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A SURVEY ON PATIENT SYNCHRONIZED ELECTRONIC VENTILATOR WITH OPTIMIZED ASSISTANCE

Miss. Shatabdi Jayant Talbar
Department of Electronics
WCE, Sangli, Maharashtra, India

Prof.Y.B.Mane
Department of Electronics
WCE, Sangli, Maharashtra, India

***Abstract*— The life support devices which supply breathable air inside the body to the patients with respiratory insufficiency is called 'Medical ventilators'. The ventilators mimic as an 'artificial lungs' in which there is only the gas exchange between respiratory organs and atmosphere to maintain the respiration of the patient by using different modes and methods. The breathable air is in form of controlled parameters such as pressure, volume and flow. Due to the availability of various modes in ventilators the treatment has become easier for the patient. But, for medical professionals, it is the big challenge to choose the correct mode and synchronize the system with the patient's body.**

To supply breathable air, there is a need to calculate the amount of gases required by the body, supplied with the machine and unnecessary air exhausted from the body in proper proportion. There is a dependency on various equipment for the calculation of gases in the blood. Instead of using this equipment we can use pulse oximetry to calculate the saturated percentage of gases in the blood and heart rate. Nowadays, most of the scientists are practicing to develop a CDSS (Clinical Decision Support Systems) in order to exonerate patients from diseases and naturally build up their immunity.

Keywords— **Non-invasive (NIV), CDSS (Clinical Decision Support Systems), ABG (Arterial Blood Gases), Pulse oximetry, SIMV (Synchronized Intermittent Mandatory Ventilation), ARDS (Acute Respiratory Distress syndrome).**

I. INTRODUCTION

The proportionate amount of air and oxygen mixture with pressure, volume and flow is an essential driving force for the operation of ventilators. The flow controller are electrically controlled or proportional solenoid valve in feedback with flow sensors. The mixture of air and oxygen is blended in reservoir having pressure transducer and flow sensor. The flow is maintained with turbine based pneumatic unit. Earlier, compressors were used for flow control, but got rejected due to its high maintenance and huge size. With precise control of pressure and flow the humidified air is supplied to the patient by inhalation valve having flow sensor at beginning of exhalation tube as well. The exhalation tube expels the air containing Co_2. The control of all sensors is decided by microcontroller of cortex m series. The speed of turbines to generate flow is decided by microcontroller.

There is need to calculate amount of Co_2 thrown out of body which is not calculated in most of the ventilators. Due to the availability of various modes in ventilators the treatment has become easier for the patient. But, for the medical professionals, is the big challenge to choose correct mode and synchronized the system with patient's body. To supply breathable air, there is need to calculate amount of gases required by the body, supplied with the machine and unnecessary air exhausted from the body in proper proportion. There is dependency on an equipment called **'ABG'** (Arterial Blood Gases) for calculation of gases in the blood. Instead of using this equipment we can use pulse oximetry to calculate saturated percentage of gases in the blood and heart rate.

II. LITERATURE SURVEY

Bhattacharyya Col D[1], Prasad Brig BNBM[2], Rajput Col AK[3], (2011) in their work addresses NIPPV (Non-invasive Positive Pressure Ventilators) method, advisable to treat asthma and acute respiratory failure. Even after the inclusion of 'Continuous Positive Airway pressure' (CPAP) or Bi-level Positive Airway Pressure (BiPAP) still a plunge for myocardial infarction. It doesn't work for a patient with pneumonia, neuromuscular diseases, ARDS and during sedation. The reduction of work of breathing and dyspnoea method with the use of helium and oxygen (heliox) in Nasal Intermittent Positive Pressure Ventilation reduces. This method is not acceptable as there is a lack of availability [1].

In the paper, Mahmud Farahidayah Bt.[1], Shih Chung-Hung[2], Yang Chia-Hsiang[3] (2011), suggested CDSS (Clinical Decision Support System) based on ontology, recently most preferred method. The ontology is integrated with computer application, supports conceptual and model to capture the information and reuse. In this paper, an attempt is to portray various CDSS functions and propose a CDSS during the weaning phase of ventilation based on ontology-based on various CDSS methods such as Bayes theorem, IF-THEN rule-based theorem, rule-based theorem. The tasks based on data collection and analysis are in textual format. This results in huge database requirements, the complexity of methods and time complexity [2].

Tang Kea-Tiong[1], Shih Chung-Hung[2], Yang Chia-Hsiang[3], (2014) in their paper, exposed a captious situation after the use of a ventilator for a long time, ventilator-associated pneumonia (VAP). To diagnose this disease, the standard procedure includes radiography of chest, empiric therapy, sputum culture and sputum gram stains. The further procedure may get delayed if accumulated stain and lower respiratory tract specimen culture is time inefficient. During the infection, microorganisms generate metabolites that are complex in nature. Hence, fast detection is practicable by scanning the proximal end of the expiratory device. In this work, to fulfill the vital need of clinicians, a nose-chip on fully integrated low power with integrated learning kernel is developed. The model using KNN classifier is used for feature extraction requires 5000 epochs to achieve accuracy [3].

Pettenuzzo Tommaso[1], Fan Eddy[2], (2016) [4] reviewed methods of mechanical ventilation by taking consideration of different respiratory diseases that have been described in this paper. It also describes the iatrogenic harmful effects of mechanical ventilation. The correct timing of initiation and weaning of ventilator support and lung muscle protective strategies has discussed and the topic for future research.

Hussain Tassadaq[1,2], Haider Amna[1,2], Akram Wasim[1,2], Rehman Mujeeb Ur[1,2] , Khan Azam[1,2], Abbas Muhammad[1,2],(2018) [5] emphasizes, Synchronized Intermittent Mandatory Ventilation (SIMV) mode with Pulse oximetry among all other ventilator modes which is cheap, accurate and easy to use the technique. The pulse oximeter sensor is placed on a finger to check the saturation level of oxygen in the blood instead of depending on the ABG machine. To provide reasonable treatment along with better medical facilities, Pulse oximeter based SIMV ventilator strategy must have incorporated in ventilator systems as it provides SpO2 values in 10.5microseconds of time.

Niu Jinglong[1], Shi Yan[2], Shen Dongkai[3], Wang Yixuan[4], Xu Weiqing[5], Cai Maolin[6] and Li Yunhua[7], (2018) [6] presents method including division of respiratory signal into an inspiration and expiration phase in their work. Based on energy various parameters such as mean (μ), standard deviation (σ), coefficient of variation, entropy and fluctuation are procured. The random forest classifier avoids fluctuations as well as overfitting to provide greater accuracy than other classifiers. To make a decision of classification, the system should be analyzed with multiple breaths including more number of features with enhanced accuracy by comparing with various classifiers like KNN,bayesnet, logistic,reptree, J48. Thus, the method has high computational complexity, data integration complexity and time complexity.

Faverio Paola[1], Stainer Anna[2] in the paper [7] suggested a method that indicates the procedure to identify weaning phase. There are a series of procedures for ventilation during the weaning phase. Whenever there is an absence of negative outcomes in the NIV procedure, the interruption in one of the three daily sessions of NIV is noticed. An appearance of delirium during ventilation and even after is absolutely necessary for the evaluation of patients suffering from AHRF (Acute Hypoxemic Respiratory Failure).The one specific treatment cannot be a feasible practice for the patient from adult to frail age groups and here use of the SIMV method can be applied as there are no nocturnal respiratory events and can be used during weaning.

In a paper [8] BOREL JEAN-CHRISTIAN[1,2], PALOT ALAIN[2,3], PATOUT MAXIME[5,6],(2019) stated the tele-monitoring for the patients which are out of ICU can be treated well without any risk by using web platforms. The tele-monitoring methods used in medical treatment adopt NIV (Non-invasive) which provides comfort to the patient. The tele-monitoring through web platforms is pertinent to medicate the patients in the future. The data is sent to a cloud platform when a ventilator is not in use may lose important information by clinicians. As there is no active involvement of the patient with the time difference may create complications for the patient observed under continuous assessment. The NIV software, desktop platform and cloud platform formats vary from manufacturers. The use of pulse oximetry along with ventilator software helps to monitor the nocturnal events.

F.Gordo1, A.Abella[2], B.Lobo-Valbuena[3], (2019) introduces the CDSS method indicating an appropriate treatment for an individual patient depending on predictions based on emergency situations in this paper [10]. The system used various machine learning algorithms to achieve higher accuracy must involve deep learning, blockchain data encryption. As the system has a dependence on ABG machine parameters, various ventilator modes, it will require more time to produce results and take corrective actions based on algorithms. Being high time complexity and comorbidities varying from patient to patient, this ICU ventilator system will not be appropriate during emergency cases. The CDSS method with SIMV mode may be suitable for tele-monitoring.

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In a paper [11] , Patroniti Nicolo[1-2], Bonatti Giulia[2], Senussi Tarek[3] and Robba Chiara[1], (2019) highlighted an expensive method used nowadays, ECMO (Extracorporeal membrane oxygenation) for ARDS (acute respiratory distress syndrome) patients. This method minimizes the VILI (Ventilator Induced Lung Injury). Like ventilator it provides temporary gas exchange support. Blood in veins is getting diverted to ECMO machine where it removes CO_2 and oxygenates. The patient is then provided with oxygenated blood.

1. Table of comparison of ventilator methods.

Paper	Mode of ventilation	Method used	Problems Recovered	Problems uncovered	Problems Occurred
[1]	• **NIPPV** (Non-invasive Positive Pressure Ventilators) • **CPAP** • **BiPAP**	Helium + oxygen	• Acute respiratory failure • Asthma • Dyspnoea	Myocardial infarction. Pneumonia. Neuromuscular diseases. Weaning decisions.	Lack of availability.
[2]	The ontology is integrated with computer application, supports conceptual, model to capture the information and reuse.	**CDSS** • Bayes theorem • IF-THEN rule based theorem • Rule based theorem	Weaning decisions	Pneumonia. Time complexity. Weaning decisions	Huge database requirement. Complexity of method Time complexity.
[3]	NIV Ventilation(Non-invasive)	KNN classifier is used for feature extraction.	**VAP**(ventilator associated pneumonia)	Myocardial infarction. **ARDS, Asthma** Weaning decisions	Model requires 5000 epochs to achieve the accuracy.
[4]	NIV Ventilation(Non-invasive)	Lung muscle protective strategies	• **COPD** • **ARDS** • The correct timing of initiation and weaning of ventilator	Myocardial infarction. Neuromuscular diseases. **ARDS, Asthma**	**VAP** (ventilator associated pneumonia)

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[5]	Synchronized Intermittent Mandatory Ventilation (SIMV).	Pulse oximetry	• SpO_2 in 10.5 microseconds • Heart Rate detection. • No dependence on ABG machine. • Weaning • **COPD** • **ARDS** • Asthma • Nocturnal respiratory events. • Low cost.	Neuromuscular diseases.	Not highly accurate for frail patients.
[6]	NIV (Non-invasive)	Random forest classifier	• Avoid overfitting and fluctuations. • Greater accuracy. • Asthma	Neuromuscular diseases.	To achieve an accuracy by comparing with various classifiers like KNN, Bayesnet, logistic, reptree,J48.
[7]	NIV (Non-invasive)		• Weaning • AHRF (Acute Hypoxemic Respiratory Failure) • **COPD**	Neuromuscular diseases.	Time complexity. Complicated to work on.
[8]	NIV (Non-invasive)	• Telemonitoring. • Cloud platform	• Weaning decisions • **COPD**	• Asthma • Pneumonia • Myocardial infarction. • Neuromuscular diseases. • Not suitable for continuous assessment.	The NIV software, desktop platform and cloud platform formats vary from manufacturers. No active involvement of the patient.
[9]	**CDSS**	• Machine learning algorithm. • Deep learning. • Block chain data encryption.	• **ARDS.** • Weaning decisions • **COPD**	• Asthma • Pneumonia • Myocardial infarction.	Dependence on ABG machine parameters. High time complexity. Algorithm complexity.

[10]	**ECMO** (Extracorporeal membrane oxygenation)	De-oxygenated blood from veins is diverted to machine where it removes CO_2 and oxygenates.	• **ARDS.** • **VILI** (Ventilator Induced Lung Injury).	• Asthma • Pneumonia • Myocardial infarction. • **COPD**	Most expensive treatment. Complete dependence on machine.

III. DISCUSSIONS

The trend of using non-invasive (NIV) methods are most accepted by medical professionals which give relief for the patient suffering through some critical respiratory diseases like ARDS, VILI, VAP and so on. Instead of integrating number of modes, it is advisable to depend on SIMV mode with pulse oximetry which built patient's natural tendency of breathing. The overall ventilation procedure is dependent on other equipment like ABG, ECG machine etc. The pulse oximetry helps to offer oxygen percentage along with heart rate with less time and less cost. It is necessary to identify the exact phase of weaning for the patients with critical respiratory status. The Autonomous systems with learning algorithms in the abnormal health condition is not recommended by clinicians. The continuous advancement is vital in a system to assist medical professionals with better accuracy to take delicate decisions easily.

IV. REFERENCE

[1] Bhattacharyya Col D[1], Prasad Brig BNBM [2], Rajput Col AK [3], (2011). **Recent advances in the role of non-invasive ventilation in acute respiratory failure,** in MJAFI Vol 67 No 2 187 © AFMS, (Pg 187-191).

[2] Mahmud Farahidayah Bt.[1], Yusof Maryati Mohd[2], Naoh Shahrul Azman [3], (2011). **Ontological Based Clinical Decision Support System (CDSS) for Weaning Ventilator in Intensive Care Unit(ICU),** in International Conference on Electrical Engineering and Informatics, 17-19 July 2011, Bandung, Indonesia ©2011 IEEE.

[3] Tang Kea-Tiong[1], Shih Chung-Hung[2], Yang Chia-Hsiang[3], (2014). **A 0.5V 1.27mW Nose-on-a-Chip for Rapid Diagnosis of Ventilator-Associated Pneumonia**, in IEEE International Solid-State Circuits Conference on, (Pg 420-421).

[4] Pettenuzzo Tommaso[1], Fan Eddy[2], (2016). **2016 Year in Review: Mechanical Ventilation,** RESPIRATORY CARE, MAY 2017 VOL 62 NO 5 on, (Pg 629-639).

[5] Hussain Tassadaq [1,2], Haider Amna [1,2], Akram Wasim [1,2], Rehman Mujeeb Ur [1,2] , Khan Azam [1,2] , Abbas Muhammad [1,2],(2018). **Synchronized Intermittent Mandatory Ventilation Mode Control Using Pulse Oximeter,** in 2018 International Conference on Computing, Mathematics and Engineering Technologies – iCoMET 2018 ©2018 IEEE.

[6] Niu Jinglong [1], Shi Yan [2], Shen Dongkai [3], Wang Yixuan [4], Xu Weiqing [5], Cai Maolin [6] and Li Yunhua[7],(2018).**The Identification of Sputum Situation Based on the Sound from the Respiratory Tract,** in IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM), Auckland, New Zealand, July9-12, 2018 ©2018 IEEE on ,(Pg 1166-1171).

[7] Faverio Paola[1], Stainer Anna[2], (2019). **Noninvasive Ventilation Weaning in Acute Hypercapnic Respiratory Failure due to COPD Exacerbation: A Real-Life Observational Study**, in Hindawi Canadian Respiratory Journal Volume 2019, Article ID 3478968, on (Pg 1-10).

[8] BOREL JEAN-CHRISTIAN[1,2], PALOT ALAIN[2,3], PATOUT MAXIME[5,6],(2019).**Technological advances in home non-invasive ventilation monitoring: Reliability of data and effect on patient outcomes,** in 2019 Asian Pacific society of Respiratory, on (Pg 1-9).

[9] F.Gordo[1], A. Abella[2] , B.Lobo-Valbuena[3], (2019).**Innovations in ICU ventilation**, in ICU Management & Practice 1 – 2019 on (Pg15-18).

[10] Patroniti Nicolo[1-2], Bonatti Giulia[2], Senussi Tarek[3] and Robba Chiara[1], (2019). **Mechanical ventilation and respiratory monitoring during extracorporeal membrane oxygenation for respiratory support**,in Ann Transl Med.2018 Oct; 6 (19):386. © Annals of Translational Medicine on (Pg1-12).