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# Nursing care plan on gas exchange impairment due to SARS-CoV-2: case report

# Plan de cuidados de enfermería sobre deterioro del intercambio gaseoso por SARS-CoV-2: reporte de caso

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**Abstract**

INTRODUCTION: Over the years, mankind has been in contact with several viruses, which have threatened human existence by becoming pandemics such as influenza in 1918. However, in January 2020, the Chinese Centre for Disease Control and Prevention identified SARS-CoV-2 as the etiological agent of the 2019 coronavirus. So far it is known that 5% of patients with severe COVID-19 will require attention in intensive care units. To this end, critical care nursing staff use the nursing care process to prioritize the care of the critically ill patient. OBJECTIVE: To develop a nursing care plan by analyzing a clinical case of an adult patient with a diagnosis of COVID-19. METHODOLOGY: The case of a patient with a diagnosis of COVID-19 was analyzed to develop a nursing care process using the taxonomies of the North American Nursing Diagnosis Association, Nursing Interventions Classification and Nursing Outcomes Classification. Documentary research was carried out through a literature search in databases such as: Scielo, Medicgraphic, Google Scholar and PubMed. RESULTS: Three real nursing diagnoses and seven risk diagnoses were identified. The priority nursing diagnostic label based on Maslow's pyramid of needs was deterioration of related gas exchange. CONCLUSIONS: The critical care nurse takes a leading role in the care of patients with a diagnosis of COVID-19, the development of the nursing care process contributes to providing quality care focused on the well-being of the user.

**COVID-19, intervections**

**Resumen**

INTRODUCCIÓN: A lo largo de los años la humanidad ha estado en contacto con diversos virus, los cuales han amenazado la existencia del ser humano al convertirse en pandemia como el de la influenza en 1918. Sin embargo, en enero de 2020 el Centro Chino para el Control y la Prevención de Enfermedades identificó al SARS-CoV-2 como el agente etiológico del coronavirus 2019. Hasta el momento se sabe que el 5% de los pacientes con COVID-19 grave requerirán de cuidados en las unidades de cuidados intensivos. Para ello el personal de enfermería en cuidado crítico utiliza el proceso cuidado enfermero para priorizar la atención del paciente crítico. OBJETIVO: Elaborar un plan de cuidados de enfermería mediante el análisis de un caso clínico de paciente adulto con diagnóstico de COVID-19. METODOLOGÍA: Se analizó el caso de un paciente con diagnóstico de COVID-19 para el desarrollo de un proceso cuidado enfermero implementado las taxonomías de la North American Nursing Diagnosis Association, Nursing Interventions Classification y Nursing Outcomes Classification. Se realizó investigación documental mediante una búsqueda bibliográfica en bases de datos como: Scielo, Medicgraphic, Google académico y PubMed. RESULTADOS: Se identificaron tres diagnósticos de enfermería reales y siete de riesgo. La etiqueta diagnóstica de enfermería prioritaria con base a la pirámide de las necesidades de Maslow fue deterioro del intercambio de gases relacionado CONCLUSIONES: La enfermera en cuidado critico se posiciona como líder en el cuidado de pacientes con diagnóstico de COVID-19, el desarrollo del proceso cuidado enfermero contribuye para brindar una atención de calidad enfocada en el bienestar del usuario.

**COVID-19, Intervenciones**

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## Introduction

Coronaviruses (CoV) are a family of viruses that can cause multiple conditions, ranging from the common cold to different complications such as those caused by SARS-CoV-1 (Severe Acute Respiratory Syndrome Coronavirus 1) (Rossi, Sacco, Mancino, Cristiani , Midulla , 2020). However, during 2019, the SARS-CoV-2 virus that causes coronavirus disease 2019 (COVID-19) emerged, which is different from the coronaviruses that commonly cause mild human illness, as it is suggested that SARS-CoV-2 may evade the immune system more effectively than SARS-CoV-1 and thus cause pneumonia whose main feature on Computer Axial Tomography (CAT) is ground-glass opacity (Rossi et al, 2020), (Wiersinga, Rhodes, Cheng, Peacock, Prescott, 2019).

On December 31st 2019, a cluster of pneumonia cases with unknown etiology was reported in Wuhan, the capital of the Hubei province, China. On 9 January 2020, the Chinese Centre for Disease Control and Prevention identified the novel SARS-CoV-2 coronavirus as the causative agent of this outbreak. On 30 January 2020, the Director-General of the World Health Organization (WHO) declared the outbreak to be a public health emergency of international concern (Carvalho, Krammer, Iwasaki, 2021).

On 11 February 2020, the WHO officially named the disease COVID-19. In this abbreviation COVID-19, "CO" stands for "corona", "VI" for "virus" and "D" for "disease". Previously, the way to refer to this disease was "new coronavirus 2019" or "2019-nCoV"(Parlakpinar, Gunata, 2021). By March 2020, the epidemic is classified as a pandemic (Megna, 2020).

Transmission of SARS-CoV-2 is primarily respiratory-mediated, i.e. it is spread by virions suspended in large droplets (>5μm) or sprays (<5μm) that are expelled from the primary patient's respiratory tract by talking, coughing or sneezing (Meyerowitz, Richterman, Gandhi, 2021), (Greenhalgh et al, 2021). Although the evidence suggesting transmission by direct contact or fomites is inconclusive, transmission can occur due to poor hand hygiene by touching surfaces containing viral particles and direct conjunctival inoculation or contact with the respiratory mucosa (Heneghan et al, 2021), (Karia, Gupta, Khandait, Yadav, Yadav, 2020).

For all these reasons, it is a virus with a high rate of contagiousness and lethality, especially in older adults (>65 years). This lethality may be due to the comorbidities of the patients, the pathogenicity of the virus, the immunity of the population and the host's response to infection; it should be mentioned that depending on the country, this lethality rate may be modified (Piroth, Cottenet, Mariet, 2021). It is known that some of the comorbidities that increase the risk of death due to the development of hypoxemia generated by SARS-CoV-2 are arterial hypertension, obesity and diabetes (Fernández-Rojas, et al 2021).

Among the main complications that COVID-19 patients develop is severe acute respiratory distress syndrome, which is considered a major predictor of intensive care unit (ICU) admission, mechanical ventilation and death (Bickler, Feiner, Lipnick, McKleroy, 2021). Intrapulmonary derivation and ventilation/perfusion imbalance are the main causes of impaired gas exchange leading to hypoxemia in patients with COVID-19, if not resolved with supplemental oxygen it indicates that the deterioration has progressed beyond ventilation/perfusion mismatch, (Bickler, Feiner, Lipnick, McKleroy, 2021),( Dhont, Derom, Van Braeckel, Depuydt, Lambrecht, 2020), (Diehl, Peron, Chocron, 2020); approximately 50-85% of patients with ICU admission developed hypoxemia or respiratory exhaustion, (Haouzi, Zamir, Villarreal-Fernandez, 2020), (Ouyang L, Yu M, Zhu Y, Gong, 2021).

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Evidence from other countries estimates that 5% of patients who develop severe COVID-19 will require ICU care, consequently, this has led to critical care nurses becoming more skilled in recognizing, preventing and intensifying care in a holistic manner for patients with this condition (Carter, Notter, 2020). Nursing staff, compared to other healthcare professionals, spend more time in contact with patients and therefore play a key role in their care and attention (Bayih, Ayalew, Belay, 2021).

This care provided by nurses is based on the nursing care process, which is a practical tool that guides the critical thinking of these professionals for the development of Nursing Care Plans (NCP) (Bayih, Ayalew, Belay, 2021). For all of the above reasons, an NCP was developed in the present study, which focuses on a clinical case of an adult patient with a diagnosis of COVID-19, who was hospitalized in an ICU and whose priority nursing diagnosis was deterioration of gas exchange.

## Methodology

A clinical case was identified of a patient with a diagnosis of COVID-19 who was hospitalized in an ICU in a private hospital in the city of San Luis Potosí, Mexico. Subsequently, a nursing assessment was carried out using Marjory Gordon's functional patterns, which made it possible to identify the main nursing diagnoses according to the taxonomy of the North American Nursing Diagnosis Association (NANDA), (Kamitsuru, Herdman, 2018) and the diagnoses were prioritized based on Maslow's pyramid of needs (Desmet P, Fokkinga, 2020) in order to plan nursing interventions through the Nursing Interventions Classification (NIC), (Butcher, Bulechek, Dochterman, 2018) and the expected results were established according to the Nursing Outcomes Classification (NOC) (Moorhead, 2018).

The analysis and substantiation of the clinical case was carried out by consulting the literature through the review of various articles in indexed, refereed journals and *Journal Citation Reports*. The literature search was carried out in databases such as: Sciense Direct, Scielo, Medicgraphic, Medic Latina, Clinical Key, Elsevier, Google Scholar and PubMed. The characteristics of the articles consulted were no less than three years old in English and Spanish.

## Results

### *Clinical findings*

The following is the nursing assessment data obtained from the clinical case patient using Marjory Gordon's functional patterns:

### *Health perception and health management.*

Patient with a diagnosis of diabetes mellitus and arterial hypertension (the time of evolution of both pathologies is unknown) with pharmacological treatment. A CAT scan was performed (Figure 1).

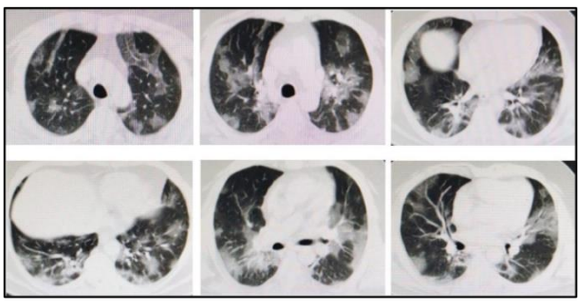

**Figure 1** Lung CAT scan of the patient with a diagnosis of COVID-19. The image shows in both lungs the main characteristic of this pathology, which is ground-glass opacity in both lungs
*Source: Own elaboration*

### *Nutrition and metabolism*

Dry oral mucosa, pale gums, weight 105 kg, height 165 cm and body mass index of 38,5. On admission with fever of 38.4°C and dysthermia. Laboratory studies at the time of initial evaluation showed some data out of normal ranges: blood biometry: leukocytes 13,23 k/µL, lymphocytes 8%, segmented neutrophils 90%; blood chemistry: blood glucose 336 mg/dl and urea in blood 79,18 mg/dl.

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*Elimination*

Urinary catheter is installed to shunt, managing a urine output of 0.6 ml/kg/h, diuresis is observed concentrated with slight sediment. The patient is diaphoretic, with a balance in turn of -412 ml; without defecation in the last 48 hours.

*Activity-exercise*

Hypotensive patient with blood pressure of 90/50 mmHg with BPM (76 mmHg), tachycardic (121x'1), eupneic (20x'1), oxygen saturation 77% by pulse oximetry, pulmonary auscultation reveals hypoventilation, capillary filling of 3 secs, distal and peribuccal cyanosis. Patient on invasive mechanical ventilation with the following programming: A/C mode, pressure management with a frequency of 20 l/min. PEEP 14, pressure support of 16 and a sensitivity of 2 l/min. His acid-base balance was monitored **(Figure 2).**

| Parameters | Admission | Before MV | Post MV | Normal parameters |
|---|---|---|---|---|
| pH | 7,441 | 7,460 | 7,378 | 7,32-7,43 |
| $PaCO_2$ (mmHg) | 31,1 | 34,5 | 40 | 35-48 |
| $PaO_2$ (mmHg) | 31,3 | 31 | 42 | 83-108 |
| $HCO_3$ (mmol/L) | 21,2 | 24,5 | 23,6 | 21-28 |
| $StO_2$ | 63,9% | 60% | 77% | 94-98% |

**Figure 2**. Blood gas parameters of the patient with a diagnosis of COVID-19. The difference between the patient's blood gas parameters on admission to the ICU before mechanical ventilation (MV) and after MV can be seen

*Cognitive-perceptual*

Under sedoanalgesia with fentanyl and midazolam (200ml of 0.9% saline + 200mg of midazolam + 2gr of fentanyl), with -4 RASS (Richmond Agitation-Sedation Scale) points, normoreflexic isochoric pupils.

*Roles and relationships*

Relatives at home, but in constant communication to be informed about the patient's health status.

*Values and beliefs*

In his unit he has a religious image.

*Main nursing diagnoses in the patient*

Ten nursing diagnoses were identified in the patient with a diagnosis of COVID19 (Table 1) of which seven are risk and three are actual.

| Functional health patterns | NANDA Domain | Type | Nursing diagnosis |
|---|---|---|---|
| Nutritional Metabolic | 2. Nutrition | 4. Metabolism | (00179) Risk of blood glucose level r/f physical health condition. |
| Nutritional Metabolic | 2. Nutrition | 5. Hydration | (00028) Risk of fluid volume deficit r/f (risk factor) situation affecting access, intake or absorption of liquids. |
| Elimination | 3. Eliminatio n | 4.Respiratory function | (00030) Impaired gas exchange r/t (related to) alveolar capillary membrane changes s/b/ (shown by) abnormal skin color, diaphoresis, abnormal gasometry, hypoxemia, hypoxia, tachycardia |
| Activity Exercise | 4. Activity/ rest | 4.Cardiovascular/pulmonary responses | (00200) Risk of decreased cardiac output r/t alteration in preload. |
| Nutritional Metabolic | 11. Safety protection | 6. Thermoregulation | (00007) Hyperthermia r/t disease s/b hypotension, tachycardia, warm skin to touch. |
| Nutritional Metabolic | 11. Safety protection | 2. Physical injury | (00045) Deterioration of oral mucosa r/f dehydration s/b gum paleness. |
| Nutritional Metabolic | 11. Safety protection | 2. Physical injury | (00047) Risk of deterioration of skin integrity r/f hyperthermia, humidity, alteration in fluid volume. |
| Activity Exercise | 11. Safety protection | 2. Physical injury | (00205) Risk of shock r/t systemic inflammation response syndrome. |
| Activity Exercise | 11. Safety protection | 2. Physical injury | (00206) Risk of bleeding r/f therapeutic regimen s/b hypotension, hypovolemia, hypoxemia, hypoxia, systemic inflammatory response syndrome. |
| Nutritional Metabolic | 11. Safety protectio n | 2. Physical injury | (00249) Risk of pressure sore r/f dehydration, hyperthermia, skin moisture, decreased mobility. |

**Table 1** Nursing diagnoses identified in the patient with COVID-2019 diagnosis

*Priority nursing care process on the deterioration of gas exchange in a patient with a diagnosis of COVID-19*

Table 2 shows the NCP of the deterioration of gas exchange in the patient diagnosed with COVID-19, which was prioritized according to Maslow's pyramid, in the section of physiological needs in which we can include the respiratory aspect.

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| **Domain:**0004 Elimination | **Type:** 0004 Respiratory function | **Expected result** | | |
|---|---|---|---|---|
| **Nursing Diagnosis (NANDA)** | **Result (NOC)** | **Indicator** | **Measurement scale** | **Target score** |
| **Label (Problem) (P)** (00030) Deterioration of gas exchange **Related factors (causes) (E)** Capillary alveolar membrane changes **Defining Characteristics (Signs and Symptoms)** Abnormal skin color, diaphoresis, abnormal blood gas, hypoxemia, hypoxia, tachycardia. | Mechanical ventilation response: adult (0411) | Respiratory rate in expected range (040301) Breathing depth (040303) | 1. Grave 2.Substantial 3.Moderate 4.Mild 5.None | **Maintain: 3** **Increase: 4** **Result: 5** |
| | Respiratory status: ventilation (0410) | Absence of accessory muscles use (040309) Absence of fever (041001) Absence of anxiety (041002) Respiratory rate in the expected range (041004) | 1.Extremely 2.Substantially 3.Moderately 4.Slightly 5.Not compromised | **Maintain: 2** **Increase: 3** **Result: 5** |
| | Vital signs status (0802) | Sputum movement out of airway (041006) Temperature (080201) Apical pulse rate (080202) Respiratory rate (080204) Systolic blood pressure (080205) | 1.Extremely 2.Substantially 3.Moderate 4.Mild 5.No deviation | **Maintain: 2** **Increase: 4** **Result: 5** |

| **Nursing intervention (NIC)** Respiratory monitoring (3350) | **Nursing intervention (NIC)** Caution to avoid aspiration (3200) |
|---|---|
| **Activities:** - Placement of continuous non-invasive oxygen sensors, with an appropriate alarm system. - Continuous monitoring of oxygen saturation levels. - Auscultation of respiratory sounds, noting areas of decreased ventilation and presence of adventitious sounds. - Determining if there is a need for aspiration by auscultation. - Monitoring and recording mechanical ventilator readings. - Observing changes in arterial blood gas values. - Frequent monitoring of the patient's respiratory status. - Follow up on radiology reports. | **Activities:** - Keep head of bed elevated 30-45 degrees. - Keep endotracheal tube balloon inflated. - Keep aspiration equipment available. - Check NG tube placement. - Check gastric residue before starting feeding. |
| **Nursing intervention (NIC)** Management of mechanical ventilation: invasive (3300) | **Nursing intervention (NIC)** Management of artificial airways (3180) |
| **Activities:** - Consulting with other healthcare professionals on ventilator mode selection. - Make sure ventilator alarms are turned on. - Routinely check ventilator settings, including temperature and humidification of inhaled air. - Regularly check all ventilator connections. - Observe for a decrease in exhaled volume and an increase in inspiratory pressure. - Administer appropriate muscle relaxants, sedatives and narcotic analgesics. - Control activities that increase O2 consumption (fever, chills, pain, basic nursing activities) that may overwhelm ventilatory support settings and cause O2 desaturation. - Control factors that increase patient/ventilator work of breathing (morbid obesity, lowered head of bed, obstructed ET, condensation on ventilator tubing, occluded filters. - Monitor for symptoms indicating increased work of breathing (tachycardia, hypertension, diaphoresis, change in mental state. - Monitor efficacy of mechanical ventilation on the patient's physiological state. - Provide care to relieve patient discomfort. - Monitor ventilator pressure readings, patient/ventilator synchrony and patient's vesicular murmur. - Monitor patient progress with current ventilator settings and make appropriate changes according to physician order. - Monitor for oral, nasal, tracheal, or laryngeal mucosal injury from artificial airway pressure, elevated balloon pressure or unscheduled extubation. - Use tube holders or strips to secure the artificial airway to prevent unscheduled extubation. - Place the patient in a manner that facilitates ventilation/perfusion matching. - Routinely set up oral care with moist soft gauze, antiseptic and gentle suctioning. - Monitor the effects of ventilator changes on oxygenation: arterial blood gases, as well as the patient's subjective response. Document all ventilator setting changes with their justification. Document all patient responses to the ventilator and ventilator changes. Monitor for complications following extubation. Ensure the presence of the emergency equipment at the patient's bedside at all times. | **Activities:** - Wash hands. - Use universal precautions. - Correct and complete use of personal protective gear. - Provide 100% humidification. - Inflate ET balloon using a minimally occlusive technique or minimal leak technique. - Keep ET balloon inflated to 15-20 mmHg during mechanical ventilation. - Check balloon pressure immediately after handling the ET balloon. - Mark the reference in cm on the ET to check for possible shifts. - Help in the radiological examination of the chest, if necessary to control the position of the ET. - Minimize leverage and airway traction by suspending ventilator tubing from overhead holders, using flexible catheter swivel mounts, and supporting tubing during rotation, aspiration, and ventilator disconnection and reconnection. - Check secretions for color, quantity and consistency. - Perform oral care. - Monitor for decreased exhaled volume and increased inspiratory pressure in patients receiving mechanical ventilation. - Implement measures to prevent extubation. - Prepare additional intubation equipment and an ambu in a readily available location. |

| **Nursing intervention (NIC)** Management of basic acid balance: respiratory alkalosis (1914) |
|---|
| **Activities:** - Keep airway permeable. - Monitor respiratory status. - Keep IV access permeable. - Reduce oxygen consumption. - Manage sedation to reduce hyperventilation. - Monitor venous blood gas trends to determine efficacy of interventions. - Monitor for worsening symptoms of respiratory alkalosis. - Obtain samples for laboratory analysis of basic acid balance. - Place the patient to facilitate adequate ventilation. - Water balance. - Monitor for the presence of cardiopulmonary manifestations of respiratory alkalosis (arrhythmias, decreased cardiac output). - Facilitate stress reduction. - Provide frequent oral hygiene. |

**Table 2** NCP of the deterioration of gas exchange in the patient diagnosed with COVID-19

Despite providing continuous care, the evolution of the disease was not satisfactory as in the following days the patient presented a progressive deterioration in his health condition which led to his death; this coincides with different studies showing that people with COVID-19 with comorbidities are more at risk of developing complications which end in a fatal outcome.

## Discussion

Alteration of gas exchange was one of the most frequent nursing diagnoses in patients with SARS-CoV-2, and at the beginning of the pandemic it caused a large percentage of deaths, a situation that has currently changed since its frequency has decreased thanks to vaccination.

Globally, as of May 2023, approximately a total of 13,350,487,934 vaccine doses have been administered and 765,903,278 confirmed cases of COVID-19 have been reported and of which 6,927,378 correspond to deaths, as reported by the WHO (World Health Organization, 2023).

However, it is important to mention that in addition to vaccination, a series of actions have contributed not only to prevention, but also to providing care to the population during the pandemic through the training of nursing staff in: use of medical equipment. protection, techniques for the care of critical patients, in addition to collaborating in the reconversion of COVID-19 hospitals, participating in the communication of patients with their families through electronic devices, courses for the development of resilience, to mention a few.

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However, even now there are areas of opportunity in relation to post-COVID conditions in patients and health personnel who present Bournot syndrome, these becoming new areas of opportunity.to implement health strategies, and thus continue providing quality care to users (Danesh, Garosi, Golmohamadpour, 2021), (Roberts, Kelly, Lippiett, Ray, Welch, 2021).

The current challenges derived from the pandemic are the physical and emotional rehabilitation of patients with long COVID or post-COVID-19 syndrome, as well as health personnel and the restructuring of health services to be prepared for a future pandemic, as well as reduce barriers to access to health (Bauer S, Eglseer D, Hödl, 2020), (Løkke, F. B, et al, 2023), (Pujolar G, Oliver-Anglès A, Vargas I, Vázquez, 2022), (Yong,2021), (Zhang, 2023).

## Conclusion

When the patient with a diagnosis of COVID-19 is admitted to the ICU, the critical care nurse specialist becomes a leader in providing care. Thus she plays a very important role in patient management, therefore putting her theoretical and practical knowledge on trial, the management of a critically ill patient involves specialized care whose objective is to provide quality care aimed at improving and maintaining health. The implementation of NCP, such as the one developed in this study, allows improvement in the planning of nursing care to be provided to critically ill patients with a diagnosis of deterioration of gas exchange due to SARS-CoV-2.

## Conflict of interest

The authors have no conflicts of interest to declare.

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