Nurses' Detection and Management of Patient Ventilator Asynchrony: A Study at Korle Bu Teaching Hospital

Gladys Peace Yeboah[1]; Irene Sena Wemarko[2]; Stephen Naavure[3]; Anita Otchere Darko[4]; Dorcas Dansowaa Addo[5]

[1]Enchi Government Hospital, Ghana Health Service, Western North Region Ghana
[2]Korle Bu Teaching Hospital, Greater Accra region, Ghana
[3]Gushegu Municipal Hospital, Ghana Health Service, Northern Region, Ghana
[4]Tema General Hospital, Ghana Health Services, Greater Accra Region, Ghana
[5] Komfo Anokye Teaching Hospital, Ashanti Region

Corresponding Author: Gladys Peace Yeboah;
[1]Enchi Government Hospital, Ghana Health Service, Western North Region Ghana

Abstract: Nurses' role in every nursing facility is important because they essential healthcare system's critical life-saving moments and procedures. One of the critical procedures they perform is the assistance to patients using mechanical ventilation as part of their care process. In such situations, ventilators should be positioned to maintain synchrony. However, there may be instances of ventilation asynchrony. Since Nurses are often the carers of patients under critical care, it behoves them to be able to detect and manage such situations to avert life-threatening situations. Against this background, this study explores Nurses' detection and management skills to improve ventilator synchrony. This study deployed a qualitative method with a case study design using an interview guide to collect data from Nurses in the Greater Accra region of Ghana. Specifically, the study engaged 15 nurses in seven critical care units in the Korle-Bu Teaching Hospital. Interviews were recorded, transcribed and analysed using thematic analysis. The study revealed that nurses at the ICU of the Korle-Bu Teaching Hospital had various techniques for detecting ventilator asynchrony which include monitoring of ventilator and monitoring patients' breathing. It was discovered that nurses deployed various strategies in managing asynchrony including changing the settings on the ventilator, handling issues of dislodgment and in more complex situations, they referred to the engineers at the facility. Nurses also indicated that they lacked adequate training and skills in managing asynchrony also, they lacked adequate resources in developing skills in detecting and managing asynchrony. To ensure that nurses acquire adequate skills and knowledge, they needed training and workshops organised for them and also, they needed adequate resources in the unit.

I. INTRODUCTION

Nursing is an integral aspect of the healthcare industry since nurses are an essential part of the healthcare delivery system worldwide. According to the International Council of Nurses (ICN), nursing encompasses the independent and collaborative treatment of sick and healthy people of all ages, families, groups, and communities (Bulleri et al., 2018). Care for the sick, disabled, and dying is part of the nursing profession's remit. Besides providing direct care to patients, nurses are also responsible for various other activities, including but not limited to advocating for their patients, fostering a secure working environment, conducting research, contributing to the formation of health policy, and teaching

(Gravante et al., 2022). To better provide care, nurses must have a set of competencies (Zhou et al., 2022). Professionals and institutions need to define and execute management skills for nurses because nurses have traditionally held management positions in the healthcare industry, particularly within hospitals (Schroedl & Vitale, 2022). Interaction with other professionals, everyday practice/experience, and ongoing learning via courses, specialisations, and upgrades are only a few of how nurses are expected to grow in their careers (Holanda et al., 2018a).

Nurses need to be able to recognise the need for mechanical ventilation and take appropriate action. It is standard practice in hospital intensive care units (ICUs) to utilise mechanical ventilation as a last resort. Complications, including lung injury, pulmonary infections, ventilator-induced diaphragmatic dysfunction, and ventilator-associated pneumonia, can arise when doctors assist a patient with supplemental breathing using a ventilator (Jerofke-Owen et al., 2022). Respiratory failure is the most common cause of death in critically ill individuals. Most of these patients will require mechanical ventilation (MV) to help them breathe easier, keep their gas exchange stable, and reduce strain on their respiratory muscles. Acute respiratory failure (69%), coma (17%), chronic obstructive pulmonary disease (COPD) (3%), and neuromuscular diseases (2%) were found to be the most common reasons for MV in a global assessment of about 5,000 patients (Wood et al, 2021).

The global incidence of patient-ventilator asynchrony (PVA) differs from one study to the next and from one technique of PVA detection to the next. There is a wide range of reported incidence rates for PVA; some studies even indicate rates as high as 80% (Holanda et al., 2018b; Luo et al., 2020). The greatest reported incidence rates of PVA were in patients with acute respiratory distress syndrome (ARDS) and those undergoing assist-control ventilation, according to a comprehensive review and meta-analysis of research on PVA in critically sick patients (Bulleri et al., 2018b; Danielis et al., 2020). The prevalence of PVA during non-invasive ventilation (NIV) varies greatly across patient populations and breathing strategies. Patients with COPD who were given NIV had an incidence rate of 60%, whereas patients with neuromuscular illnesses who were given NIV had an incidence rate of 18% (Garofalo et al., 2018; Mirabella et al., 2020a; Zhou et al., 2021).

Patient health outcomes may suffer if PVA is misdiagnosed, since this may result in improper treatment of the patient's respiratory disease (Danielis et al., 2020; Gravante et al., 2022; L. Zhang et al., 2020). Underdiagnosis of PVA has been linked to worse clinical outcomes, according to research that was employed to identify asynchronies, only found that 17% of PVAs were discovered by physicians, and up to 68% of asynchronies were missed by doctors when using ventilator wave form analysis, but using wave form analysis might enhance asynchrony identification and minimise incidence

(Antonogiannaki et al., 2017; Vennedey et al., 2020). Therefore, PVA is common in patients with mechanical ventilation and may go undiagnosed. Improved patient outcomes may be achieved using improved monitoring methods and wave form analysis to better identify asynchronies and advise optimal patient care (Holanda et al., 2018a; Luo & Zhou, 2021a; Mireles-Cabodevila et al., 2022a). Several potentially negative consequences have been associated with patient-ventilator asynchronies (PVA) in mechanically ventilated patients.

Depending on the length and intensity of the asynchrony, PVA might have varying consequences from patient to patient. Discomfort, shortness of breath, and anxiety are all symptoms of PVA that may contribute to the patient's emotional suffering (Guttormson et al., 2023; Merliot-Gailhoustet et al., 2022). As a result, the patient may experience respiratory discomfort and muscular exhaustion because of the increased labour of breathing. Moreover, PVA might make it challenging to wean the patient off mechanical ventilation, which can increase the duration of ventilation, the risk of complications, the length of time spent in the intensive care unit, and the overall cost of treatment. Lastly, PVA has been linked to a higher risk of death in those who are being kept alive by a ventilator. Therefore, it is essential to improve patient outcomes and reduce the risk of problems associated with mechanical breathing if PVA is detected and treated promptly.

While nurses are deemed vital in addressing PVA, there have been concerns about the skill of nurses in this regard. At present, there is a lacked of clarity concerning the spread of nurses' knowledge and abilities connected to the interpretation of ventilator wave forms and the detection of asynchronies, as lamented by Bulleri et al. (2018). Again, nurses in Ghana and much of sub-Saharan Africa have been seen to have peculiar challenges that may impede their skills development and subsequent detection and management of such critical care situations. Consequently, they may be hindered in the management of PVAs. In my experience, I have noticed breathing patterns that are off-balance, with patients trying to breathe in while the ventilator was exhaling, which is a sign of patient-ventilator asynchrony. I swiftly contacted the attending physician to change the ventilator settings after spotting the possible risk and preventing a potential health emergency. This is a concern for study because human lives may be lost.

➢ *Objectives*
The study aims to investigate the detection and management skills required of nurses to improve issues of ventilator asynchrony. The study has the following objectives:

- To explore the ability of nurses to detect ventilator asynchrony.
- To assess how nurses manage ventilator asynchrony.
- To identify the challenges that impede nurses' ability to develop the requisite skills for detecting and managing ventilator asynchrony

II. METHODS

A qualitative approach was used in this study, and a case study design adopted. The study used a purposive sampling strategy to select participants, and gather data using an interview guide. The researcher deliberately chose nurses to be part of the study since they were involved in the use of ventilators. The target population was nurses in the Greater Accra Region of Ghana, where the study was set in the Korle-Bu Teaching Hospital. The study's sampling frame comprised nurses working in Critical Care Units in the Korle-Bu Teaching Hospital. Data were analysed using thematic analysis.

III. RESULTS

A. Knowledge of Ventilator Asynchrony

➢ *Perspectives*

Participants had different definitions of ventilator asynchrony. Some defined it as a mismatch of patients' breathing to the ventilator while others described it as a situation where the output of the ventilator is not supporting the patient's effort. Some participants described it as when the patient and the ventilator are acting in opposite ways.

- It is detecting the mismatch of the patient's breath to the ventilator –R1
- It is when the patient is fighting the ventilator which means the patient is also breathing while the ventilator is showing otherwise – R2
- Detection of ventilator asynchrony is when a patient is fighting the vent when the output of the ventilator is not supporting the effort of the patient, they are working in two different ways- R4
- Asynchrony is a medical term for something that doesn't follow how it is supposed to work for example a patient and a ventilator are supposed to work harmoniously so if there is no harmonious activity between a patient and a ventilator it is asynchrony - R5
- It is noticing a mismatch between the patient's breath and the ventilator. –R8
- If there is no coordinated activity between a patient and a ventilator – R10
- It is when the ventilator is not supplying sufficient oxygen as needed by the patient – R12

B. Detecting Ventilator Asynchrony

➢ *Ways of Detecting Ventilator Asynchrony*

Participants stated the different ways of detecting ventilator asynchrony. While some nurses indicated the monitoring of the alarms of the ventilator, others indicated the monitoring of patient breathing and the parameters and settings of the ventilators.

- I can detect it by noticing the alarms and looking at the patient's effort that the patient is making- R4

- I will see it from the parameters and my assessment- R5
- In detecting ventilator asynchrony, I attend to the alarm that the ventilator will give out –R6
- I can detect asynchrony by monitoring the patient's breath as compared to the output of the ventilator-R7
- I identify asynchrony when I observe the ventilator waveform does not correspond to the patient's breathing-R10
- Asynchrony is detected when you monitor the breathing pattern of the patient is not coordinating with the output of the ventilator- R11
- You should be able to tell because synchronization also means in another way that the patient is making an effort and the ventilator is also giving its volume that is where the mismatch comes in, so you can see that the patient is neither tolerating the volume or is uncomfortable or saturations are dropping and the ventilators usually blow alarms and they have colour coded signals that will tell you that this alarm means that something is faulty or something that is not too good is happening-R13

C. Management of Ventilator Asynchrony

➢ *Ability To Manage Ventilator Asynchrony*

In managing ventilator asynchrony, study participants stated the various ways of dealing with it. While some stated the changes in the settings and mode of the ventilator could solve the situation others stated that it be referred to engineers and other technical staff. These solutions however depended on the cause of the asynchrony

- We called the engineers to come and have a look at the ventilators-R1
- We change the ventilator mode- R2
- With ventilator asynchrony, it depends on a lot of factors either from the vent or the patient so based on your assessment you get to know if it's from the patient or the ventilator. If it is from the ventilator you check on the settings and the tubing - R5
- You first have to check the patient's connection with the ventilator if it's truly connected and also monitor whether there is a fault or dislodgement of the tube in administering the modes that you set for the ventilator then also search to see whether the settings you have given the ventilator is the right settings to which it can support your patient- R6
- We first change the settings of the ventilator to suit the patient- R9
- It depends on the cause of the asynchrony, sometimes it may be caused by the tubes not being positioned well so we fixed the tubes –R11

➢ *Ventilator Asynchrony Management Challenges*

Participants outlined some of the challenges they faced in developing the adequate skills needed to handle ventilator asynchrony. They stated that they lacked adequate equipment to develop skills in detecting ventilator asynchrony. They also

indicated that some of the ventilators were faulty thus, preventing their use in developing the skills needed to detect ventilator asynchrony.

➢ *Resources*

You know ICU is a specialized unit, We have sophisticated machines like ventilators and monitors, but I think that it should be something on our finger tips just like the world is moving to the technological stage, now even dogs have been trained to do BLS in USA, BLS have come to live with us and should be part of you as a health worker and a normal human being so should it be with machines as well because ventilator is very important, it's a life support so it should be commonly used by everybody not just a critical care nurse but a normal nurse, midwife, general nurse, psychiatric nurse should be able to manipulate the ventilator properly to be able to save lives- R15

- *We have not been equipped with the needed tools – R1*
- *The equipment or materials needed to change the settings or the availability of resources needed for monitoring the flow of the ventilator to the patient will not be available. Maybe the ventilator will be faulty and not be able to give out the modes you have set for the patient - R6*
- *The equipment in this unit is not enough thus making it impossible to learn more about how to detect asynchrony- R7*

➢ *Training And Workshops*

Participants indicated that they were not empowered or given much education on the use of the machines thus they lacked certain skills needed to detect ventilator asynchrony. Others also stated that they did not have adequate hands-on training as there were not many patients on the ventilator.

- *We don't have much education to use these machines so when they bring the machine training isn't given- R1*
- *When there are not many patients to use these ventilators it is difficult to develop skills in detecting ventilator asynchrony- R3*
- *Training and workshops are not sufficient so we are not able to be abreast with changes in handling the ventilator especially when it is complex –R8*
- *When they bring new ventilators, they hardly train us to use them, especially the modern ones which makes it difficult for us to use- R12*

➢ *Addressing Challenges*

Participants stated that the organisation of workshops and training will help them acquire the needed skills in detecting ventilator asynchrony. They also stated that continuous learning on their part would ensure that they are abreast with the use of the equipment.

➢ *Training And Workshops*

So constant training, creating awareness, organising workshops and then creating the means for it because if you are telling me that you are organising a workshop on ventilation

and it is so expensive, somebody who thinks that I am not a critical care nurse so I don't need it might not want to pay that much to go and learn anything so it should be sponsored from the beginning and nurses should be encouraged and the essence of ventilators and ventilation should be put across to health workers especially and the need to know what a ventilator is- R14

- They should organise workshops for us on how to change the mode and detect it. -R2
- Constant training and workshops of staff, Once all the staff are trained, we all will gather that knowledge to identify it as soon as possible. - R4
- We should encourage ourselves to learn as critical care nurses because if we don't continue learning our knowledge will be low Secondly the ward should be organising quarterly seminars to educate the staff. –R5
- We need more training to be abreast with modern techniques in detecting asynchrony-R8
- There should be training organised for us especially when they bring in new equipment-R12

➢ *Resources And Equipment*

Participants indicated that the availability of equipment and tools would enable them to develop their skills in detecting ventilator asynchrony. They also indicated that adequate human resources will enable them to learn from each other

- This can be addressed by having enough resources in terms of materials, equipment- R6
- human personnel as in other team members always being available, even if you not being able to identify the issue at least one can identify that the modes have been changed to benefit the patient-R4
- I think they should provide adequate equipment in the unit to-10

IV. DISCUSSION

This theme aimed to explore the different perspectives and understanding that nurses at the Korle-Bu Teaching Hospital had on ventilator asynchrony. Some described it as the mismatch of the patient's breath to the ventilator while others described it as the non-harmonious activity between the ventilator and the patient. This was in line with the definition provided by Holanda et al. (2018), who defined it as the mismatch between the ventilator's MV supply and the patient's respiratory system's requirements for time, flow, volume, or pressure. Patient-ventilator asynchrony was also defined as a mismatch between neural and ventilator timing during the breathing cycle or between the level of assistance provided and the level of assistance sought (Bulleri et al., 2018; Mirabella et al., 2020). Other nurses also defined ventilator asynchrony as the situation where the output of the ventilator is not supporting the effort of the patient. This corresponds to the description by Strickland (2019) who described it when the demand of the patient surpasses the ventilator support.

Based on the findings, it can be concluded that nurses at the ICU of the Korle Bu Teaching Hospital had knowledge of patient-ventilator asynchrony and this influenced their behaviour when they had patients in that situation. On the detection of ventilator asynchrony, study established that, nurses stated that they were able to identified ventilator asynchrony through various means like the beeping on the ventilator. According to Mireles-Cabodevila et al. (2022) to diagnose patient-ventilator asynchrony, complex respiratory physiology needs to examine the wave forms of ventilators during several breath cycles from inspiration, the transition from inspiration to expiration, and expiration. Gholami et al. (2018) indicated that ventilator asynchrony depended on the ventilator modes, settings, and patient features. This was in line with the detection procedure carried out by the nurses at the Korle Bu Teaching Hospital. Some of the nurses indicated that they detected asynchrony by monitoring the breathing of the patient. Studies show that patients on ventilators were at risk of getting reverse triggering and in the situation of asynchrony, there was inadequate diaphragm contraction which could be noticed when the breathing of the patient was done (Bitker et al., .2019). Studies show that the majority of patient-ventilator asynchrony was identified visually by inspecting the airway flow of patients. The airway flow and pressure were visually inspected to determine ventilator asynchrony, according to a study by Carteaux et al. (2021), which is consistent with the detection method used by the nurses at the Korle Bu Teaching Hospital. Other nurses also indicated that they detected ventilator asynchrony by monitoring the ventilator. Studies show that by observing the wave forms of the ventilator screen, ventilator asynchrony can be detected (Mirabella et al. 2020). From the findings of the study, nurses at Korle Bu Teaching Hospital frequently use clinical assessment and observation such as respiratory patterns, patient-ventilator interaction, and Bedside Monitoring and Waveform Analysis to detect patient-ventilator asynchrony. However, nurses could not detect patient-ventilator asynchrony using Advanced Techniques and Scoring Systems and Indices. The findings of this also study add to the existing literature that healthcare practitioners usually rely on visually inspecting airway flow and pressure data when managing ventilator asynchrony, though Carteaux et al. (2021) noted that relying on the Electromyographic activity of the diaphragm would provide the most reliable gold standard. These abilities in detecting ventilator asynchrony were associated with the training they received as critical care nurses as well as the hands-on training they received in the ward. This was affirmed by Chakkarapani et al. (2020) that knowledge of patient-ventilator asynchrony was fundamental to assessing and detecting ventilator asynchrony. On the management of ventilator asynchrony, findings indicate that in the situation where the asynchrony was a fault on the ventilator, they changed the settings of the ventilator to suit the patient's condition. Research shows that ventilator asynchrony was influenced by the settings of the ventilator. A study conducted that asynchrony was observed as the settings of the ventilator were changed (Schönhofer et al.,2020). A study done by Enrico et al. (2018), found that ventilator settings should be changed to keep the patient and ventilator working together in harmony. Other nurses managed asynchrony by addressing issues relating to tube dislodgement if that was the cause of the asynchrony. A study conducted by Vargas et al. (2022) changed the gastric tubes of participants in their study and discovered that the tubes on the ventilator connecting to the patients played a role in asynchrony.

The findings of this study relate that Korle Bu nurses have the appropriate education and training to manage various forms of patient-ventilator asynchrony. This is supported by Lim et al. (2021) findings which proved that better results can be achieved by managing patient-ventilator asynchrony when healthcare professionals receive regular education and refresher courses. Moreover, nurses at Korle Bu demonstrated that identification, assessment and ventilator setting optimisation are all steps in managing patient-ventilator asynchrony. Research by Marmot and Bell (2017) and Zieff et al. (2020) to corroborate these findings. Nurses' actions in the management of ventilator asynchrony were influenced by their ideas and knowledge of the situation and this correlates with the theory of planned behaviour. Regarding ventilator asynchrony management challenges, it was discovered that some nurses lacked the requisite knowledge and skills needed for the detection and resolution of ventilator asynchrony. According to Mohammed (2019), caregivers need to have a thorough understanding of respiratory physiology and mechanics as well as the capacity to decipher ventilator visuals and patient indications and symptoms. As a result, managing ventilator asynchrony at the Korle-Bu Teaching Hospital was difficult due to nurses' limited understanding. The challenges faced by nurses in Korle-Bu were observed by Enrico et al. (2018) study which noted that nurses in Saudi Arabia had challenges detecting ventilator asynchrony.

Some also indicated that they had little hands-on experience in handling ventilator asynchrony as there were not a lot of patients being treated on the ward using ventilators. A study conducted in Egypt indicated that a large number of their nurses had poor knowledge of wave form monitoring in detecting ventilator asynchrony (Abdelgawad et al. 2022) and this was associated with lack of training received on ventilator asynchrony. They also lacked adequate equipment on the ward to assist in learning the detection of ventilator asynchrony. Nurses continuously analyse the wave forms on ventilators in detecting asynchrony (Aquino Esperanza et al. 2020) and the availability of equipment and tools will enable nurses to enhance their skills in detecting ventilator asynchrony.

In term of how to address the challenges faced by nurses with ventilator asynchrony, the nurses stated the need to develop the skills needed to detect ventilator asynchrony and manage it, they said they needed workshops and in-service training to help build on their knowledge and skills. Previous training on mechanical ventilation and attendance of courses on ventilator wave form analysis was found to be significantly correlated with nurses' level of knowledge and attitude

regarding ventilator wave form monitoring (Abdelgawad et al., 2022). Nurses monitor indicators in detecting ventilator asynchrony regularly (Wang et al. 2020) and the continuous training and workshop given to nurses will ensure their skills are enhanced. Enrico et al. (2018) support that providing specific post-graduate university courses would better equip nurses with the requisite knowledge and skills to detect ventilator asynchrony.

They also stated that they needed to continuously learn to ensure that they were abreast with the use of the equipment. This corresponds with Dexter and Clark's (2020), Understanding asynchrony and how to fix it may be a valuable component of intraoperative care for caregivers who often handle patients on ventilators. The development of technical skills and professional understanding plays a role in nurses' abilities to detect ventilator asynchrony (Windisch et al. 2018). According to Alqahtani et al. (2020), nurses' detection outcomes would be improved when given practical teaching and training programmes and guidelines.

V. CONCLUSION

The findings of this study have brought to the fore important issues related to nurses' abilities in detecting and managing ventilator asynchrony. Firstly, nurses at the Korle Bu Teaching Hospital know what ventilator asynchrony is as they outlined their understanding of it. Also, most of the nurses can detect and manage asynchrony to an extent however, a few of them are still learning as they are relatively new in the unit. Additionally, nurses lack the skills to deal with complex situations associated with detecting ventilator asynchrony as there isn't enough training and skills development given to them. Also, nurses lack the requisite tools and equipment to develop their skills in detecting ventilator asynchrony making the management of asynchrony difficult for them.

REFERENCES

[1]. Aquino Esperanza, J., Sarlabous, L., de Haro, C., Magrans, R., Lopez-Aguilar, J., & Blanch, L. (2020). Monitoring Asynchrony During Invasive Mechanical Ventilation. Respiratory Care, 65(6), 847–869. https://doi.org/10.4187/respcare.07404

[2]. Bulleri, E., Fusi, C., Bambi, S., & Pisani, L. (2018a). Patient-ventilator asynchronies: types, outcomes and nursing detection skills. Acta Bio Medica: Atenei Parmensis, 89(Suppl 7), 6. https://doi.org/10.23750/ABM.V89I7-S.7737.

[3]. Bulleri, E., Fusi, C., Bambi, S., & Pisani, L. (2018b). Patient-ventilator asynchronies: types, outcomes and nursing detection skills. Acta Bio-Medica: Atenei Parmensis, 89(7-S), 6–18. https://doi.org/10.23750/abm.v89i7-S.7737

[4]. Carteaux, G., Parfait, M., Combet, M., Haudebourg, A.-F., Tuffet, S., & Mekontso Dessap, A. (2021a). Patient-Self Inflicted Lung Injury: A Practical Review. Journal

[5]. Chakkarapani, A. A., Adappa, R., Mohammad Ali, S. K., Gupta, S., Soni, N. B., Chicoine, L., & Hummler, H. D. (2020). "Current concepts in assisted mechanical ventilation in the neonate" - Part 2: Understanding various modes of mechanical ventilation and recommendations for individualized disease-based approach in neonates. International Journal of Pediatrics and Adolescent Medicine, 7(4), 201–208. https://doi.org/10.1016/j.ijpam.2020.11.002

of Clinical Medicine, 10(12), 2738. https://doi.org/10.3390/jcm10122738

[6]. Dexter, A. M., & Clark, K. (2020a). Ventilator Graphics: Scalars, Loops, & Secondary Measures. Respiratory Care, 65(6), 739–759. https://doi.org/10.4187/respcare.07805

[7]. Gravante, F., Crisci, F., Palmieri, L., Cecere, L., Fusi, C., Bulleri, E., Pisani, L., & Bambi, S. (2022). The Impact of a Training Intervention on Detection of Patient-Ventilator Asynchronies in Nursing Students. Acta Biomedica Atenei Parmensis, 93(Suppl 2), 2022144. https://doi.org/10.23750/ABM.V93IS2.12716

[8]. Holanda, M. A., Vasconcelos, R. dos S., Ferreira, J. C., & Pinheiro, B. V. (2018a). Patient-ventilator asynchrony. Jornal Brasileiro de Pneumologia, 44(4), 321. https://doi.org/10.1590/S1806-375644-04-00321

[9]. Holanda, M. A., Vasconcelos, R. dos S., Ferreira, J. C., & Pinheiro, B. V. (2018b). Patient-ventilator asynchrony. Jornal Brasileiro de Pneumologia, 44(4), 321–333. https://doi.org/10.1590/s1806-37562017000000185

[10]. Gravante, F., Crisci, F., Palmieri, L., Cecere, L., Fusi, C., Bulleri, E., Pisani, L., & Bambi, S. (2022). The Impact of a Training Intervention on Detection of Patient-Ventilator Asynchronies in Nursing Students. Acta Biomedica Atenei Parmensis, 93(Suppl 2), 2022144. https://doi.org/10.23750/ABM.V93IS2.12716

[11]. Jerofke-Owen, T. A., Tobiano, G., & Eldh, A. C. (2022). Patient engagement, involvement, or participation — entrapping concepts in nurse-patient interactions: A critical discussion. Nursing Inquiry. https://doi.org/10.1111/NIN.12513

[12]. Lim, B. C., Kueh, Y. C., Arifin, W. N., & Ng, K. H. (2021). Modelling knowledge, health beliefs, and health-promoting behaviours related to cardiovascular disease prevention among Malaysian university students. PLOS ONE, 16(4), e0250627. https://doi.org/10.1371/journal.pone.0250627

[13]. Marmot, M., & Bell, R. (2017). Social determinants and dental health. Advances in Dental Research, 23(2), 201–206. https://doi.org/10.1177/0022034511402079

[14]. Merliot-Gailhoustet, L., Raimbert, C., Garnier, O., Carr, J., De Jong, A., Molinari, N., Jaber, S., & Chanques, G. (2022). Discomfort improvement for critically ill patients using electronic relaxation devices: results of the cross-over randomized controlled trial E-CHOISIR (Electronic-CHOIce of a System for Intensive care Relaxation). Critical Care, 26(1), 1–12.

https://doi.org/10.1186/S13054-022-04136-4/TABLES/3

[15]. Mirabella, L., Cinnella, G., Costa, R., Cortegiani, A., Tullo, L., Rauseo, M., Conti, G., & Gregoretti, C. (2020a). Patient-ventilator asynchronies: Clinical implications and practical solutions. Respiratory Care, 65(11), 1751–1766. https://doi.org/10.4187/respcare.07284

[16]. Schroedl, C., & Vitale, K. (2022). Assessing Mechanical Ventilation Management Skills: More Tools for the Toolbox. ATS Scholar, 3(2), 167. https://doi.org/10.34197/ATS-SCHOLAR.2022-0043ED.

[17]. Secunda, K. E., & Kruser, J. M. (2022). Patient-Centered and Family-Centered Care in the Intensive Care Unit. Clinics in Chest Medicine, 43(3), 539–550.

[18]. Vennedey, V., Hower, K. I., Hillen, H., Ansmann, L., Kuntz, L., & Stock, S. (2020). Patients' perspectives of facilitators and barriers to patient-centred care: Insights from qualitative patient interviews. BMJ Open, 10(5). https://doi.org/10.1136/bmjopen-2019-033449.

[19]. Wang, Y., Liang, J., Yang, J., Yang, G., Ren, G., & Feng, Y. (2019). Analysis of the environmental behaviour of farmers for non-point source pollution control and management: An integration of the theory of planned behaviour and the protection motivation theory. *Journal of Environmental Management*, *237*, 15–23. https://doi.org/10.1016/j.jenvman.2019.02.070

[20]. Windisch, W., Geiseler, J., Simon, K., Walterspacher, S., & Dreher, M. (2018). German National Guideline for Treating Chronic Respiratory Failure with Invasive and Non-Invasive Ventilation – Revised Edition 2017: Part 2. Respiration, 96(2), 171–203. https://doi.org/10.1159/000488667

[21]. Wood, E., Garvey, K., & Aborigo, R., E. (2021). Constructing a Nurse-led Cardiovascular Disease Intervention in Rural Ghana: A Qualitative Analysis. /https://doi.org/10.1016/j.ccm.2022.05.008

[22]. Zhou, Y., Holets, S. R., Li, M., Cortes-Puentes, G. A., Meyer, T. J., Hanson, A. C., Schulte, P. J., & Oeckler, R. A. (2021). Etiology, incidence, and outcomes of patient–ventilator asynchrony in critically-ill patients undergoing invasive mechanical ventilation. Scientific Reports, 11(1), 12390. https://doi.org/10.1038/S41598-021-90013-Z

[23]. Zieff, G., Kerr, Z. Y., Moore, J. B., & Stoner, L. (2020). Universal Healthcare in the United States of America: Medicina, 56(11), 1–7. https://doi.org/10.3390/MEDICINA56110580