC-MS) analysis was performed at the Forest Research Institute of Malaysia (FRIM) using an Agilent GC 7890 B and Agilent Technologies 7890A/5975C. The major constituents of the oil were Linalool (44%) and Linalyl acetate (34.5%).

All female patients aged 18 to 65 y with ASA physical status I or II, scheduled for elective surgeries in the general operating theatre of UKMMC, from September 2018 until December 2018 were recruited into this study. Those on β -blockers or anti-depressants, history of chronic alcoholism, substance abuse or smoking, a history of atopy, BMI > 35 kg/m², and cancer or psychiatric disorders were excluded. Patients were randomized into groups A and B using computer-generated randomization numbers. The study population was recruited during the preoperative assessment rounds with written and informed consent obtained. Their age, race, weight and height were recorded.

The anxiety towards the surgery was assessed on three specific factors that may cause anxiety in relation to anesthesia and surgery.²¹ The first factor assessed for anxiety was about fear of the unknown, the second factor assessed anxiety about feeling ill and the third factor assessed anxiety about regaining consciousness after anesthesia. The anxiety level for each factor was assessed using the VAS score which is a 10 cm scale. The patients were defined as having anxiety when the VAS score was more than 5 cm.²² The anxiety level assessed during the premedication round was recorded as a 'before aromatherapy' anxiety score. No sedative premedication was prescribed.

On arrival at the operation theatre (OT) on the day of the surgery, patients in both groups had nasal strips applied to their noses. Patients in the Lavender Group immediately had a drop of lavender oil (Claire®) instilled onto the strips while patients in the control group had none. The time of exposure to the aromatherapy was recorded. Prior to transferring to the operating room (OR) their anxiety level was reassessed using the same

Table 1: Demographic and clinical data of the study population

Variable	Lavender Group n = 52	Control Group n = 53	P-value
Age (year)	47.05 ± 14.63	47.13 ± 15.68	0.978
BMI (kg/m ²)	28.14 ± 4.10	28.58 ± 4.13	0.587
Previous surgery, n (%)	40 (76.92)	40 (75.47)	0.861
Time taken to LOC (min)	3.72 ± 2.85	4.64 ± 2.99	0.110
Total amount of propofol used for induction (mg)	118.46 ± 40.01	140.38 ± 35.29	0.004*

Data is presented as mean ± standard deviation (SD) and numbers (percentage); LOC - loss of consciousness; *P < 0.05 considered significant

questions and scored and the nasal strip was removed. It was recorded as 'after aromatherapy' anxiety score.

In the OR, continuous electrocardiogram (ECG), non-invasive blood pressure (NIBP), and pulse oximetry (SpO₂) were monitored. A 20-G intravenous (IV) cannula was inserted and connected to a 3-way connector. The induction of anesthesia was commenced with propofol Lipuro® (1%) 10 mg/mL infused using the Schnider protocol, administered via the Injectomat® TIVA Agilia infusion pump to achieve a target plasma concentration of 4 µg/ml until loss of consciousness (LOC). Upon commencement of the propofol infusion, the patients were repeatedly called by their first names at 15 sec intervals, without any tactile stimulation. The patients were required to answer 'yes' each time their names were called and this continued until loss of verbal response. LOC was defined as the point of loss of verbal response. The propofol infusion rate was adjusted according to the National Total Intravenous Guideline if LOC was not achieved. The amount of propofol required to attain LOC was recorded. Intravenous fentanyl 100 µg bolus was given to all patients after LOC and anesthesia was conducted as per surgical requirement.

2.1. Sample size calculation

The sample size was calculated using Fleiss²³ formula, Epi Info™ 7 statistical software. We estimated a sample size of 108 patients, with 54 patients in each arm, based on findings by Fayazi, Babashahi,¹² which showed a significant difference in the incidence of severe anxiety between aromatherapy group and a control group (25% vs 2.8%).

2.2. Statistical Analysis

Statistical analysis was performed using Statistical Package for Social Sciences

(SPSS Inc.; Chicago, IL, USA) version 20. The distribution of each quantitative dataset was assessed for kurtosis and skewness, with a range of -1.5 to +1.5 accepted as the normal distribution. Normally distributed quantitative data are presented as mean ± SD. Continuous data are presented as mean ± SD and categorical data as the number of cases and percentage. Kolmogorov-Smirnov test was used to check the normality assumption or equality of probability distribution. The difference between the two groups with scale variables was analysed using an Independent Sample *t*-test. McNemar test was used to compare the proportion of patients with and without anxiety before and after aromatherapy in both groups. All significant analysis was considered a 95% confidence interval or P < 0.05.

3. RESULTS

A total of 108 female patients undergoing elective surgeries with general anesthesia were initially recruited. However, during the data analysis phase, three patients were excluded from the study. In the Lavender Group, one patient had poor tolerance to aromatherapy and another patient received regional anesthesia instead of general anesthesia. In the Control Group, one patient had their surgery cancelled. As a result, the final data analysis included 105 patients.

Table 2: Comparative McNemar's analysis of the anxiety status of patients in 'fear of the unknown' category

		Patients after aromatherapy			
		Lavender Group n = 52		Control Group n = 53	
		Not Anxious	Anxious	Not Anxious	Anxious
Patients before aromatherapy	Not Anxious	1	0	6	4
	Anxious	40	11	0	43
	P-value	< 0.001*		0.125	

Table 3: Comparative McNemar’s analysis of the patient’s anxiety in thinking of the ‘postoperative pain’

		Patients after aromatherapy			
		Lavender Group n = 52		Control Group n = 53	
		Not Anxious	Anxious	Not Anxious	Anxious
Patients before aromatherapy	Not Anxious	2	0	4	3
	Anxious	44	6	0	46
	P-value	< 0.001*		0.25	

Table 4: Comparative McNemar’s analysis of the patient’s anxiety status in thinking of ‘regaining consciousness after the anesthesia’

		Patients after aromatherapy			
		Lavender Group n = 52		Control Group n = 53	
		Not Anxious	Anxious	Not Anxious	Anxious
Patients before aromatherapy	Not Anxious	10	0	10	5
	Anxious	39	3	2	36
	P-value	< 0.001*		0.453	

Table 5: Comparison of the mean VAS scores before and after treatment in both groups.

VAS time	Lavender Group n = 52	Control Group n = 53	P-value ^a
Fear of the unknown			
Before treatment	8.27 ± 1.21	6.49 ± 2.11	0.007*
After treatment	4.33 ± 1.31	6.89 ± 1.98	< 0.001*
P-value ^b	< 0.001*	0.007*	
Thinking of postoperative pain			
Before treatment	7.38 ± 1.62	6.81 ± 2.12	0.301
After treatment	4.08 ± 1.22	7.26 ± 2.01	< 0.001*
P-value ^b	< 0.001*	0.002*	
Thinking of regaining consciousness after anaesthesia			
Before treatment	6.06 ± 1.13	5.32 ± 1.60	0.121
After treatment	3.44 ± 1.16	5.70 ± 1.53	< 0.001*
P-value ^b	< 0.001*	0.017*	

Data is presented as mean ± SD in cm; VAS score > 5 is defined as having anxiety.
^a P-value comparing between groups; ^b P-value comparing intragroup

All demographic data including age, BMI, race and history of previous surgery between both groups were comparable as shown in Table 1. The mean total amount of propofol used for induction was significantly lesser in

VAS scores after aromatherapy across all factors evaluated.

Conversely, there was a significant increase in the mean VAS scores in the Control Group after treatment for all

the Lavender Group (118.46 ± 40.01 mg vs. 140.38 ± 35.29 mg; P = 0.003). However, the time taken for loss

of consciousness between both groups was insignificant (3.72 ± 2.85 min vs. 4.64 ± 2.99 min; P = 0.110). The time of exposure to lavender aromatherapy in the Lavender Group as compared to the Control Group was also statistically insignificant (19.04 ± 10.23 min vs. 22.94 ± 11.25 min; P = 0.095).

The analysis using the McNemar test showed that the Lavender Group experienced a significant reduction in anxiety levels across all three factors assessed compared to the Control Group. Specifically, after receiving lavender aromatherapy, a large proportion of patients in the Lavender Group transitioned from being anxious to a non-

anxious state. In the fear of the unknown factor, 40 (76.9%) patients no longer felt anxious. Similarly, in the thinking of postoperative pain and thinking of regaining consciousness after anesthesia factors, 44 (84.6%) and 39 (75%) patients, respectively, experienced a significant anxiety reduction. In contrast, a considerable percentage of patients (ranging from 67.9% to 86.7%) in the Control Group remained anxious even after receiving treatment, as shown in Tables 2, 3, and 4.

Table 5 displays the average scores obtained from the VAS before and after treatment in both the Lavender Group and the Control Group. In the Lavender Group, there was a significant decrease in the mean

factors. It is worth noting that the mean VAS scores in the Control Group were consistently above 5 for all factors, indicating higher levels of anxiety.

When comparing the two groups, the mean VAS scores before treatment were similar for all factors, except for the fear of the unknown factor, where there was a noticeable difference. However, after treatment, the mean VAS scores in the Lavender Group were significantly lower compared to the Control Group for all factors, indicating a greater reduction in anxiety levels in the Lavender Group.

4. DISCUSSION

In this study, we found that exposure to lavender aromatherapy during the pre-induction period was able to significantly reduce the proportion of patients with preoperative anxiety. Similarly, Fayazi, Babashahi reported a significant reduction in the number of patients with preoperative anxiety after inhalation of lavender aromatherapy.¹² Their report suggested that the odour of aromatherapy may motivate the limbic system and stimulate the release of neurotransmitters which affect emotions in humans.¹² Earlier reviews had also reported the role of various oils of aromatherapy including lavender in reducing anxiety.^{13,14}

The study showed that the patients in the control group who did not receive exposure to lavender aromatherapy showed a significant increase in their anxiety level at the second assessment which was just before the induction of anesthesia. Facco, Zanette evaluated preoperative anxiety at 3 different timings before surgery.¹³ They concluded that the cause of patient anxiety is multifactorial and it may change over time. They suggested that anesthesia-related anxiety increased as the operation drew nearer.

The exact mechanism of lavender aromatherapy in reducing anxiety levels is still unclear. The major components of lavender oil were identified as linalyl acetate and linalool. It is postulated that both linalyl acetate and linalool can stimulate the parasympathetic system.¹⁹ It is believed that linalyl acetate has narcotic effects,¹⁹ while linalool may produce sedation. A report by Franco, Blanck¹⁵ suggested that the effects of lavender oil odour play a role in the modulation of GABA neurotransmission and the cholinergic neurological system making it effective as an antianxiety, anti-depressive, analgesic and also anticonvulsant.¹⁵ In another discussion, Stanley, Wan suggested that lavender extract stimulates the olfactory receptors and transfers the olfactory message to the limbic system in the brain, releasing enkephalin, endorphin and serotonin in response to stress that can calm a person and reduce anxiety.¹⁸ It has also been

shown that lavender aromatherapy was able to induce electroencephalography (EEG) patterns that were characteristic of subjects feeling comfortable.¹⁸

We also found that the time taken to LOC at induction of anesthesia was not affected by the lavender aromatherapy even though the anxiety level of these patients was significantly reduced at this point. This was similar to the report by Koehler *et al.* Their study showed that aromatherapy had no significant effect on the duration of time to LOC at induction but offered a smoother process of induction.¹⁹⁻²¹ We, however, did not describe nor record the quality of the anesthesia induction.

Significantly, our study found that the total amount of propofol required for induction of anesthesia was less in patients who received lavender aromatherapy. It has been shown that patients with high levels of preoperative anxiety required a higher dose of propofol for induction of anesthesia.¹⁵⁻¹⁷ The requirement of propofol during induction and maintenance of anesthesia was significantly less in patients with lower levels of anxiety as compared to patients with higher levels of anxiety.^{16,17}

The available preparation of lavender oil in the market has various proportions of linalyl acetate and linalool contents. There is no preparation approved for medical use. To date, the use of aromatherapy in medicine is still considered an alternative to pharmacological therapy. The available data suggest that short-term therapy with lavender aromatherapy is relatively safe.^{18,19} Since lavender aromatherapy showed no potential for addiction or abuse, it may be a beneficial alternative to pharmacological treatment of preoperative anxiety.¹⁹

In this study, all patients had an average exposure time of about 20 min which suits the average waiting time from arrival to the OT to the time for induction of anesthesia in our settings. There is no recommendation on the optimum exposure time for lavender aromatherapy to produce its anti-anxiety effect. Previous studies that used 20 min of exposure time had reported similar findings.²⁴⁻²⁶

5. LIMITATIONS

There were several limitations in this study. It is difficult to standardise the exact amount of lavender oil administered to produce aromatherapy. In our study, we instilled a drop of the lavender oil preparation and the application was done by multiple operators. The exact amount of the applied oil may have varied. The lavender scent was tolerated by most of the patients in our study except one of our drop outs was a patient, who could not tolerate the smell, which was reported as too strong. Moreover, we included only female patients in the trial.

Further studies may involve both genders and compare the differences, If any.

6. CONCLUSION

In conclusion, our study showed that preoperative exposure to lavender aromatherapy significantly reduced preoperative anxiety and the amount of propofol required for the induction of anesthesia in female patients undergoing elective surgeries with general anesthesia and may potentially be considered as a beneficial premedication strategy before surgeries in the future.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Acknowledgement

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9. Conflict of interest

The study utilized the hospital resources only, and no external or industry funding was involved.

10. Authors' contribution

RAR and MVD conceptualized and designed the study and drafted and wrote the manuscript. NMN, MVD and SNSM acquired, analysed, and interpreted the data and images. FHA, MNM and RAR edited the manuscript content and provided writing assistance. FHA and RAR critically revised and proofread the manuscript. All authors approved the final version of the manuscript.

11. REFERENCES

1. Matthias AT, Samarasekera DN. Preoperative anxiety in surgical patients - experience of a single unit. *Acta Anaesthesiol Taiwan*. 2012 Mar;50(1):3-6. [PubMed] DOI: [10.1016/j.aat.2012.02.004](https://doi.org/10.1016/j.aat.2012.02.004)
2. Osborn TM, Sandler NA. The effects of preoperative anxiety on intravenous sedation. *Anesth Prog*. 2004;51(2):46-51. [PubMed]
3. Masri SN, Rahman RA, Masdar A, Mat WRW, Nor NM, Izaham A. Does anxious patients require more propofol at induction? *Anaesth Pain & Intensive Care*. 2018;22(4):419-423 [FreeFullText]
4. Kovac M. Music Interventions for the Treatment of Preoperative Anxiety. *J Consumer Health Internet*. 2014;18(2):193-201. DOI: [10.1080/15398285.2014.902282](https://doi.org/10.1080/15398285.2014.902282)
5. Bae H, Bae H, Min BI, Cho S. Efficacy of acupuncture in reducing preoperative anxiety: a meta-analysis. *Evid Based Complement Alternat Med*. 2014;2014:850367. [PubMed] DOI: [10.1155/2014/850367](https://doi.org/10.1155/2014/850367)
6. Butje A, Repede E, Shattell MM. Healing scents: an overview of clinical aromatherapy for emotional distress. *J Psychosoc Nurs Ment Health Serv*. 2008 Oct;46(10):46-52. [PubMed] DOI: [10.3928/02793695-20081001-12](https://doi.org/10.3928/02793695-20081001-12)
7. Maddocks-Jennings W, Wilkinson JM. Aromatherapy practice in nursing: literature review. *J Adv Nurs*. 2004;48(1):93-103. [PubMed] DOI: [10.1111/j.1365-2648.2004.03172.x](https://doi.org/10.1111/j.1365-2648.2004.03172.x)
8. Koulivand PH, Khaleghi Ghadiri M, Gorji A. Lavender and the nervous system. *Evid Based Complement Alternat Med*. 2013;2013:681304. [PubMed] DOI: [10.1155/2013/681304](https://doi.org/10.1155/2013/681304)
9. Perry R, Terry R, Watson LK, Ernst E. Is lavender an anxiolytic drug? A systematic review of randomised clinical trials. *Phytomedicine*. 2012;19(8-9):825-35. [PubMed] DOI: [10.1016/j.phymed.2012.02.013](https://doi.org/10.1016/j.phymed.2012.02.013)
10. Salamati A, Mashouf S, Mojab F. Effect of Inhalation of Lavender Essential Oil on Vital Signs in Open Heart Surgery ICU. *Iran J Pharm Res*. 2017;16(1):404-9. [PubMed]
11. Bakhsha F, Mazandarani M, Aryaei M, Jafari SY, Bayate H. Phytochemical and anti-oxidant activity of *lavandula angustifolia* mill. Essential oil on preoperative anxiety in patients undergoing diagnostic curettage. *Int J Women's Health*. 2014;2:268-271. DOI: [10.15296/ijwhr.2014.42](https://doi.org/10.15296/ijwhr.2014.42)
12. Fayazi S, Babashahi M, Rezaei M. The effect of inhalation aromatherapy on anxiety level of the patients in preoperative period. *Iran J Nurs Midwifery Res*. 2011;16(4):278-83. [PubMed]
13. Facco E, Zanette G, Favero L, Bacci C, Sivoiella S, Cavallin F, et al. Toward the validation of visual analogue scale for anxiety. *Anesth Prog*. 2011;58(1):8-13. [PubMed] DOI: [10.2344/0003-3006-58.1.8](https://doi.org/10.2344/0003-3006-58.1.8)
14. Wotman M, Levinger J, Leung L, Kallush A, Mauer E, Kacker A. The efficacy of lavender aromatherapy in reducing preoperative anxiety in ambulatory surgery patients undergoing procedures in general otolaryngology. *Laryngoscope Investig Otolaryngol*. 2017;2(6):437-41. [PubMed] DOI: [10.1002/liv.121](https://doi.org/10.1002/liv.121)
15. Franco L, Blanck TJ, Dugan K, Kline R, Shanmugam G, Galotti A, et al. Both lavender fleur oil and unscented oil aromatherapy reduce preoperative anxiety in breast surgery patients: a randomized trial. *J Clin Anesth*. 2016;33:243-9. [PubMed] DOI: [10.1016/j.jclinane.2016.02.032](https://doi.org/10.1016/j.jclinane.2016.02.032)
16. Jaruzel CB, Gregoski M, Mueller M, Faircloth A, Kelechi T. Aromatherapy for Preoperative Anxiety: A Pilot Study. *J Perianesth Nurs*. 2019;34(2):259-64. [PubMed] DOI: [10.1016/j.jopan.2018.05.007](https://doi.org/10.1016/j.jopan.2018.05.007)
17. Guo P, Li P, Zhang X, Liu N, Wang J, Yang S, et al. The effectiveness of aromatherapy on preoperative anxiety in adults: A systematic review and meta-analysis of randomized controlled trials. *Int J Nurs Stud*. 2020;111:103747. [PubMed] DOI: [10.1016/j.ijnurstu.2020.103747](https://doi.org/10.1016/j.ijnurstu.2020.103747)
18. Stanley PF, Wan LF, Karim RA. A randomized prospective placebo-controlled study of the effects of lavender aromatherapy on preoperative anxiety in cataract surgery patients. *J Perianesth Nurs*. 2020;35(4):403-6. [PubMed] DOI: [10.1016/j.jopan.2019.12.004](https://doi.org/10.1016/j.jopan.2019.12.004)
19. Pardede J, Simanjuntak GV, Manalu N. Effectiveness of deep breath relaxation and lavender aromatherapy against preoperative patient anxiety. *Diversity Equality Health Care*. 2020;17(4):168-73. [FreeFullText]
20. Huang H, Wang Q, Guan X, Zhang X, Kang J, Zhang Y, et al. Effect of aromatherapy on preoperative anxiety in adult patients:

- A meta-analysis of randomized controlled trials. *Complement Ther Clin Pract.* 2021;42:101302. [PubMed] DOI: [10.1016/j.ctcp.2021.101302](https://doi.org/10.1016/j.ctcp.2021.101302)
21. Koehler T. Lavender Aromatherapy as a Nurse-Driven Intervention for Preoperative Anxiety. *Nurs Womens Health.* 2021;25(4):286-95. [PubMed] DOI: [10.1016/j.nwh.2021.05.005](https://doi.org/10.1016/j.nwh.2021.05.005)
 22. Karaman T, Karaman S, Dogru S, Tapar H, Sahin A, Suren M, et al. Evaluating the efficacy of lavender aromatherapy on peripheral venous cannulation pain and anxiety: A prospective, randomized study. *Complement Ther Clin Pract.* 2016;23:64-8. [PubMed] DOI: [10.1016/j.ctcp.2016.03.008](https://doi.org/10.1016/j.ctcp.2016.03.008)
 23. Fleiss JL. *Statistical Methods for Rates and Proportions.* 1st ed. London: John Wiley & Sons; 1981.
 24. Eslami J, Ebrahimi A, Hosseinkhani A, Khazaei Z, Darvishi I. The effect of aromatherapy using Lavender (*Lavandula angustifolia* Miller) and *Citrus aurantium* L. extracts to treat anxiety of patients undergoing laparoscopic cholecystectomy: A randomized clinical trial in Iran. *Biomed Res Ther.* 2018;5(3):2096-110. DOI : [10.15419/bmrat.v5i3.423](https://doi.org/10.15419/bmrat.v5i3.423)
 25. Beyliklioğlu A, Arslan S. Effect of Lavender Oil on the Anxiety of Patients Before Breast Surgery. *J Perianesth Nurs.* 2019;34(3):587-93. [PubMed] DOI: [10.1016/j.jopan.2018.10.002](https://doi.org/10.1016/j.jopan.2018.10.002)
 26. Ayik C, Özden D. The effects of preoperative aromatherapy massage on anxiety and sleep quality of colorectal surgery patients: A randomized controlled study. *Complement Ther Med.* 2018;36:93-9. [PubMed] DOI: [10.1016/j.ctim.2017.12.002](https://doi.org/10.1016/j.ctim.2017.12.002)