PRONE POSITION REDUCES GASTRIC RESIDUAL VOLUME IN INFANTS IN CRITICAL CARE: A SYSTEMATIC REVIEW

Santy Ercelina Nainggolan[1)], Syafrida Hanum[2)], Wulan Pramadhani[3)], Cindy Febriyeni[4)], Hazrina Adelia[5)], Syarifah Aini Tanjung[6)]
Fakultas kedokteran[1)], Fakultas Keperawatan[2)], Fakultas Ilmu Kesehatan[3)], Fakultas Keperawatan[4)], Fakultas Farmasi dan Ilmu Kesehatan[5)]
Universitas Tanjungpura[1)], Universitas Riau[2)], Universitas Awal Bros[3)], Institut Kesehatan Payung Negeri Pekanbaru[4)], Universitas Abdurrab[5)], RSAB Harapan Kita[6)]
Email : santyercelinanainggolan.n@ners.untan.ac.id[1)]; syafrida.hanum@lecturer.unri.ac.id[2)]; wulanpramadhani98@gmail.com[3)]; cindyfebriyeni.akut@gmail.com[4)]; hazrina.adelia@univrab.ac.id[5)]; iffahtanjung@gmail.com[6)]

ABSTRACT

This literature study aims to analyze the effectiveness of the prone position on gastric emptying in infants treated in critical rooms. A systematic review was conducted using The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines. The method used in this study is an online database search at Scopus, Wiley Online Library, Proquest, EBSCOhost, ScienceDirect, and Google Scholar with the application of inclusion-exclusion criteri. The database using predetermined combinations of keywords: *Prone OR Positioning AND Gastric Residual Volume OR GRV AND Pediatric* OR *Infant* OR *Neonate*. Articles published between 2010 and 2024 that described studies with a randomized controlled trial (RCT) design, prospective observational study, quasy experiment, and that were published in English and had the full text available were included. The quality of each article was assessed using the Joanna Briggs Institute Critical Appraisal Checklist. The results showed that the 8 articles reviewed showed that pronation position can reduce gastric residue and better food tolerance to prevent vomiting and regurgitation (GER). The review identified various infant feeding positions aimed at reducing gastric residual volume, including prone, right and left lateral, semi fowler's, supine, and kangaroo mother care. Across five included studies, the prone position demonstrated the most consistent effect in decreasing gastric residual volume. Nevertheless, one study reported potential adverse outcomes, such as vomiting and gastroesophageal reflux (GER), while another study concluded that the prone position ranked as the second most effective compared with other positions.The conclusion of the study shows that the prone position has fairly good effectiveness in terms of reducing gastric residual volume in infants treated in critical rooms compared to other positions. Therefore, infant care unit can apply for this prone position as one of the interventions in nursing care related to tolerance of the nutrition given.

Keywords: *GRV, Gastric Residual* Volume, *Pediatrics, Positioning, Prone*

Corresponding author:
Santy Ercelina Nainggolan. Fakultas Kedokteran, Universitas Tanjungpura, Jln Prof. H. Hadari Nawawi, Pontianak 78124. Email: Anchiza28@gmail.com. Nomor Hp: 085278290333

INTRODUCTION

Critically ill patients in intensive care units (ICUs) are at a high risk of developing malnutrition, which is strongly associated with adverse clinical outcomes (Hoffmann et al., 2021). Malnutrition not only delays wound healing but also increases the risk of complications and mortality (Yu et al., 2020). Early and adequate nutritional support is essential to facilitate gastrointestinal maturation and development, optimize nutrient absorption, and maintain

gastrointestinal motility (Rahmawati et al., 2020). Therefore, timely and appropriate nutritional management is crucial in the care of critically ill patients.

In pediatric critical care, early initiation of enteral nutrition is recommended, as it has been shown to improve clinical outcomes, reduce hospital length of stay, and lower mortality rates (Dewi & Supriatna, 2021). Enteral nutrition is generally preferred over parenteral nutrition because it is more cost-effective and associated with fewer complications. It is indicated when patients cannot meet their nutritional requirements orally, either in the short or long term. Administering enteral feeds through a nasogastric or orogastric tube helps optimize gastrointestinal function, prevent weight loss, reduce infection risk, minimize the need for surgical interventions, and improve quality of life (Doley, 2022).

Gastric residual volume (GRV) is a widely used parameter to assess tolerance to enteral nutrition. Monitoring GRV provides valuable information about bowel function and abdominal status. Enteral feeding may be delayed or withheld in the presence of significant vomiting, abdominal distension, or severe discomfort (Doley, 2022). High gastric volumes increase gastric acidity, which can influence pyloric sphincter opening and ultimately elevate GRV (Prasetia et al., 2020). Several factors influence GRV, including patient positioning, feeding tube placement and size, syringe size, nurse aspiration technique, and the feeding method used (bolus or continuous) (Hoffmann et al., 2021; Rahmawati et al., 2020; Prasetia et al., 2020).

One simple, nurse-initiated intervention to improve feeding tolerance in critically ill infants is optimal positioning during enteral feeding. Evidence from multiple studies indicates that the prone position consistently reduces GRV. For example, Khatony et al. (2019) reported that prone positioning is more effective than other positions in reducing gastric residuals and enhancing nutrient absorption in preterm infants. Given this evidence, the present review systematically examines the impact of prone positioning on GRV in infants admitted to critical care units.

METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework guided this review. All investigators independently screened abstracts and reviewed the complete articles. Figure 1 presents the search strategy as a flowchart.

A comprehensive and systematic literature search was undertaken across six electronic databases Pubmed, Wiley Online Library, ProQuest, EBSCOhost, ScienceDirect, and Google Scholar using predetermined combinations of keywords: Prone OR Positioning AND Gastric Residual Volume OR GRV AND Pediatric *OR* Infant *OR* Neonate. The search was designed to capture primary research articles that met the following inclusion criteria: (a) studies investigating the effect of prone positioning on gastric emptying or gastric residual volume in infants, (b) studies involving enteral feeding via nasogastric tube (NGT) or orogastric tube (OGT), (c) articles published in either English or Indonesian, (d) publications dated between 2010 and 2024, and (e) intervention studies, including randomized controlled trials (RCTs), quasi-experimental designs, and prospective observational studies. Studies were excluded if they were duplicates across databases, lacked full-text availability, or were literature reviews or systematic reviews. In this systematic review, four researchers independently assessed the selected studies. Key information was extracted, including author, country, year of publication, program type, sample size, intervention and control groups, as well as reported outcomes. The methodological quality of each study was evaluated using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist (Munn, 2020). This tool consists of eight domains: (1) clarity of inclusion criteria, (2) description of participants and study setting, (3) validity and reliability of exposure measurement, (4)

standardized methods for condition measurement, (5) identification of potential confounders, (6) strategies to address confounding variables, (7) validity and reliability of outcome measurement, and (8) appropriateness of statistical analyses. Following this process, eight studies met the eligibility requirements and were included in the final review. The study selection process is summarized in the PRISMA flow diagram (Figure 1).

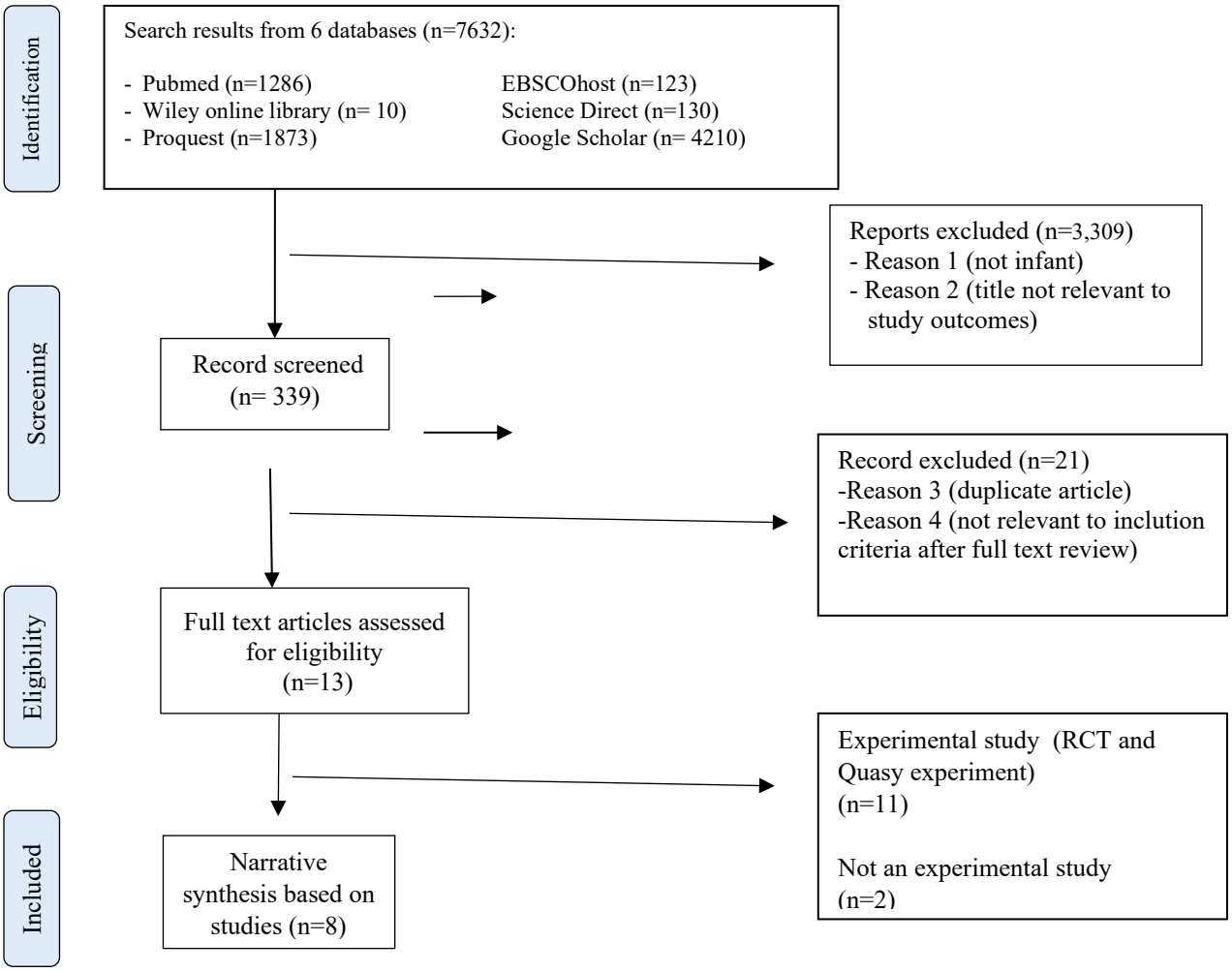

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Flowchart for The Study Selection Process

RESULTS

A total of eight studies met the inclusion criteria and were included in the final synthesis. All selected studies employed experimental or quasi-experimental methodologies, encompassing randomized crossover trials, time-series crossover designs, quasi-experimental approaches, and prospective observational studies. The study populations primarily consisted of neonates, including preterm infants under 30 days of age, with inclusion and exclusion criteria varying according to the respective study protocols.

Among the included studies, five reported a statistically significant reduction in mean gastric residual volume (GRV) following prone positioning compared to alternative positions, including right lateral, left lateral, and supine positioning. These studies also documented improved feeding tolerance, reflected in decreased episodes of vomiting and gastroesophageal regurgitation (GER). One study reported no statistically significant differences in GRV between prone and other positions; however, the authors observed enhanced comfort and feeding tolerance in infants placed in the prone position. Another study indicated that, while the right lateral position demonstrated the lowest mean GRV in certain cases, it was associated with an increased risk of regurgitation, whereas prone positioning provided more consistent gastrointestinal tolerance.

Despite methodological heterogeneity across studies—such as differences in feeding protocols, volume and type of enteral nutrition, sample characteristics, and the use of mechanical ventilation—the overall findings suggest that prone positioning is the most consistently effective intervention for reducing GRV and optimizing enteral feeding tolerance among critically ill infants.

Table 1. Summary of Reviewed Literature

NO	Journal Reference	Methodology	Key Finding
1	Alireza K., Alireza Abdi, Batol K., Abbas A., and Hamidreza S. (2019). The effects of position on gastric residual volume of premature infants in NICU. Open access: Italian Journal of Pediatrics, Kermanshah.	Randomized crossover clinical trial	- All three positions showed no significant difference in effectiveness; however, the prone position resulted in the lowest mean GRV compared to other positions. - Baseline characteristics by disease diagnosis (prematurity, respiratory failure, sepsis) were not evenly distributed across groups
2	Mahbobeh, S., Mehran, A., Saeed, A., Sharareh, K. (2019). Comparison of Effect of Prone and Right Lateral Positions on Gastric Residual Volume in Preterm Newborns. Open access : Iranian Journal of Neonatology.	Randomized crossover clinical trial	- Mean GRV was lower in the prone position than in the right lateral position following breast milk feeding via NGT. - Baseline disease characteristics (RDS, sepsis, pneumonia, chorioamnionitis) were not reported per group.
3	Deniz Özdel & Hatice Yildirim Sarı. (2018). Effects of the prone position and kangaroo care on gastric residual volume, vital signs and comfort in preterm infants.	Quasi ekperimental, one group pre test post test design	No significant difference in GRV was observed between prone positioning and kangaroo care following enteral feeding,

NO	Journal Reference	Methodology	Key Finding
	Open access: Japan Journal of Nursing Science.		
4	Shiau-Shr Chen, Ya-Ling Tzeng, Bih-Shya Gau, Pi-Chao Kuo, and Jia-Yuh Chen. (2013). Effects of prone and supine positioning on gastric residuals in preterm infants: A time series with cross-over study. Open access: International Journal of Nursing Studies.	Randomized time series with cross-over	- Prone positioning at 30 and 60 minutes post-feeding significantly reduced GRV compared to supine positioning. - Feeding consisted of expressed breast milk (50 ml/kg/day on day 1, 100 ml/kg/day on day 2) via pump, with GRV measured at 30, 60, 90, 120, and 150 minutes. - Baseline group characteristics regarding mechanical ventilation type were not reported.
5	H. Sangers, P.M. de Jong, S.E. Mulder, G.D. Stigter, C.M. van den Berg, A.B. te Pas, & F.J. Walther. Savio, R. D., Parasuraman, R., Lovesly, D., Shankar, B., Ranganathan, L., Ramakrishnan, N., & Venkataraman, R. (2021). Feasibility, tolerance and effectiveness of enteral feeding in critically ill patients in prone position. Open access: Journal of the Intensive Care Society.	Prospective observational study	- Prone positioning did not significantly reduce GRV. - Baseline characteristics varied widely, including use of invasive mechanical ventilation, NCPAP, HFOV, and presence of intraventricular hemorrhage, with uneven distribution between groups
6	Varanpal Kaur, Rupinder Kaur, & Shiv Sajan Saini. (2018). Comparison of Three Nursing Positions for Reducing Gastric Residuals in. Open access: Indian Journal of Pediatrics.	Randomized cross over clnical trial	Prone position ranked second in reducing GRV (0.3%) after the right lateral position (0.1%). However, prone positioning was superior in gastric tolerance, while right lateral positioning had the highest regurgitation risk.

NO	Journal Reference	Methodology	Key Finding
7	Emriye Hilal Yayan, Sibel Kucukoglu, Yeliz Suna Dag, & Nazlı Karsavuran Boyraz. (2018). Does the post-feeding position affect gastric residue in preterm infants? Open access: Breastfeeding Medicine, 13(6), 438–443.	Quasi-experimental, one-group pretest-posttest design	Prone positioning was associated with lower GRV than other positions (p = 0.08).
8	Natalia Devi Oktarina, Yeni Rustina, & Defi Efendi. (2020). Pemberian Posisi untuk Mengatasi Masalah Pengosongan Lambung pada Bayi Prematur. Open access: Jurnal Keperawatan Raflesia, 2(2), 51–60.	Quasi experimental, pretest dan posttest without control group design	- Prone positioning demonstrated better gastric tolerance than other positions, with a 95% non-vomiting rate compared to others. Right lateral position had the highest vomiting rate (35%). - For GRV, prone position ranked second lowest after the right lateral position.

In the reviewed studies, several infant feeding positions were compared to determine the most effective approach for reducing gastric residual volume (GRV). These included the supine, semi-Fowler, right and left lateral, prone, and kangaroo care positions. Two studies compared prone with supine positions (Chen et al., 2013; Savio et al., 2021), two compared prone with right lateral (Sajadi et al., 2019; Kaur et al., 2018), while others compared prone with kangaroo care (Ozdel & Sari, 2018), prone with supine and right lateral (Khatony et al., 2019), prone with right and left lateral (Oktaria, Rustina, & Efendi, 2020), and prone with supine, right, and left lateral (Yayan et al., 2018). Observation durations varied, with most studies monitoring GRV for three hours (Chen et al., 2013; Khatony et al., 2019; Oktarina et al., 2020; Yayan et al., 2018; Ozdel & Sari, 2018), two studies for two hours (Sajadi et al., 2019; Kaur et al., 2018), and one for six hours (Savio et al., 2021). Feeding methods also differed: some studies administered enteral nutrition via gravity (Sajadi et al., 2019; Oktarina et al., 2020), while only one included fortified breast milk with added protein (Ozdel & Sari, 2018), and the rest used breast milk alone. One study involved neonates with ARDS receiving ventilatory support (Savio et al., 2021).

DISCUSSION

Overall, the eight studies consistently evaluated GRV in neonates (gestational age 28–37 weeks) receiving enteral feeding via NGT/OGT. Five studies demonstrated that prone positioning reduced mean GRV, while one study found no significant difference compared with non-prone positions. One trial reported vomiting and regurgitation (GER) as adverse effects, though others did not. Collectively, prone positioning was associated with better feeding tolerance and reduced risk of regurgitation compared to supine and lateral positions. Physiologically, the prone position characterized by flexed lower extremities, head turned sideways, supported pelvis, and chest elevation with a rolled cloth—appears to facilitate gastric emptying, improve feeding tolerance, and enhance oxygenation. Right lateral positioning also supported gastric emptying and reduced abdominal distension.

The findings of this systematic review indicate that prone positioning generally demonstrates favorable outcomes in reducing gastric residual volume (GRV) and enhancing feeding tolerance among critically ill infants. This effect is consistent with prior evidence suggesting that body positioning plays a critical role in facilitating gastric emptying and preventing feeding intolerance (Khatony et al., 2019; Bruni et al., 2020). In several included studies, prone positioning not only lowered GRV but also reduced the incidence of vomiting and gastroesophageal regurgitation (GER), thus supporting its use as a non-invasive nursing intervention to optimize enteral feeding outcomes.

These results align with the observations of Savio et al. (2021), who reported that prone positioning was well tolerated and effective in maintaining enteral feeding in critically ill patients. Similarly, Dwi Astuti et al. (2018) emphasized that feeding intolerance in infants may be indicated not only by vomiting, abdominal distension, and delayed bowel movements but also by systemic signs such as hypothermia, bradycardia, and desaturation. In such contexts, prone positioning appears to contribute positively to gastrointestinal motility, thereby improving feeding tolerance.

Nevertheless, some studies reported mixed findings. Kusmiati and Heny (2014), for instance, observed that right lateral positioning was equally effective as prone positioning in lowering GRV among low birth weight infants, although prone positioning provided superior tolerance. The potential advantage of the right lateral position has been attributed to its facilitation of gastric emptying due to anatomical positioning of the stomach. Conversely, prone positioning may, in some cases, slow intestinal transit because of the relative position of the gastrointestinal tract, although it still offers benefits in comfort and reflux prevention.

Despite these promising findings, methodological variability across studies—including differences in feeding volumes, nutritional composition, ventilation status, and monitoring intervals—limits the generalizability of results. Moreover, many of the reviewed studies involved small sample sizes, short observation periods, and lacked blinding, which may introduce bias. Therefore, while prone positioning appears to be an effective and practical intervention for reducing GRV and enhancing feeding tolerance, further large-scale, high-quality studies are warranted to strengthen the evidence base.

CONCLUSION

The cumulative evidence derived from this systematic review suggests that prone positioning may serve as an effective, non-invasive intervention to enhance feeding tolerance in critically ill neonates, primarily through the reduction of gastric residual volume (GRV) and the mitigation of vomiting and gastroesophageal regurgitation (GER). Despite the overall positive trend across the majority of included studies, the strength of this evidence remains constrained by substantial methodological limitations, including small and often non-representative sample sizes, variability in patient populations and clinical contexts, heterogeneity in enteral feeding protocols, short observation periods, and the lack of rigorous blinding procedures. Such limitations introduce potential biases and reduce the certainty with which causal inferences can be drawn. Accordingly, the current findings should be interpreted with measured caution, and the clinical application of prone positioning should be contextualized within individual patient needs, institutional protocols, and broader multidisciplinary care considerations.

RECOMMENDATIONS

Advancing the evidence base on prone positioning in neonatal critical care necessitates the implementation of methodologically rigorous research designs. Future investigations should prioritize adequately powered, multicenter randomized controlled trials with extended follow-up durations, standardized intervention parameters, and balanced distribution of baseline clinical characteristics. Furthermore, consistent operational definitions of GRV measurement, uniform criteria for feeding intolerance, and robust outcome monitoring are essential to facilitate comparability across studies. Expanding research to encompass diverse clinical settings and patient populations will improve the external validity and generalizability of findings, thereby enabling a more definitive appraisal of the safety, efficacy, and optimal integration of prone positioning into evidence-informed enteral feeding protocols in neonatal intensive care practice.

DAFTAR PUSTAKA

Bruni, A., Garofalo, E., Grande, L., Auletta, G., Cubello, D., Greco, M., Lombardo, N., Garieri, P., Papaleo, A., Doldo, P., Spagnuolo, R., & Longhini, F. (2020). Nursing issues in enteral nutrition during prone position in critically ill patients: a systematic review of the literature. *Intensive and Critical Care Nursing*, *60*(xxxx), 102899. https://doi.org/10.1016/j.iccn.2020.102899

Chen, S. S., Tzeng, Y. L., Gau, B. S., Kuo, P. C., & Chen, J. Y. (2013). Effects of prone and supine positioning on gastric residuals in preterm infants: a time series with cross-over study. *International Journal of Nursing Studies*, *50*(11), 1459–1467. https://doi.org/10.1016/j.ijnurstu.2013.02.009

Cohen, S., Mandel, D., Mimouni, F. B., Solovkin, L., & Dollberg, S. (2004). Gastric residual in growing preterm infants: effect of body position. *American Journal of Perinatology*, *21*(3), 163–166. https://doi.org/10.1055/s-2004-823778

Dewi, Y. S., & Supriatna, M. (2021). Perbedaan lama rawat dan luaran pemberian nutrisi enteral dini dan lambat pada anak sakit kritis di rumah sakit dr. kariadi semarang. *Sari Pediatri*, *22*(6), 378. https://doi.org/10.14238/sp22.6.2021.378-85

Doley, J. (2022). Enteral nutrition overview. *Nutrients*, *14*(11). https://doi.org/10.3390/nu14112180

Dwi Astuti, D., Rustina, Y., & Tri Waluyanti, F. (2018). Pengaturan posisi tidur bayi berat lahir rendah dapat menurunkan kejadian intoleransi pemberian minum enteral. *Jurnal Keperawatan Dan Pemikiran Ilmiah*, *4*(2), 10–17

Hoffmann, M., Schwarz, C. M., Fürst, S., Starchl, C., Lobmeyr, E., Sendlhofer, G., & Jeitziner, M. M. (2021). Risks in management of enteral nutrition in intensive care units: a literature review and narrative synthesis. *Nutrients*, *13*(1), 1–31. https://doi.org/10.3390/nu13010082

L'Her E, Renault A, Oger E, Robaux MA, Boles JM. (2002). A prospective survey of early 12-h prone positioning effects in patients with the acute respiratory distress syndrome. *Intensive Care Medicine.* 28(5), 570-575. https://doi.org/10.1007/s00134-002-1258-x

Kusmiati, T., & Heny, N. (2014). Efektifitas posisi prone (telungkup) dan posisi right lateral (miring kanan) terhadap penurunan residu lambung pada neonatus dengan berat lahir rendah diruang seruni rsab harapan kita. Skripsi SI Ilmu Kpeerawatan Universitas Muhammadiyah Jakarta.

Khatony et. all. 2019. The effect of position on gastric residual volume of premature infant in nicu. *Italian Journal of Pediatrics* 45(1), 1-6. https://doi.org/10.1186/s13052-018-0591-9

Oktarina, N. D., Rustina, Y., & Efendi, D. (2020). Pemberian posisi untuk mengatasi masalah

pengosongan lambung pada bayi prematur. *Jurnal Keperawatan Raflesia*, *2*(2), 51–60. https://doi.org/10.33088/jkr.v2i2.505

Özdel, D., & Sarı, H. Y. (2020). Effects of the prone position and kangaroo care on gastric residual volume, vital signs and comfort in preterm infants. *Japan Journal of Nursing Science*, *17*(1), 1–8. https://doi.org/10.1111/jjns.12287

Prasetia, K., Erawati, E., & Donantya, H. (2020). Perbedaan volume residu lambung berdasarkan metode pemberian nutrisi enteral bolus dan intermittent pada pasien stroke di rumah sakit st. elisabeth semarang. *Jurnal Manajemen Asuhan Keperawatan*, *4*(2), 70–78. https://doi.org/10.33655/mak.v4i2.89

Rahmawati Elfira Awalia, Yeni Rustina, D. E. (2020). Toleransi minum enteral bayi prematur menggunakan spuit 20 ml dan spuit 50 ml. *Jurnal Keperawatan Silampari*, *21*(1), 1–9

Sajadi, M., Akbari, M., Alinejad, S., & Khosravi, S. (2019). Comparison of effect of prone and right lateral positions on gastric residual volume in preterm newborns. *Iranian Journal of Neonatology*, *10*(2), 55–60. https://doi.org/10.22038/ijn.2019.34332.150

Sangers, H., de Jong, P. M., Mulder, S. E., Stigter, G. D., van den Berg, C. M., te Pas, A. B., & Walther, F. J. (2013). Outcomes of gastric residuals whilst feeding preterm infants in various body positions. *Journal of Neonatal Nursing*, *19*(6), 337–341. https://doi.org/10.1016/j.jnn.2012.12.003

Savio, R. D., Parasuraman, R., Lovesly, D., Shankar, B., Ranganathan, L., Ramakrishnan, N., & Venkataraman, R. (2021). Feasibility, tolerance and effectiveness of enteral feeding in critically ill patients in prone position. *Journal of the Intensive Care Society*, *22*(1), 41–46. https://doi.org/10.1177/1751143719900100

Tume, L.N dan Valla, F.V. 2018. A review of feeding intolerance in critically ill children. *Eropean jurnal of Pediatric*. http://doi.org/10.1007/s00431-018-3229-4

Varanpal Kaur, Rupinder Kaur, & Shiv Sajan Saini. (2018). Comparison of three nursing positions for reducing gastric residuals in preterm neonates: a randomized crossover trial. *Indian Pediatrics, 55(7),* 568–572. https://doi.org/10.1007/s13312-018-1298-0

Yayan, E. H., Kucukoglu, S., Dag, Y. S., & Boyraz, N. K. (2018). Does the post-feeding position affect gastric residue in preterm infants? *Breastfeeding Medicine*, *13*(6), 438–443. https://doi.org/10.1089/bfm.2018.0028

Yu, Q. sheng, Zheng, Z., Peng, H., Shen, Y., Liu, J. da, & Zhou, F. hai. (2020). effect of qihuang decoction combined with enteral nutrition on postoperative gastric cancer of nutrition and immune function. *Evidence-Based Complementary and Alternative Medicine*, *2020*. https://doi.org/10.1155/2020/1795107

Yu Victor, Y. H. (1975). Effect of body position on gastric emptying in the neonate. *Archives of Disease in Childhood*, *50*(7), 500–504. https://doi.org/10.1136/adc.50.7.500