We never stop

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The journal particularly welcomes studies that aim to evaluate and understand complex health care interventions and health policies, and which employ the most rigorous designs and methods appropriate for the research question of interest. The journal also seeks to advance the quality of research by publishing methodological papers introducing or elaborating on analytic techniques, measures, and research methods. The journal publishes original peer-reviewed articles of interest to the international health care community.

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Placement of ultrasound-guided peripheral intravenous access: the use of biological model

Credits: Domenica Petta
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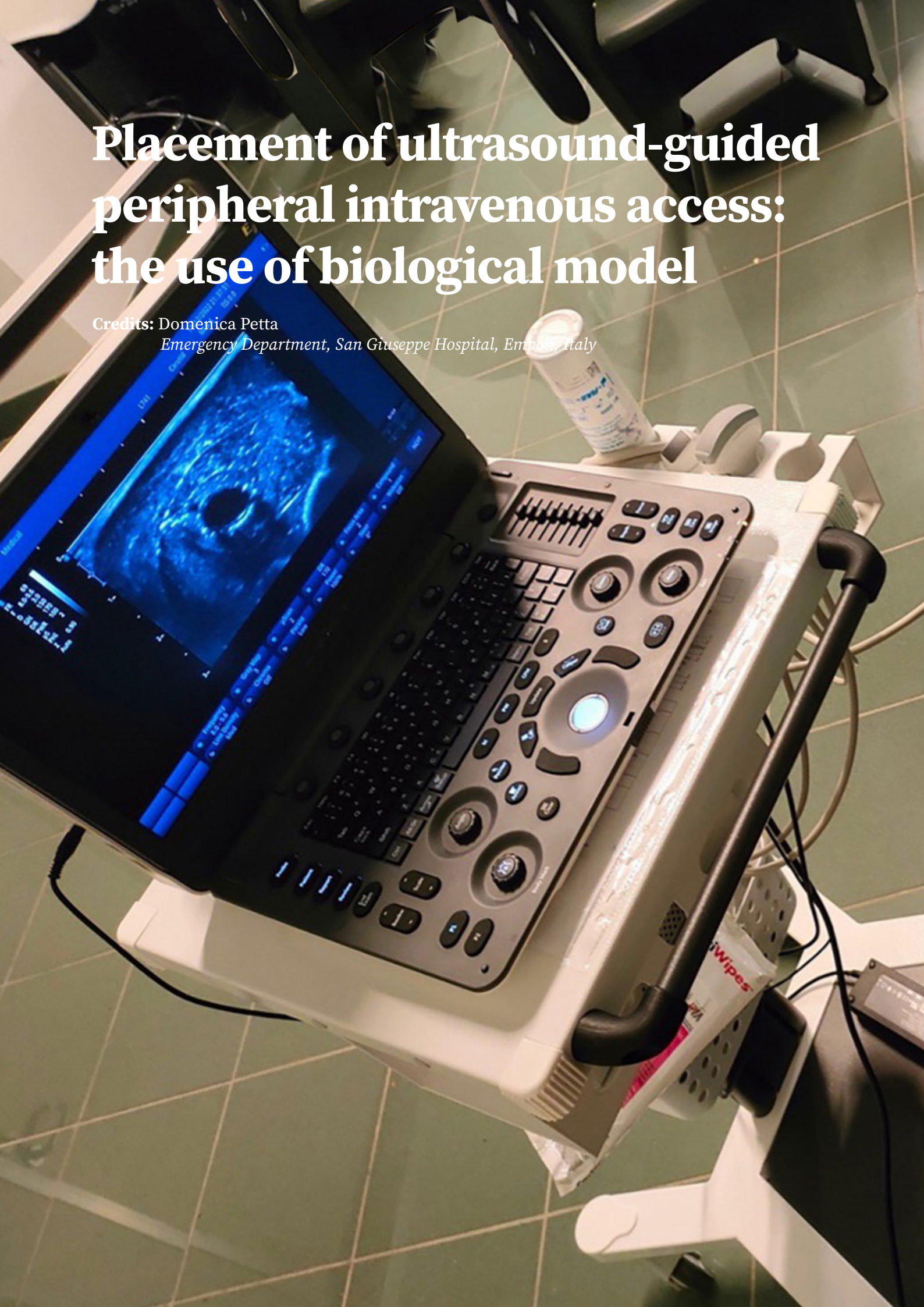

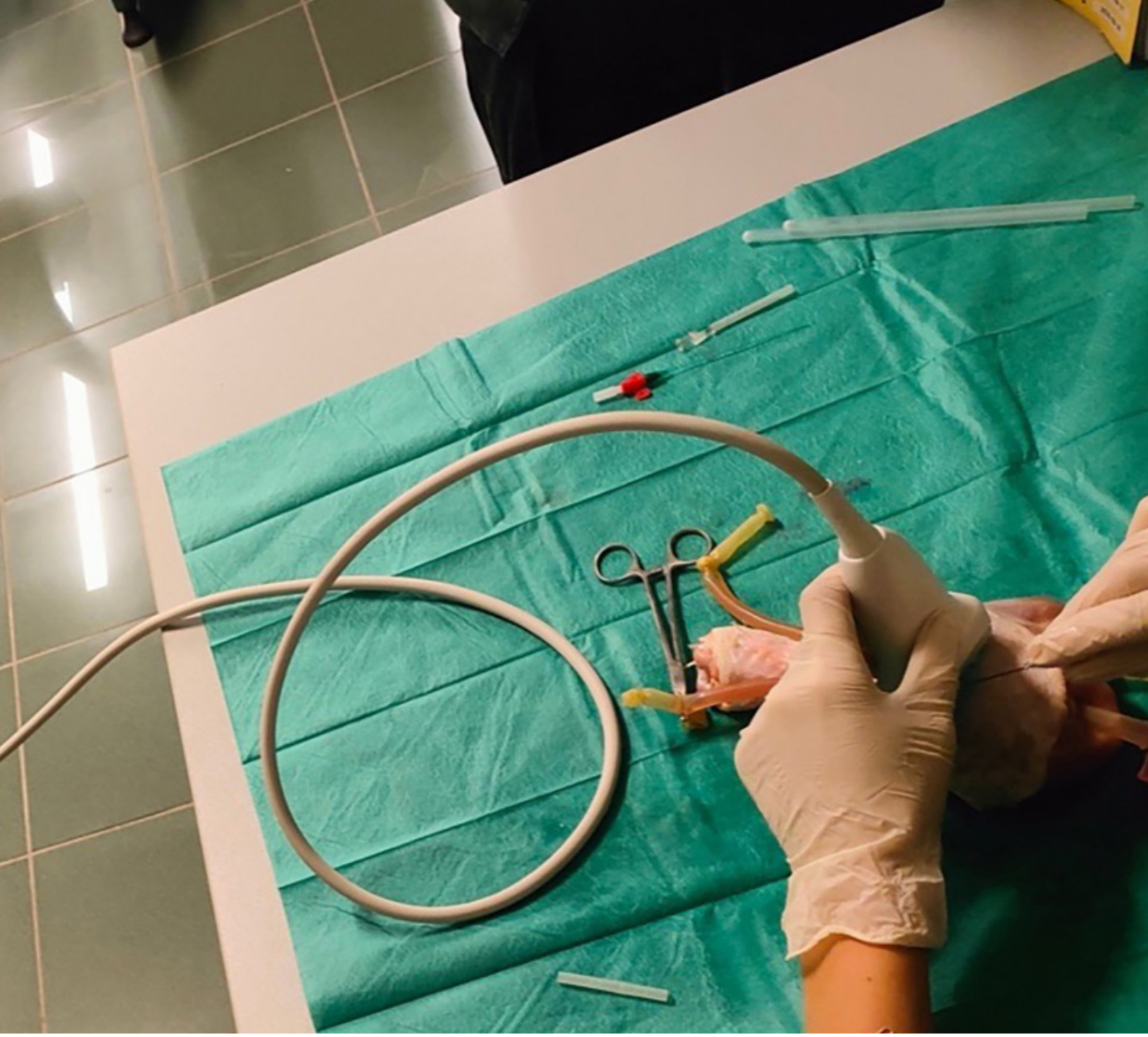

Biologic simulator: what is it, when is it used, and how is it prepared?

To train practical skills on placement of ultrasound-guided vascular accesses it is necessary to prepare a simulator.

The simulator consists of a turkey leg. A hollow tourniquet is passed through it, inside which red fluid is run, refilled by a syringe attached to the base of the tourniquet.

Using a biological model is possible to simulate a human arm as faithfully as possible:

- Simulator tissues can be almost compared with human tissues, as they exhibit similar echogenicity.
- The tourniquet faithfully simulates the venous component: its depth can be understood and its compressibility assessed with the ultrasound probe.
- The red liquid passed inside the tourniquet simulates the blood component, which will leak out similarly to human blood, once the vessel (tourniquet) is punctured properly.

Editorial

The essentiality of nursing in modern health systems

Loredana Sasso[1]

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Since Florence Nightingale, the essentiality of the nursing profession has seen a constant expansion; particularly, the variation and contextualization of this profession over time and across societies has laid the foundations of the nursing discipline[1]. Nowadays, the essentiality of nursing is constantly being supported by the concept of need and the ability of the nurses to respond to it (i.e., in terms of education, care, rehabilitation, and end-of-life support). The concept of need was dominant in the early stages of nursing care theorization.

The essential nature of nursing can be drawn from the three fundamental questions that define nursing as a scientific discipline and contextualize it over time: What do nurses do? How? With what results?[2] In order to answer these three questions today, an analysis of the recent progress of the healthcare systems is pivotal. Specifically, the last decade has been characterized by a significant epidemiological transition that includes longer life expectancy, socioeconomic improvement in many countries, and the introduction of new technology, which in turn, have improved the caring process.

The National Health plans and the World Health Organization (WHO) place the nursing profession at the center of future healthcare, particularly at the center of a proactive healthcare system in the community. In The State of the World's Nursing 2020 report presented for the World Health Day, the WHO made "a stark reminder of the unique role that nurses play and a wakeup call to ensure they get the support they need to keep the world healthy".[3] However, the problem of excessive workload and staffing continues to be the "two elephants in the room" (i.e., those problems that everyone knows but prefers to ignore)[4] that can only be solved by investments, scientific evidence, and nursing leadership[5].

The International Council of Nursing (ICN) and the WHO jointly recommend more urgent significant investments in the nursing profession in order to fully express its potential, which is not exclusively confined to hospitals, but also in contexts of home care and community settings[5,6]. To become the "essential nurses" that the healthcare systems demand today, nursing leaders should give equal importance to both patient and nurses' outcomes[4]. Researchers have sufficient data to demonstrate the significant relationship existing between the nurses' and patients' outcomes; for example, a poor work environment, determined by excessive workload and nursing burnout, is highly likely to translate into adverse patient outcomes[7].

Nurses must dwell on deep reflection into the nursing discipline so that it is scientifically grounded and devoid of feelings and values. Contemporary nursing articulates the concept of response to the patient's needs through "fundamental care". Contextualizing the essentiality of nursing today means providing fundamentals of care according to a broad and strategic vision, synergistically aligning fundamental care with nursing-sensitive indicators (i.e., the patients' and nurses' outcomes)[8].

Today, across the health care systems, there is a need to make visible that providing high-quality fundamental nursing care is particularly complex and something that only some nurses can ensure[9]. It is necessary to measure and reassess the "essential care," in the context of scientific knowledge and personal responsibility for the consequence of any act committed or omitted (missed care)[10]. The literature has repeatedly shown that nurses omit these activities because they prioritize others perceived as more specialized, technological, and less "obvious" in situations of time constraints[11,12].

A few research studies show that nurses only

sometimes consider fundamental care as an essential part of their work; consequently, part of these activities are usually provided by healthcare assistants[13]. Other studies also underline an excessive distance of the nurses from the patients' needs and a subsequent increase in dissatisfaction with their job and intention to leave[13].

Nursing leaders are called upon to manage these aspects in such a way as to prioritize not only the needs of patients but also those of the nurses. This phenomenon of invisibility of fundamental nursing care carries the risk of undermining the essentiality of nursing, with severe consequences for nursing education. In nursing education training, basic care is often implicit or invisible; notably, it is taught as an introductory part in the first year of the curriculum and rarely addressed in the second and third years[14]; moreover, nursing students themselves classify fundamental care as "just common sense"[9]. This may generate an erroneous way of thinking in students because they may be prone to consider basic care as just a set of simple activities which, once learned, do not require to be continuously updated by scientific knowledge, or reassessed periodically[9].

To ensure complete and effective management of the fundamental care needs of patients and the essentiality of nursing, there is an emergent need to start with the education of nurses as healthcare professionals. The approach possibly includes a thorough review and restructuration of the undergraduate nursing curricula, to make them closer to people and capable of responding to their health needs today, like in the past[15].

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Unique and indispensable

Narrative Review

Weaning from mechanical ventilation: a narrative review

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Abstract: The process of "weaning" from mechanical ventilation involves several assessments and steps to support a patient in reaching a "liberation" from the ventilator and allow for spontaneous breathing. The weaning process consists of evaluating if the patient is able to breathe with minimal or no ventilation support. This assessment is performed by a diagnostic test named spontaneous breathing trial (SBT), repeated every 24 hours to ensure extubation success. Even though many patients do not meet the eligibility criteria for starting the weaning process, they can still be weaned. For this reason, these criteria should be evaluated in order to assess a possible weaning, rather than adopting absolute standards which have to be met simultaneously. The SBT helps the healthcare professionals to understand the patient's capacity to sustain physiological breathing once they are extubated (or on spontaneous breathing if a tracheostomy tube is maintained in place). Several patients fail to meet the weaning criteria after less than 20 minutes of the SBT. Therefore, a 30-minute trial is enough to estimate the patient's capacity to withhold spontaneous breathing.

Even if the SBT is currently the gold standard method to conduct the weaning trial, it does not prevent the occurrence of complications after extubation such as upper airways obstruction, increased resistance, loss of airway protective reflexes, cough efficiency, and drainage of tracheobronchial secretions. The preventive use of NIV or High Flow Nasal Cannula is strongly recommended for patients experiencing extubation failure and mechanically ventilated for more than 24 hours after an SBT.

A well-performed SBT usually leads to definitive extubation; on the other hand, SBT failure requires a comprehensive investigation on potentially reversible conditions. Prolonged weaning is highly wasteful in terms of time and resources due to the need for a systematic and multidisciplinary approach to successfully face the weaning process.

Keywords: Mechanical Ventilation, Weaning, ICU, Spontaneous Breathing Trial.

Introduction

The process of "weaning" from mechanical ventilation (MV) involves several assessments and steps to aid a patient in reaching a complete separation from the ventilator and obtaining spontaneous breathing. This does not necessarily involve detachment from an artificial airway such as the tracheostomy tube. In fact, even if spontaneous breathing is present, in some cases the patients cannot protect their airways. Therefore, the operator needs to achieve the *"liberation"* of the patient from the ventilator and concurrently from the artificial airway (this usually occurs when the artificial airway is an endotracheal tube). There are multiple advantages in weaning patients from artificial airways; these include reduction of the excessive respiratory work caused by the endotracheal tube, decrease in the risk of ventilator-associated pneumoniae (VAP), promotion of the patient's verbal communication and comfort; reduction of sedation needs, promotion of effective cough, clearance of secretions and sinus improvements.

The weaning process consists of *two phases*[1]:

1. Evaluating if the patient is eligible for weaning;
2. Performing the spontaneous breathing trial (SBT), a diagnostic test to ensure extubation success.

Weaning Eligibility Criteria

Patients that meet the criteria will be considered ready to be weaned from mechanical ventilation. In fact, not extubating patients that fit the criteria for weaning is more damaging than a failed SBT.

Even though many patients do not meet the eligibility criteria, they can still be weaned. For this reason, these criteria should be evaluated in order to assess a possible weaning, rather than adopting absolute standards which have to be met simultaneously. Table 1 summarizes the principles emanated from the International Consensus Conference (ICC)[2], which should be considered prior to starting the SBT procedure.

Table 1: Eligibility criteria for weaning
Resolution of the illness underlying the need for mechanical ventilation (MV) if such illness is the cause for intubation;
Cardiovascular stability (heart rate ≤ 140, systolic blood pressure range of 90-160 mmHg, absence of acute myocardial ischemia, absence or minimal use of vasopressor drugs);
Adequate consciousness levels (evaluate the sedation levels daily and, if possible, reduce them)
Appropriate use of oxygen, defined by $PaO_2/FiO_2 \geq 150$ mmHg, O_2 saturation ≥ 90% with $FiO_2 \leq 0.4$;
Positive End Expiratory Pressure (PEEP) ≤ 8 cmH2O;
Patient collaboration;
Effective cough;
Excessive respiratory secretions;
Respiratory Rate ≤ 35 Respiratory Rate/min;
No significant respiratory acidosis;
Tidal Volume (Vt) > 5 ml/kg with low support;
Rapid Shallow Breathing Index (RSBI) < 105 breaths/min/L
Metabolic stability

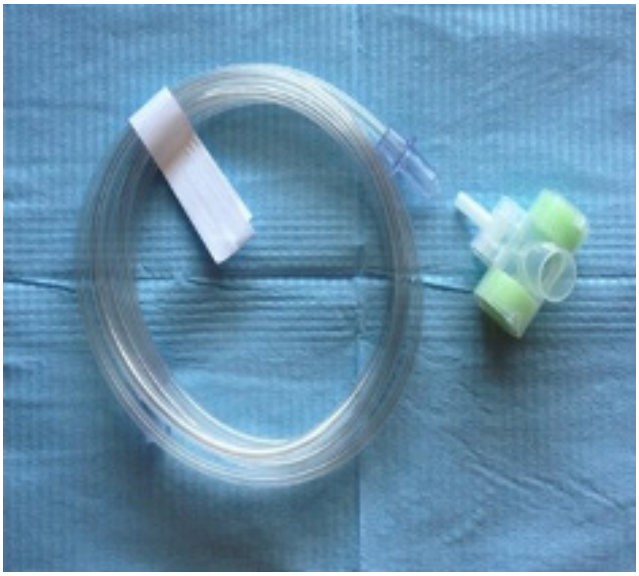
Considering the eligibility criteria, this trial allows the healthcare professionals to understand the patients' ability to sustain physiological breathing (or spontaneous breathing if a tracheostomy tube is maintained in place) after extubation. The literature mentions different methods[3]:

- the T-tube, which provides an oxygen supply without the use of positive pressure;
- pressure support ventilation (PSV) up to 5-7 cmH_2O with or without positive end-expiratory pressure (PEEP) and Automatic Tube Compensation (ATC);
- continuous positive airway pressure (CPAP).

The SBT performed through a T-tube junction (Figure 1) shows several advantages:

1. better patient's psychological conditions as if he/she was extubated[3].
2. hidden cardiomyopathies, such as coronary artery disease or left ventricle dysfunction, can be revealed during the SBT by an increase in venous return, due to the negative transthoracic pressure and cardiac work induced by spontaneous breathing in T-Tube[4].
3. the T-tube SBT can reduce MV duration, especially in patients with difficult weaning[5].

Figure 1. T-tube example



A 30-minute trial is enough to estimate the patient's capacity to withhold spontaneous breathing.[6] Several patients show failure of weaning criteria after less than 20 minutes of the SBT. In the presence of a tracheostomy tube, the removal of this device should be evaluated according to the following criteria:

- adequate swallowing ability (ensuring that there is no risk of aspiration);
- Glasgow Coma Scale > 8;
- spontaneous cough reflex;
- ability to manage secretions;
- attentive and collaborative level of consciousness.[7,8]

If SBT is successful, the next step will be extubation, or in the case of a tracheostomy tube, the patient will be maintained under spontaneous breathing through the device. Table 2 reports the weaning recommendations, which should occur on a daily basis.[1]

Table 2: Weaning recommendations on a daily basis

Healing Process (MV)	Reduce or minimize sedation levels
	Use ventilation modes that allow the patient to have a spontaneous breathing
	Daily awakening trial
	Mobilize patients as soon as possible and frequently
Weaning readiness	Standardize screening and weaning procedure
	Early check for eligible criteria even if the primary cause of MV is still present
	Avoid excessive ventilator assistance
	Observe that every ventilator breathing is triggered by the patient (prevent and avoid systematic auto-cycling)
	Disconnect the ventilator if RSBI < 105 breaths/min/L
Weaning trail	At least once a day
	SBT ~ 30 min
Extubation if SBT is successful	Promote cough
	Evaluate risk of upper airways obstruction (glottis oedema)
	Consider preventive NIV for COPD patients
	Evaluate prophylactic NIV use in patients with high risk of post extubation respiratory failure
	Do not delay re-intubation if weaning is failed
Difficult weaning	Diagnostic workup: respiratory pump insufficiency, lung parenchymal dysfunction, myocardial dysfunction
	Correct all the reversible causes for weaning failure and illnesses, and repeat the SBT
	Consider BNP measurements to find hidden cardiomyopathies
Weaning long term	Consider the plan for a tracheostomy to improve the patient's comfort and the chances to be weaned from MV
	Global (multidimensional) approach including nutrition, psychological factors and sleep cycle
	Consider specialized units if available to achieve the goal of weaning
	Discuss realistic goals to achieve with the patient

Legend: *BNP (Brain Natriuretic Peptide), COPD (Chronic Obstructive Pulmonary Disease), MV (Mechanical Ventilation), NIV (Noninvasive Ventilation), RSBI (Rapid Shallow Breathing Index), SBT (Spontaneous Breathing Trial).*

Failed Spontaneous Breathing Trial criteria

The criteria to detect the failure of a SBT are listed in Table 3.

Table 3: Subjective and objective criteria to detect SBT failure

Subjective	Objective
Agitation, anxiety, dyspnea	$PaO_2 \leq$ 50-60 mmHg with $FiO_2 >$ 50%
Altered sensorium, drowsiness	$PaCO_2 >$ 50 mmHg or increase > 8 mmHg
Peripheral or mucosal cyanosis	pH < 7.32 or pH decrease more than > 0.07 from the baseline
Diaphoresis	RR > 35/min or 50% increase from the baseline
Increased work of breathing (WOB) with the use of accessor respiratory muscles	Heart rate> 140/min or 20% increase from the baseline
	Systolic blood pressure> 180 mmHg or 20% increase from the baseline
	Systolic blood pressure < 90 mmHg
	Cardiac arrhythmia

Locate and resolve the cause (when possible) if an SBT fails. The most likely physiological causes of SBT failure are reported in Table 4. Eligibility criteria screening for SBT should be repeated every 24 hours to determine whether the extubation will be successful.[2,9]

Even if the SBT is currently the gold standard method to conduct a weaning trial, it does not prevent the occurrence of complications after extubation, such as upper airways obstruction, increased resistance, loss of airway protective reflexes, cough efficiency, and drainage of tracheobronchial secretions.[10] The preventive use of NIV or High Flow nasal cannula (HFNC) is strongly recommended in patients experiencing extubation failure and mechanically ventilated for more than 24 hours after an SBT.[11,12]

With adult patients in the acute phase of an illness that are mechanically ventilated for more than 24 hours, early mobilization and rehabilitation are recommended by the guidelines[11], to increase the chances of weaning and extubation. Patients who fail an SBT should be provided proper ventilation support to avoid fatigue.[13] Healthcare providers must set adequate levels of ventilator inspiratory support allowing the respiratory muscles to relax.

Table 4: common pathophysiological conditions, that can negatively impact weaning from mechanical ventilation.[2]

Respiratory load	Increasing respiratory work: inadequate ventilator settings
	Low compliance: VAP; pulmonary oedema cardiogenic or not; pulmonary fibrosis; pulmonary hemorrhage; diffuse pulmonary alveolar infiltrates.
	Bronchoconstriction and airflow obstruction
	Increased resistive load: • during SBT: endotracheal tube; • after extubation: glottis oedema; increased airway mucus secretions; sputum retention.
Cardiac load	Hidden cardiovascular disease
	Increased cardiac workload up to a dysfunctional myocardium
Neuromuscular	Respiratory drive: metabolic alkalosis; sedative-hypnotic drugs
	Ventilatory central command: neuromuscular respiratory failure
	Ventilator-induced diaphragmatic dysfunction
	Peripheral neuropathy: primary cause of weakness, numbness and pain.
Neuropsychological	Delirium, depression, and anxiety
Metabolic	Metabolic disorders linked to corticosteroids and hyperglycemia
Nutrition	Overweight, malnutrition
Anaemia	-

Classification

The weaning process is determined by the number of attempts and the time employed to liberate the patient from MV. The ICC classification is composed of three categories:

- Simple weaning: liberation from the ventilator/successful extubation after the first spontaneous breathing trial;
- Difficult weaning: liberation from ventilator/successful extubation after two or three SBTs and below seven days from the first attempt;
- Prolonged weaning: liberation from the ventilator/successful extubation after three or more SBT or more than seven days from the first attempt.

Successful weaning from a ventilator is identified when the patient does not need to be reintubated, nor any ventilatory support needs to be restored 48 hours after removing the endotracheal tube.

ICC classification presents some limitations. In 2007 two categories were not included: patients deceased before an SBT trial, and those discharged from ICU but still ventilated. ICC does not specify how to categorize tracheostomized patients and offers an unclear definition for patients undergoing NIV support within 48 hours after extubation. ICC is based on the SBT but does not consider the fact that several patients are not weaned with planned extubation. Several authors of this categorization have yet to be able to identify specific ICC definitions to classify other patients with different results in their studies.

In 2017 REVA network (Reseau Européen de Recherche en Ventilation Artificielle) submitted the WIND[14] categorization, which defines weaning as the beginning of any type of liberation trial.

For Intubated patients

1. Attempt to liberate from mechanical ventilation: SBT with or without extubation or direct extubation (whether planned or unplanned without an SBT).
2. Attempt to liberate from mechanical ventilation: non-occurred death or reintubation seven days after the extubation, regardless of whether NIV has been used or discharged from ICU. The actual weaning date is calculated retrospectively with respect to the extubation after the patient has completed seven days without reintubation.

For tracheostomized patients

- Attempt to liberate from mechanical ventilation: 24 hours or more in spontaneous ventilation mode through the tracheostomy tube without the use of mechanical ventilation.
- Attempt to liberate from mechanical ventilation: 7 consecutive days in spontaneous ventilation mode through the tracheostomy tube without using VM or the patient's discharge in spontaneous ventilation mode.

This classification includes four groups based on the weaning process duration (successful weaning or premature death). The "No weaning" group includes patients who have not had an SBT; "Short weaning": interruption within the first 24 hours of the first weaning attempt (successful weaning or premature death); "Difficult weaning": weaning has been completed after more than 24 hours but less than a week from the first attempt (successful weaning, or premature death); "Prolonged weaning": weaning process has not been successful within first seven days (successful weaning, or premature death).

Conclusions

The process of weaning critically ill patients from mechanical ventilation has significantly changed during the last forty years. The two-phased approach (daily evaluation of eligibility criteria and the SBT) is an effective procedure for early liberation from mechanical ventilation.

A well-performed SBT generally leads to definitive extubation. On the other hand, SBT failure requires a comprehensive investigation of the potentially reversible conditions. To prevent reintubation, precautionary NIV and HFNC after the extubation is also recommended. Prolonged weaning is highly wasteful in terms of time and resources due to the need for a systematic and multidisciplinary approach that successfully deals with the weaning process.[1]

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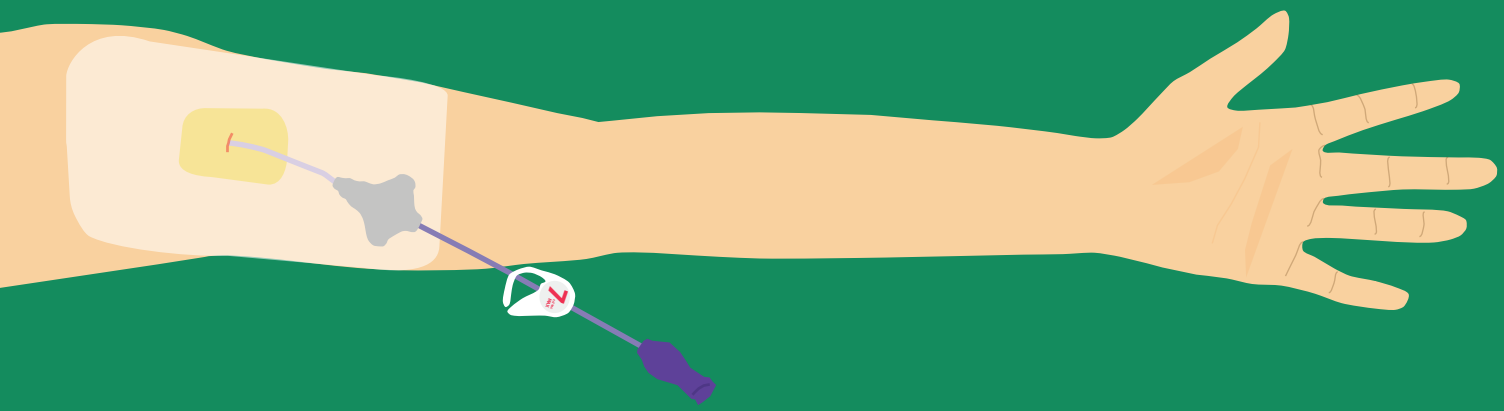

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Cultural Article

Handling the challenge of antimicrobial resistant superbugs in the clinical setting: nursing staff as a pivotal player

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Abstract: Bacterial resistance to antibiotics (antimicrobial resistance, AMR) is rapidly spreading globally among major Gram-positive and Gram-negative bacterial pathogens (including staphylococci, enterococci, *Enterobacterales*, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii*); this phenomenon has a remarkable impact on morbidity, mortality and healthcare-associated costs. Evolution and dissemination of AMR can be counteracted with a combined strategy based on I) antimicrobial stewardship programs aimed at a prudent and appropriate use of antibiotics to improve clinical outcomes and reduce the selective pressure for resistance; and II) infection prevention and control (IPC) practices, to limit the spread of resistant pathogens within the healthcare settings. In this scenario, the nursing staff plays a pivotal role, since these figures are involved in the enforcement and supervision of IPC bundles (e.g., contact precautions, hand, and environmental hygiene, active surveillance, patient isolation, or cohorting), which are essential to limit the spread of resistant pathogens among different patients.

Keywords: Antimicrobial Resistance, Infection Prevention and Control, Nursing Staff.

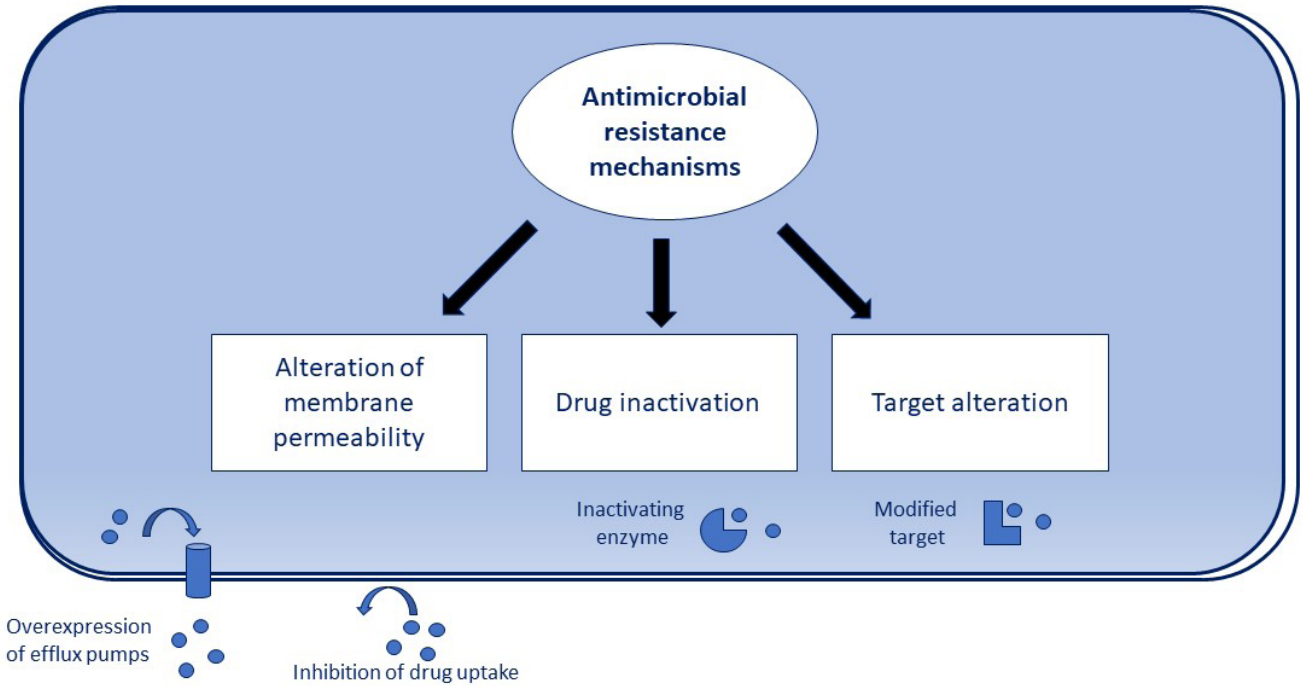
The increasing burden of antimicrobial resistance

Since their introduction in clinical practice, antibiotics have provided an outstanding contribution to decrease morbidity and mortality by bacterial infections; they have also been instrumental to the success of medical practices associated with a high risk of secondary infections such as contaminated surgery, organ and tissue transplantation, implantation of devices, and other invasive procedures.[1]

However, the efficacy of antibiotics has been impaired by the phenomenon of antimicrobial resistance (AMR), which is mediated by several mechanisms that bacteria have evolved to defend themselves, such as antibiotic-degrading enzymes,

antibiotic target modification, or reduced drug uptake (Figure 1).[2] Accretion of several resistance mechanisms may also occur in bacterial strains, with ultimate conferral of complex multidrug-resistant (MDR) phenotypes that leave limited treatment options.

Figure 1. Main antimicrobial resistance mechanisms.



During the past decades, AMR has spread globally among many bacterial pathogens, and the simultaneous lagging of antimicrobial discovery and development programs has magnified the impact of this phenomenon. This conjuncture, also indicated as AMR crisis, has led to the emergence of bacterial strains which are resistant to most or even all available agents; such a mechanism carries a substantial risk of moving back to the pre-antibiotic era, with dramatic consequences in terms of morbidity, mortality and healthcare-associated costs.[3] In 2016, the number of deaths associated with AMR infections was estimated at around 700,000, with an increasing trend,[4] and in 2019, a total of 1.27 million deaths related to AMR infections per year have been estimated globally based on statistical models with data for 23 pathogens and 88 pathogen–drug combinations in 204 countries and territories.[5]

The recent revamping of specific antimicrobial development programs in response to this AMR crisis has led to the introduction of some new antibiotics that are active against MDR pathogens[6,7]. Still, more is needed to cover all unmet needs, while a substantial effort is warranted to minimize the emergence of resistance against these new antibiotics.

The major antimicrobial resistant superbugs in the clinical setting

AMR affects most bacterial pathogens, but it has become especially problematic with some of them, often referred to as antimicrobial-resistant superbugs. These include methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE) among Gram-positive cocci, and carbapenem-resistant *Enterobacterales* (CRE), carbapenem-resistant *Acinetobacter baumannii* (CRAB), and extensively drug-resistant Pseudomonas aeruginosa (XDR-PA) among Gram-negative bacilli.[8] The repertoire of drugs exhibiting activity against these pathogens is overall limited and, in some cases, seriously limited. In fact, the WHO has listed some of these resistant superbugs among those with the highest priority to target, with the final aim of developing new antibiotics.[9]

Strategies to mitigate the phenomenon of antimicrobial resistance

The phenomenon of AMR is virtually unavoidable after the introduction of therapeutic and prophylactic use of antibiotics. Still, two major factors can modulate its evolution: I) the policies of antibiotic prescription and II) the efficacy of infection prevention and control (IPC) practices. Indeed, robust antimicrobial stewardship,

promoting the prudent and appropriate antimicrobial use, minimizes the selective pressure for resistance and maximizes favorable clinical outcomes. At the same time, efficient IPC practices can control the spread of already selected resistant superbugs within the hospital settings.[10] In fact, variable compliance with antimicrobial stewardship and IPC practices are among the major causes of different AMR prevalence in other countries. In Europe, where the rate of AMR among the most important pathogens are overall high, remarkable differences are apparent across different countries, with higher rates being observed in Eastern Europe and the Mediterranean Area,[11] where problems of poorer compliance with these practices and understaffing tend to be more common.

Since antibiotics are also used outside the clinical sector (e.g., in veterinary medicine and agriculture), AMR can also emerge in those settings, and the importance of the transference of AMR among different sectors has been increasingly acknowledged from a so-called "one-health" perspective. has been increasingly acknowledged from a so-called "one-health" perspective[12].

In hospital settings, the risk for AMR selection and spread is higher due to the frequent use of antibiotics and the higher likelihood of cross-transmission of resistant bacteria among inpatients. This is true both for acute-care hospitals and long-term-care facilities, where the prevalence of AMR may be similar to or even higher than that observed in acute-care hospitals.[13]

Specific bundles have been designed to limit the dissemination of AMR superbugs in healthcare settings based on IPC interventions; these activities include passive and active surveillance, isolation precautions, patient and staff cohorting, personal and environmental sanitation, and staff education, combined with antimicrobial stewardship programs aimed at optimizing antimicrobial prescriptions. In this context, all healthcare professionals are involved, with nursing staff representing crucial players.

The crucial role of nursing staff in curbing antimicrobial resistance

Nurses involved in clinical settings play a pivotal role in correctly deploying infection prevention and control (IPC) practices; these are essentially aimed at limiting the spread of resistant superbugs among different patients within healthcare environments, thereby limiting the phenomenon of AMR.

In this perspective, it should be noted that while basic IPC measures (e.g., contact precautions, hand and environmental hygiene) should be adopted in all settings, other measures such as active surveillance of multi-drug resistance organisms (MDRO), patient isolation or cohorting, and staff cohorting, could be dependent on the type of patients and wards, and the local MDRO epidemiology. Colonization and cross-transmission pathways can differ for resistant superbugs.[14] For instance, the main reservoir of CRE and VRE is represented by intestinal colonization of carriers. At the same time, MRSA, CRAB, and XDR-PA are commonly isolated from the skin or upper respiratory tract. Moreover, when different resistance mechanisms are present among the same category of resistant superbugs (e. g. serine- or metallo-beta-lactamases in CRE), it may be necessary to modulate cohorting accordingly, in order to avoid the emergence of strains with multiple resistance mechanisms that are resistant to new antibiotics. with multiple resistance mechanisms that are resistant to new antibiotics.

It should also be underscored that the presence, in each hospital, of experienced infection control nurses, who are able to supervise IPC protocols and provide continuous training to other healthcare workers, is essential for the success of antimicrobial resistance control measures.

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Il Gruppo di Studio "**Assistenza infermieristica e tecnica in cardiologia**" ringrazia tutti coloro che hanno preso parte in presenza e da remoto all' 83° Congresso Nazionale della Società Italiana di Cardiologia - SIC, tenutosi nella magnifica cornice della città eterna (Roma), per l'ampia partecipazione e l'interesse dimostrato.

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Vi aspettiamo!

Case Report

A case report on pulmonary fibro-emphysema: an incorrectly framed case

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Abstract: This case report describes the combination of pulmonary fibrosis and emphysema (CPFE) as a possible new addition to the growing list of smoking-related lung diseases, which are characterised by the coexistence of usual interstitial pneumonia (UIP) or non-specific interstitial pneumonia (NSIP) with emphysema in tobacco smokers.

Keywords: COPD, Therapy, Spirometry.

Introduction

Combined pulmonary fibrosis and emphysema (CPFE) is a new addition to a growing list of smoking-related lung diseases, characterised by the coexistence of idiopathic pulmonary fibrosis (IPF) with emphysema in tobacco smokers[1]. CPFE accounts for between 5 and 10% of cases of diffuse interstitial lung disease[2].

Three distinct CPFE patterns have been described in the recent literature:

- Progressive transition with diffuse emphysema (centrilobular and bullous) and bubble/honeycomb transition zone
- Paraseptal emphysema with a predominance of subpleural bubbles of increasing size at the bases
- Separate processes with independent areas of fibrosis and emphysema.[3]

Clinical Case

A 77-year-old patient, came to my attention for reported episodes of dry cough, dyspnoea associated with desaturation under minimal exertion, and productive cough with a light-yellowish plug. The patient also reported a persistent "air hunger" sensation.

Remote pathological history: former building contractor, occupational exposure to cement dust, adverse reaction to theophylline with diarrhoea, former heavy smoker (90Pack/year), Body Mass Index: 25. Emphysematous chronic obstructive pulmonary disease (COPD) with hypoxaemic respiratory failure in long term oxygen therapy (OTLT) and inhaled corticosteroid/long-acting β2-agonist (ICS/LABA). Chronic heart failure in previous ischaemic heart disease, previous lung cancer undergoing left lobectomy in 2015, diabetes mellitus type II, systemic arterial hypertension. Up to the time of the visit, he had been treated by a pulmonologist colleague for COPD with aerosol therapy, ICS/LABA, and oral corticosteroid treatment (OCS). He performed spirometry with lung diffusing capacity test (DLCO) and computer tomography (CT) scan, whose results are reported in Figure 1.

Figure 1. Spirometry of the patient

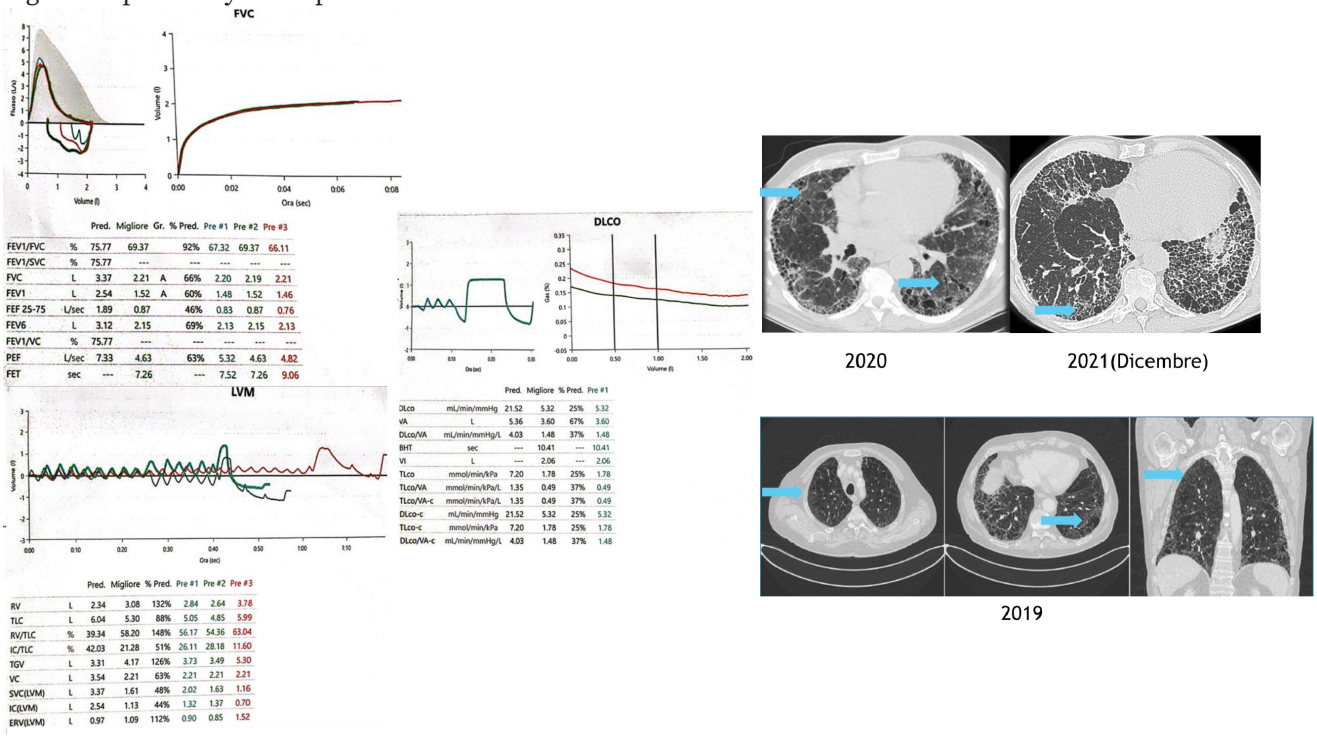

Figure 1 shows on the right the presence on global spirometry with DLCO the presence of moderate degree obstructive deficit with severe reduction of DLCO and presence of high ratio of RV to TLC (148% of predicted) and RV: 132% low tidal volume and inspiratory capacity (VT: 63% of predicted, IC(LVM): 44% predicted). The CT scan of the chest shows a progressive course of the disease resulting in the presence of distortion of the lung parenchymal architecture with prevalence at the apices of paraseptal emphysema bubbles and at the bases the presence of honeycombing with subpleural sparing, traction bronchiectasis and areas of bilateral GGO that at the left base converge into thickening (December 2021). Therefore, the picture appeared to be suggestive of CPFE at first hypothesis.

Legend*: DLCO = diffusing capacity for carbon monoxide; CT = computed tomography; RV = residual volume; TLC = total lung capacity; VT = vital capacity; IC = inspiratory capacity; LVM = Lung Volume Measurements; GGO = Ground glass opacity; CPFE = Combined Pulmonary Fibrosis and Emphysema.*

Aim

The aim of this case report is to highlight the correct approach to the diagnosis of complex pathologies, which in most cases are discussed with a multidisciplinary team. However, the expertise of a pulmonologist can change the diagnostic-therapeutic approach to complex pulmonary pathology, and this has been gaining in value in recent years, also in relation to the increased difficulty and complexity of certain pathologies such as this, which are not very common in the general population. Furthermore, it is important to value the step-by-step approach in the diagnosis of these pathologies, integrating various instrumental examinations that our structure has available.

Diagnostic-Therapeutic Approach

The diagnostic and therapeutic approach used is based on the ATS 2018 document on the diagnosis of fibrotic disorders, however, as this initial hypothesis was made at a private clinic, the patient was subsequently referred to a regional reference centre that confirmed the diagnostic hypothesis.

Anti-fibrotic therapy was started immediately as the fibrotic pathology was progressive over time with distortion of the parenchymal architecture and with damage leading to significant symptoms reported by the patient. In the first instance, the patient had been labelled as COPD and the therapeutic approach was incorrect as DLCO and global spirometry had not been performed. These examinations allow the specialist to have fundamental information to set eventual therapy and need to be more developed in our area within public structures.

Discussion

This case report highlights the importance of correctly diagnosing the idiopatic pulmonary fibrosis in the context of a COPD, which has an incidence of 5-10% within fibrotic pathologies. This is important because it shows how the symptoms and clinic of COPD patients can sometimes also underlie a fibrotic pathology. This case report also emphasises the importance of an early global spirometric examination with DLCO in patients with a high degree of dyspnoea, since it can correctly classify and diagnose the COPD. Notably, CODP and idiopatic pulmonary fibrosis can sometimes be confused given that they have common symptoms, including minimal exertional dyspnoea; however, high-resolution CT scans, together with spirometry remain the cornerstones for the diagnosis of these pathologies; lastly, use of Pirfenidone as an early antifibrotic therapy is also emphasised to slow down the progression of the fibrosis.

Conclusions

The patient's clinical and radiological features supported a CPFE diagnosis, with radiological features of emphysema, which was predominant in the upper zone, and pulmonary fibrosis of the lower lobes, which radiologically, had the characteristics of a UIP.

In this case, the radiological features described a UIP pattern, and a diagnosis of idiopathic pulmonary fibrosis was made, so the patient started Pirfenidone therapy, triple inhaled treatment with ICS/LABA plus a long-acting muscarinic antagonist (LAMA), and follow-up with CT scan once a year.

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Dressing of a venous access should be performed:

- every 7 days if sterile transparent film is present or soiled, detached, wet;
- every 48 hours if sterile gauze with plaster is present or if soiled, detached, wet or if there is a need for direct visualization of the insertion site;
- regardless of the frequency of dressing a CVC should be inspected daily for complications.

Environment

- Appropriate lighting
- Ensuring privacy for the patient
- Removal of obstacles

1 Procedure to prevent spread infections

Wash hands with hydroalcoholic gel, wear disposable cap and put on surgical mask.

2 Setting up a small sterile field

Prepare all necessary materials: prefilled syringes, empty syringes, needle-free connector (NFC), sterile clear dressing, CHG impregnated foam disk (if needed), sutureless system (if needed).

3 Procedure to prevent spread infections

Wash hands with hydroalcoholic gel and wear non-sterile disposable gloves.

4 Site inspection

Perform visual inspection of the exit site and adjacent skin, palpate over the dressing, and check the external length of the CVC to match with the implantation record. If PICC, measure the limb circumference and compare it with the baseline. All these procedures are aimed at searching complications (phlebitis, thrombophlebitis, catheter dislodgement, thrombosis, exit site infection).

5 Old dressing removal

Remove the transparent film (or gauze with patch) along with the CHG impregnated foam disk (if present) and the sutureless securement device (SDS). If the subcutaneous anchor securement system (SASS) is present, it should not be removed. Temporarily secure the CVC to the skin prevent accidental dislocation.

6 Procedure to prevent spread infections

Wash hands with hydroalcoholic gel and wear sterile disposable gloves.

7 Skin antisepsis

It is recommend to use a sterile single dose CHG dispenser. For antisepsis in cases of dressing a CVC, a 3 ml dispenser is sufficient. In case of chlorhexidine allergy, use iodiopovidone as a second-choice antiseptic.

8 CHG impregnated foam disk (if indicated) and sutureless device placement

Apply CHG impregnated foam disk (if indicated), according to manufacturer's instructions, and sutureless device. Remove CHG impregnated foam disk if dirty or soaked with blood/fluid. If subcutaneous anchor securement system (SASS) is present, it should not be remove and the placement of the sutureless device is not necessary.

Patient Education

Educate the patient to recognize signs and symptoms that indicate the occurrence of local and systemic complications (redness at the insertion site, pain at the insertion site, fever, presence of leakage from the insertion site). Explain to the patient that the dressing should be covered with appropriate devices when bathing or showering.

Further Considerations

Do not bandage the limb with elastic, if PICC is in place. Elastic bandages is a risk factor for the development of complications (venous thrombosis). If NFCs are present, it is not necessary to clamp the CVC line. Antireflux action is ensured by proper flush, lock, and NFC application.

ter - Dressing Change

USL Toscana Centro, Italy

Patient

Inform the patient about the procedure and obtain his/her verbal consent.

- For **PICC** dressing, abduct and extra-rotate the interested limb.
- For **CICC** dressing, rotate the head on the contralateral side of the catheter insertion site.
- For **FICC** dressing, extra-rotate and abduct the interested limb.

Materials

1. Sterile drape
2. Nonsterile gloves
3. Sterile gloves
4. 0.9% Sodium Chloride Pre-filled Flush Syringe
5. Empty 10 cc syringes
6. CHG impregnated foam disk (if needed)
7. Sutureless device (if needed)
8. Needle-free connectors (NFC)
9. Sterile solution applicator 2% CHG / 70% IPA
10. Sterile semipermeable clear dressing
11. Surgical mask
12. Non-sterile cap
13. CHG sterile gauze pad

Legend

CICC - Centrally Inserted Central Catheter
CHG - Chlorhexidine Gluconate
CVC - Central Venous Catheter
FICC - Femorally Inserted Central Catheter
IPA - Isopropyl Alcohol
NFC - Needle Free Connector
PICC - Peripherally Inserted Central Catheter

9 Sterile clear semi-permeable dressing placement

Use high-quality dressings with a Moisture Vapour Transmission Rate (MVTR) >1500g/m2/24h. Do not apply two dressings on top of each other. Dressings that are too occlusive can create a propitious environment for bacterial proliferation.

10 Procedure to prevent spread infections

Wash hands with hydroalcoholic gel and wear sterile disposable gloves.

11 CVC line clamping and NFC removal

CVC clamping prevents air to enter the venous circulation.

12 Catheter hub scrub

Scrub the catheter hub for 15 seconds with a CHG sterile gauze pad and allow to dry for 15 seconds.

13 Declamping and checking the patency of the CVC

Check blood return using a 10 ml syringe to exclude occlusions or catheter malfunction.

14 New NFC application and flush

After placing new NFC, perform two flushes with two 10-mL syringes of saline using stop-and-go movements. If indicated, place port protectors over antireflux valve. Place neutral displacement NFC, prefeably transarent and with the outer surface as smooth as possible

15 Procedure registration

Write the date of dressing on the new dressing and record the procedure in the medical record.

16 Material disposal

Dispose the used materials according to your country's laws and your health care institution's guidelines.

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Original Research

Parental participation in care during Neonatal Intensive Care Unit stay: a validation study

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Abstract

Introduction: Although the Neonatal Intensive Care Units (NICU) can offer lifesaving care for vulnerable newborns after birth, separation from the parents, pain, sleep disruptions, and environmental stressors can be traumatic experiences for these critically ill newborns. At the same time, the new parents can experience a situation they are not prepared for, such as separation from the newborn, and fear of the unknown, which, together disrupt the family ties, which are created and strengthened right during the moment of birth. Evaluating the participation of the parents in neonatal care during their children's stay in the NICU allows health professionals to highlight possible gaps in the correct management of the babies by the parents, intervening where it is necessary, with proper education and support.

Aim: To validate the Italian version of "The Scale of Parental Partcipation in Care: Neonatal Intensive Care Unit" (PPCS: NICU).

Methods: The study was conducted in a 22-bed mixed (medical and surgical) NICU of a public hospital. The study participants comprised parents whose infants were admitted to the NICU from April to August 2022.

Results: A total of 128 parents were included in the study. Exactly half of the sample was female, and the average age was 33.43 ± 6.51 years; 31.25% (n=40) of the sample already had a first child. Those who had a history of previous abortion were 25% (n=32). Additionally, 3.12% (n=4) of parents experienced a previous death of their child. About the type of delivery, 54.69% (n=70) of the sample experienced vaginal birth, 17.19% (n=22) of them underwent an elective cesarean, and 28.12% (n=36) underwent an emergency cesarean. Item analysis was performed on all 16 items. The corrected total item correlation coefficients for the scale items were adequate between 0.408 and 0.821. Cronbach's alpha was 0.926.

Conclusion: The Italian version of the PPCS: NICU shows high reliability and therefore, it can be used in the context of Italian NICUs to assess the degree of parental participation in neonatal care, allowing early identification of critical issues by parents in

the care of newborns admitted to NICU.

Keywords: Parenthood, Neonatal Intensive Care Unit, Parental Participation, Nurses.

Introduction

Although Neonatal Intensive Care Units (NICU) can offer lifesaving care for vulnerable newborns after birth, separation from the parents, pain, sleep disruptions, and environmental stressors may represent traumatic experiences for these critically ill newborns[1]. At the same time, the new parents can experience a situation they are not prepared for, such as separation from the newborn, and fear of the unknown, which, together disrupt the family ties, which are created and strengthened right during the moment of birth[2]. The first thirty days of a child's life represent a necessary period for correct psychophysical development; furthermore, the parents' strong knowledge and adequate and responsible behavior are fundamental in improving outcomes and providing a more effective relationship with the healthcare services[3]. Family-Centered care is one of the strategies that can help infants and parents to cope with these traumatic experiences in the NICU[4]. Parental participation in care has positive outcomes for both infants and parents[5,6]. Indeed, involvement in neonatal care reduces parents' stress levels, increasing their self-esteem and interaction with the baby[4], thus reducing parents' anxiety levels and improving their problem-solving skills[7]. Evaluating the participation of parents in neonatal care during their children's NICU hospitalization allows healthcare professionals to highlight any gaps in the correct management of the baby by the parents, intervening, where necessary, with proper education and support.

This study aims to validate the Italian version of *"The Scale of Parental Participation in Care: Neonatal Intensive Care Unit"* (PPCS: NICU)[8].

Methods

This is a cross-cultural validation study using a back translation and monolingual test[9]. In the first phase, after formal authorization from the author of the original version of the tool, a back translation using two translators was performed. The draft of the Italian version was evaluated by an expert panel composed of five NICU nurses for face and content validity. In this phase, each expert rated all items of the translated tool as "essential," "useful but not necessary," or "useless." In the second phase, an evaluation of the psychometric properties was carried out.

Setting and Population

The study was conducted in a 22-bed mixed NICU (medical and surgical) of a public hospital. The study participants comprised parents whose infants were admitted to the NICU from April to August 2022 and agreed to participate. During data collection, parents were allowed to enter the NICU twice a day, for a maximum of two hours, due to visiting limitations related to COVID-19.

Data Collection

The newborns' clinical data and the parents' socio-demographic data were collected on a personal data sheet. Parents were assisted and observed for three days after admitting the newborn. On the third day, parental participation in neonatal care was evaluated, and the assessment was carried out by the nurse who was in charge of the newborn and who assisted the parents entering the ward.

Description of the instrument

A previous review of the literature showed the need for validated tools to measure parents' participation in care[8]. For this reason, Ceylan and colleagues (2021) designed the PPCS: NICU, an instrument consisting of one dimension and 16 items[8] (Fig. 1). In this study, the corrected item-total correlation coefficients were between 0.48 and 0.78, and cronbach's alpha level was 0.93. The intraclass correlation level was 1.000 ($p = <0.001$). The response categories were as follows; 3 = always, 2 = sometimes, 1 = never. The total score of the scale ranges from 16 to 48, with higher scores indicating higher involvement of the parent in the care. No cut-off points have been provided by the authors[8].

Content validity was performed using Davis' method[10,11]. Cronbach's alpha reliability level and item-total score reliability were used to evaluate the translated scale's reliability.

Statistical Analysis

EXCEL® was used to store the data. Descriptive

statistics were reported as appropriate after testing continuous variables for normality of the distribution by the Shapiro-Wilk test. Frequency and percentage were reported for nominal variables, whereas average and standard deviation (SD) were calculated for quantitative variables. A χ^2 test was performed to compare categorical variables. Analysis of variance was performed to estimate the size of the association between parents' features and total scale scores. Statistical significance was set to a p-value lower than 0.05. Statistical analysis was performed using IBM® SPSS Statistics software version 22.0.

Ethical issues

The study was conducted by the principles of the original Declaration of Helsinki and subsequent amendments. Written informed consent was obtained from all participants. Data were stored and managed in accordance with current Italian legislation on data protection. Data were collected and analyzed in anonymous and aggregated form. The Institutional Review Board of the hospital where data collection was performed approved this study.

Results

A total of 128 parents were included in the study. Exactly half of the sample was female, and the average age was 33.43 ± 6.51 years; 31.25% (n=40) of the sample already had a first child. Those who had a history of previous abortion were 25% (n=32). Additionally, 3.12% (n=4) of parents experienced a previous death of their child. Concerning the type of delivery, 54.69% (n=70) of the sample experienced vaginal birth, 17.19% (n=22) of them underwent an elective cesarean, and 28.12% (n=36) underwent an emergency cesarean. Among the newborns, 14.07% (n=9) were twins. The average gestational age of newborns was 35.62 ± 4.31 weeks, whereas the average weight at birth was 2638.67 ± 968.83 grams.

Scale Proprieties

The five panelists judged face validity as appropriate. The content validity index (CVI) was 0.976 (Table 1). Item analysis was performed on all 16 items. The item-total correlation coefficients for the scale items were between 0.408 and 0.821. Cronbach's alpha was 0.926. Therefore, no item was removed from the translated scale (Table 2). The items of the final tool are reported in Table 3.

Tab 1 - Rating of the 16-items tool by five panelists; CVI: content validity index

Question	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Item CVI
1	✓	✓	✓	✓	✓	1
2	✓	✓	✓	✓	✓	1
3	✓	✓	✓		✓	0.6
4	✓	✓	✓	✓	✓	1
5	✓	✓	✓	✓	✓	1
6	✓	✓	✓	✓	✓	1
7	✓	✓	✓	✓	✓	1
8	✓	✓	✓	✓	✓	1
9	✓	✓	✓	✓	✓	1
10	✓	✓	✓	✓	✓	1
11a	✓	✓	✓	✓	✓	1
11b	✓	✓	✓	✓	✓	1
12	✓	✓	✓	✓	✓	1
13	✓	✓	✓	✓	✓	1
14	✓	✓	✓	✓	✓	1
15	✓	✓	✓	✓	✓	1
16	✓	✓	✓	✓	✓	1
CVI						0.976

Tab 2 - Item Analysis and internal consistency of the translated version; SD: standard deviation

N	Mean	SD	Corrected Item total correlation	Cronbach's alfa if item deleted
1	2.49	0.575	0.613	0.922
2	2.70	0.583	0.623	0.922
3	2.66	0.506	0.807	0.917
4	2.93	0.257	0.502	0.926
5	2.84	0.365	0.715	0.921
6	2.93	0.257	0.554	0.925
7	2.68	0.546	0.821	0.916
8	2.70	0.462	0.693	0.920
9	2.56	0.529	0.672	0.921
10	2.66	0.551	0.799	0.917
11	2.94	0.301	0.408	0.927
12	2.09	0.620	0.697	0.920
13	2.19	0.585	0.642	0.922
14	2.67	0.549	0.714	0.919
15	2.37	0.573	0.429	0.928
16	2.53	0.614	0.666	0.921
Total scale score			41,95 ± 5.58	
Alfa di Cronbach			0.926	

Legend: *SD - standard deviation.*

Table 3 - Items of Italian version of the Scale of Parental Participation in Care: Neonatal Intensive Care Unit

N.	**ITEM**
1	Il genitore comunica con il personale sanitario
2	Il genitore pone domande riguardo l'assistenza ed il trattamento di suo/a figlio/a
3	Il genitore è disponibile a partecipare ad addestramenti erogati nella Terapia Intensiva Neonatale
4	Il genitore desidera visitare il/la proprio/a figlio/a
5	Il genitore desidera avere contatto fisico con il/la figlio/a (accarezzare, tenere le mani, ecc…)
6	Il genitore usa termini affettuosi con suo/a figlio/a
7	Il genitore desidera tenere in braccio il/la figlio/a
8	Il genitore prova a calmare il/la proprio/a figlio/a (cullandolo, cantando, ecc…)
9	Il genitore è attento a posizionare il/la figlio/a in una posizione comoda e consona
10	Il genitore partecipa all' alimentazione del figlio/a
11a	La mamma è disposta ad allattare al seno (per le madri)
11b	Il papà supporta la mamma affinché il figlio/a riceva latte materno (per i padri)
12	Il genitore partecipa alle cure igieniche del figlio/a
13	Il genitore si accorge di qualsiasi peggioramento nelle condizioni generali del figlio/a
14	Il genitore desidera eseguire il contatto pelle a pelle o desidera partecipare alla Kangaroo care con suo figlio/a
15	Il genitore supporta suo figlio/a durante procedure dolorose
16	Il genitore esterna le proprie emozioni e i propri pensieri.

Tool Scores according newborns' characteristics

There was no statistical difference between the average total score of the scale across mothers and fathers. Parents of first children reported significantly greater participation in care (p= 0.007), compared to their counterparts. At the same time, previous deaths (p = 0.014) and abortion (p= 0.039) emerged as early barriers to parental participation in care. Difference emerged according to the type of delivery with a lower participation by those underwent emergency cesarean (p < 0.001) (Table 4).

Total scores of the scale according to newborns' characteristics.

The average scores obtained by the parents about the medical devices placed on their children at the time of the survey were detailed in Table 5. We found that the greater the criticality of the child, the lower was the participation in care by the parents. Parents of children who underwent high-frequency ventilation (p < 0.001), tracheal tube (p<0.001), and arterial catheter (p = 0.016) reported significantly lower participation in care. Furthermore, the parents of children undergoing phototherapy, which does not allow for the free manipulation of children, also reported lower scores (p = <0.001), with respect to their counterparts.

Table 4 - Mean Scores according sample's characteristics

Characteristics		Average ± SD	P Value
Parent			
Mother		42,75 ± 4,85	0.103
Father		41,14 ± 6,16	
First Child			
	Yes	42,83 ± 4,31	0.007
	No	40,00 ± 7,38	
Previous abortions			
	Yes	40,19 ± 6,65	0.039
	No	42,53 ± 5,08	
Deceased children			
	Yes	35,25 ± 5,90	0.014
	No	42,16 ± 5,46	
Delivery			
	Vaginal	42,83 ± 5,49	
	Elective Cesarean	43,77 ± 2,68	0.001
	Emergency Cesarean	39,11 ± 6,10	
Twins			
	Yes	41,68 ± 3,16	0.826
	No	41,99 ± 5,91	

Legend: *SD - standard deviation.*

Table 5 - Mean Scores according medical device placed on children

	(N) Average ± SD						P Value
Device	Yes			No			
Peripheral venous access	(77)	42,87	± 5,17	(51)	40,55	± 5,93	.021
Caval epicutaneous catheter	(16)	40,31	± 4,60	(112)	42,18	± 5,69	.212
Umbilical venous catheter	(64)	39,61	± 6,48	(64)	44,28	± 3,12	< .001
Continuous infusions	(110)	41,37	± 5,73	(18)	45,44	± 2,59	.004
Arterial catheter	(8)	37,38	± 3,96	(120)	42,25	± 5,55	.016
High flow nasal cannula	(20)	43,35	± 5,18	(108)	41,69	± 5,64	.222
Non Invasive Ventilation	(8)	39,25	± 5,12	(120)	42,13	± 5,58	.159
Tracheal tube	(36)	37,61	± 6,70	(92)	43,64	± 3,98	< .001
High frequency Ventilation	(10)	35,10	± 5,93	(118)	42,53	± 5,17	<. 001
Gastric tube	(54)	39,52	± 5,55	(74)	43,72	± 4,93	< .001
Cerebral Function Monitor	(6)	41,17	± 4,75	(122)	41,98	± 5,64	.728
Bladder catheter	(10)	37,90	± 3,78	(118)	42,29	± 5,58	.016
Temperature probe	(57)	38,58	± 5,94	(71)	44,65	± 3,42	< .001
Phototherapy	(22)	35,50	± 6,54	(106)	43,28	± 4,31	< .001
CO_2 sensor	(32)	36,44	± 6,16	(96)	43,76	± 3,97	< .001

Legend: *SD - standard deviation.*

Discussion

The Italian version of the PPCS: NICU is composed of 16 items, which is similar to the original scale[8]. No items were eliminated during the cross-cultural validation of the scale. The Cronbach's alpha coefficient of 0.926 reflects a strong reliability of the instrument. This scale can be used within the Italian NICUs to detect the level of parental participation in neonatal care and highlight those situations of need that require health education interventions to improve the process of caring for their newborns. Parents who have experienced previous abortions obtained a lower score than those who have suffered the loss of a previous child. These results can be related to the fears and insecurities of the parents resulting from their past experience. According to the type of birth, the parents who obtained a lower score are those who underwent emergency caesarean; this represent an unscheduled and disrupting surgical event they are often not prepared for, thus subjected at a higher risk of insecurities and need for support. Also, when a baby is admitted to NICU, periods of separation may result, and depending on the mother's physical health, these periods can be significantly long. The impact of separation from the child may reflect a reduction in mother-child interactions[12].

There was a statistically significant difference between those who already had a child, and those who gave birth to their firstborn; notably, this latter group reported higher scores compared to those who already had this experience. Indeed, the poor availability of babysitting services for other children may represent a barrier to parenting in NICU, as described in a previous study[13]. Furthermore, this difference could be attributed to the restricted visiting policy due to COVID-19 regulations that have reduced the times of visits and stays of parents with hospitalized newborns. We observed how greater parental participation in care is detected in the presence of minimally invasive or commonly used devices in the NICU setting, such as a high-flow nasal cannula, epicutaneous venous catheters, and the presence of continuous infusion. Lower participation in care was detected in the presence of invasive devices and instruments typical of a critical condition, such as the presence of the tracheal tube, arterial catheter, and high-frequency oscillatory ventilation. The only exception is represented by phototherapy, which negatively influences the participation in care despite being a non-invasive device, but this could be linked to the peculiarity

of this instrumentation which does not allow the mobilization of the child in the parents' arms. Implementing the PPCS: NICU in neonatal care may help promoting an early detection of parents in need of support, and may provide important information regarding which medical device aids most and influence parental participation in neonatal care, being able to intercept and educate parents already at the time of placing the specific devices on newborns.

Limitations

As reported in a previous study[9], there is no perfect translation technique, and multiple methods would have probably ensured higher accuracy. However, the sample size complies with the suggestion to follow lower minimum ratios between participants and items (5:1 or 10:1)[14].

Conclusions

The present study demonstrates that the translated tool shows high reliability and could be used in the context of Italian NICUs to assess the degree of parental participation in neonatal care, allowing early identification of critical issues by parents in the care of newborns admitted in NICU. The issues found in newborn care can be the subject of targeted health education interventions, aimed at empowering parents and making them independent in the common care activities and parenthood of their children. The systematic use of the tool could index parents based on their characteristics, being able to predict which categories need more support and health education. At the same time, it could predict which parents will need support based on the medical devices placed on the newborn.

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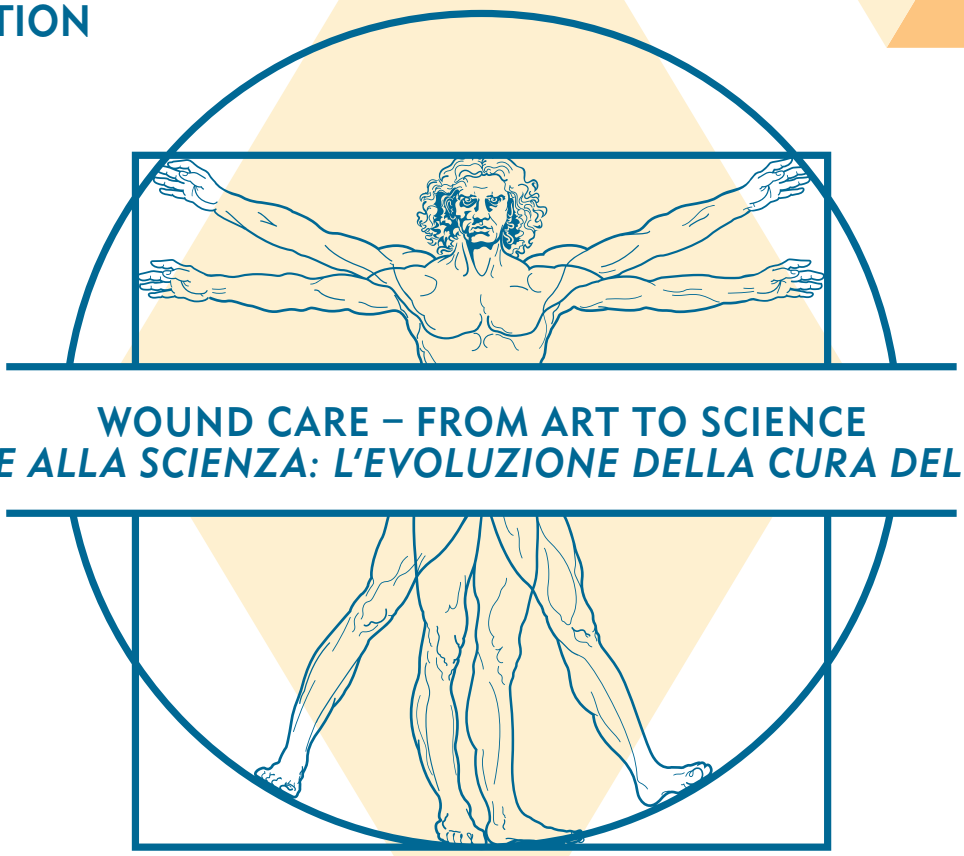

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Abstract

Introduction: The priority in critical patients is to find a vascular access. The most used access is the peripheral venous access, but when its placement goes wrong or is difficult, the literature recommends implementing intraosseous (IO) access as a valid alternative. The IO access is a rapid, reliable and a relatively safe method. Despite the recommendations, IO access is rarely used when indicated. The objective of this study was to evaluate the critical points of the IO procedure, positioning time, percentage of success at first attempt in simulation and, in according to obtained outcomes, checking of the procedure inclusion within university programs.

Material and methods: A sample of 84 people was recruited; among them 44 were students attending the third year of the Degree Course in Nursing of the University of Turin (site of Asti) and 40 nurses from intensive care unit and emergency ward of Cardinal Massaia Hospital of Asti. A short lesson about IO access took place, followed by a practical demonstration. Subsequently, the IO access insertion performance and difficulty perceived were evaluated. Statistical analysis was performed by means of inferential and descriptive bivariate analysis.

Results: The average value of the performance "IO access insertion" was 12.2±1.22 (average of the assigned points by the sample). The average difficulty perceived was 1.65±0.42, and mainly found in "selection of the correct point of insertion" with a value of 2.64±0.87, "needle placement" with a medium value of 2.35±1.02 and "medication" with a value of 2.0±0.94. Average execution time of IO access and needle placement were 73.3 and 36.1 seconds, respectively. Finally, the success rate at the first attempt was 72.6%.

Discussion: The IO access execution time, for the complete procedure and for the needle placement only, was below the 3 minutes. Among nurses and students, data of the success of the procedure show significant results, but the difference between subgroups is still lower than expected considering

the results of the statistical analysis about procedure success, execution time and error percentage. Most critical issues were found in the retrieval of area of insertion, whereas the most difficulty perceived was on reference point selection, correct needle placement and medication. The procedure may become subject of teaching in the University.
Conclusion: The study evaluates the possibility of the IO access use, by underlining how is necessary a training about it. The principal reason of 'non-use' of this device is the disinformation of healthcare professionals. The results seem to underline the importance of a possible integration of IO access technique in the programs of Degree Nursing Course and post-base course. This may improve nursing in emergency situations and therefore, patient outcomes. When healthcare staff training is possible, periodical refresh is particularly recommended in order to maintain the acquired skills.

Keywords: IO Access, Simulation, Teaching, Nursing student.

Introduction

Intraosseous (IO) access is a technique that uses blood vessels inside the epiphyseal medullary space of long bones, with the aim of handling an emergency situation when the retrieval of a venous access, is necessary to support vital functions, is not possible in any other way[1]. Drugs, crystalloids, colloids, blood products, contrast media administration and collection of blood samples are also possible via IO access.

Notably, IO access in critical patients with severe hypotension seems to have a higher success rate compared to a traditional venous access; hence, IO access should be considered an alternative priority[2,3]. However, despite the literature underlines that IO access may be easily learnt by the healthcare staff, this procedure is still scarcely used[2,4,5].

In a randomized study, a sample of 182 patients in cardiac arrest with a venous access was investigated. In 91% of cases, IO access was inserted at first attempt, compared to an unsuccess rate of 43% for the venous access. In another study, IO access was significantly fast to insert (49 seconds) compared to the venous access (194.6 seconds). Therefore, there is evidence that IO access can be obtained rapidly and with lower attempts in critical situations, compared to the venous access[6,7]. In another study, Clemency et al., (2017) 19 compared the IO and venous access during the return of spontaneous circulation (ROSC) after cardiac arrest. The findings demonstrated that the IO access approach wasn't lower than the venous access; moreover, IO access had a 100% success rate for the first insertion attempt, and therefore greater than the venous access (70-74%)[8].

The Consortium for the IO access in healthcare practice recommends that this insertion techniques and its relative management should be always embedded in University programs for the healthcare students. In 2009, the Infusion Nurses Society declared that the nurses needed specific training to maintain certified skills about the optimal use of IO access and recognition of the complications related to its use[9].

The main anatomical sites of insertion in adults are tibia, and humeral or femoral head, whereas proximal or distal tibia should be used in pediatric patients[2]. The literature underlines how an IO access should be used in emergency situations in case of double failure in venous access placement, after 90 seconds if Glasgow Coma Scale is below 3, cardiac arrest, severe respiratory failure, shock, epilepsy, and intoxications during which an immediate antidote administration is needed[1]. Generally, IO access should not be used in patients with bone diseases such as osteogenesis imperfecta, osteomyelitis, fractures, previous failed attempt of IO access insertion in the same bone, and recent orthopedic surgery[10,11].

The objective of this study was to evaluate the critical points of the IO access procedure, placement time, difficulty perceived, and success rate at first attempt in a sample of Nursing Degree students and emergency nurses. Information about procedure time and success rate of IO placement access would promote evidence on its utility in critical situations and emphasize the possibility

to introduce the IO access procedure as a teaching subject in Degree Course programs.

Materials and methods

Sample

A non-probabilistic sample of 84 people was recruited as part of an observational prospective monocentric study from November to December 2021; among them, 44 participants were students attending the third year of Degree Course in Nursing of the University of Turin (site of Asti) and further 40 participants were nurses from intensive care unit and emergency ward of Cardinal Massaia Hospital of Asti (Table 1). All the participants voluntarily joined the study, after giving verbal and written consent. Students attending the first and the second years of the University and non-critical area nurses were excluded.

Study procedure

The sample was stratified in students and nurse's groups, then further divided in groups of variable size (7-10 learners), by splitting them into "students" and "nurses". The last few were analyzed in term of who had "work experience" and "already having experience of IO access placement". All the groups received a frontal lesson about IO access which lasted about 30 minutes, followed by a practical demonstration.

Peyton method[12], composed by four phases, was implemented. In the first phase, name demonstration, participants observed at normal speed the performance of the procedure carried out by an expert. In the second phase, named deconstruction, the technique was shown at a slower pace and broken down in parts. In the third phase, named formulation, learners could ask questions about the procedure. In the fourth and the last one, performance, participants independently performed the IO access and received appropriate feedback.

The outcomes evaluation consisted of two parts. The first one was the completion of a 13-item check list, derived from infusional solutions and drugs administration via IO access elaborated by the Helicopter Emergency Medical Servuce (HEMS) (Table 2). The final score of this checklist ranges from 0 to 13 points. In the second part of the evaluation, participants had to refer the perceived difficulty experienced during the IO access placement with a 5-point Likert scale (1= no difficulty; 2 = a little; 3 = enough; 4 = a lot; 5= max difficult) for all the 13 HEMS items. Medium time for the whole procedure and only for needle placement were detected.

A pork femur coated by a synthetic leather was used for the anatomical model. Technique simulation was done by a EZ-I0G3® drill and two Teleflex® needle sets of different size (AD needle set 25mm – LD needle set 45mm).

Data collection and analysis

Data were registered on Microsoft EXCEL® and then analyzed with Jamovi®. Descriptive and inferential statistical analysis were carried out. An explorative analysis of quantitative variables was performed, through the computation of main summary indices (media, standard deviation, and range). Absolute frequencies and percentages were used for qualitative variables. Then, bivariate analysis was carried out in order to evaluate the possible association between quantitative variables. A correlation matrix was constructed to evaluate the relationship among quantitative variables. An inferential parametric and non-parametric analysis was also performed to evaluate significant statistical differences between the two groups (students and nurses).

After normality and homogeneity of the data was verified with Shapiro-Wilk and Levene's test, respectively, we carried out reliability testing by confronting parametric (Welch's t) and non-parametric (Mann-Whitney's U) data.

Ethical committee consultation was not deemed necessary because the study was performed by means of an anatomical model and with the consent of the participants. Data were collected anonymously and in accordance with the Italian legislation.

Results

The overall average value of the *"IO access placement"* performance was 12.2 (SD±1.22, range 8-13). Students' average value of *"IO access placement"* was 11.9 (SD±1.42, range 8-13), whereas the average value for the nurses' was 12.6 (SD±0.69, range 11-13). Crossed performance data between the two groups showed a statistically significant correlation ($p < 0.003$). In the portion of the sample which already experienced IO access insertion, average result was 12.3 (SD±0.91, range 11-13), whereas the average value obtained by their counterpart was 12.2 (SD±1.26, range 8-13). Correlation between these two groups was not statistically significant.

An average value of 12.6 (SD±0.74, range 11-13) in performance was foundamong those who already had an experience of IO access insertion, whereas

for those who never had the experience was 12.1 (SD±1.25, range 8-13). This difference was not statistically significant.

Pearson's index between the *"years of work experience"* and insertion performance was 0.92 and not statistically significant ($p < 0.001$). The relationship across *"years of work experience"*, *"work experience in critical area"* and insertion performance was also no statistically significant.

About *"IO access insertion"*, related to the difficulty perceived, an average value of 1,65 in the Likert scale was obtained (SD±0.42, range 1-3,15); a higher difficulty was found in: (I) *"selection of the correct insertion/reference point (E1)"* with a medium value of 2.64 (SD±0.87, range 1-4); (II) *"needle insertion (E7)"*, with 2.35 points (SD±1.02, range 1-5), and (III) *"medication (E10)"* with a value of 2.0 (DS±0.94, range 1-4).

The average difficulty perceived by the students was 1.72 (SD±0.40, range 1-2.62) and was not found in E1 (2.79 SD±0.87, range 1-4), E7 (2.40 SD±0.98, range 1-4) and E10 (2.06 SD±0.91, range 1-4). In the "nurse" group, the average difficulty perceived was 1.56 (SD± 0.45, range 1-3.15), as evidenced in E1 (2.44 SD±0.84, range 1-4), E7 (2.28 SD± 1.09, range 1-5) and in E10 (1.92 SD ±0.99, range 1-4).

The average time for IO access placement was 73.3 seconds (SD±18.6, range 46-160); 72.2 seconds were obtained for the students' group (SD±15.3, range 47-114), whereas 75.7 seconds were obtainedfor the nurses' group (SD±22.2, range 46-160). Data about "time" crossed with groups did not show a statistically significant relationship.

The average time of needle placement (ΔT) was 36.1 seconds (SD±9.29, range 18-67), of which 36 seconds were obtained for nurses (SD±12.4, range 17-79). ΔT data crossed with both groups did not show a statistically significant correlation.

The nurse group carried out the technique with lower mistakes; for some items the average value exhibited the same results as in E2 (100%) and in E13 (100%), compared to E4 (100% vs 90%) and in E10 (98% vs 93%); instead, lower mistakes occurred in the students group.

The phase of IO access in which there were more difficulties was E7 (64-80%), particularly, the group student exhibited difficulties in E7 (64%), E8 (89%) and E10 (89%) whereas the nurse group exhibited them in E7 (80%). Success rate at first attempt in the whole sample was of 72.6% (n=84), 72.7% in the student group (n=44) and 72.5% in the nurse group (n=40).

Table 1. Sample characteristics.

	Total (n)	**Students**	**Nurses**
Male (%)	60	12	16
Female (%)	24	32	24
Età	28,4 (±8,38)	24,4 (±5,25)	34,3 (±8,51)

Legend. *M, mean; SD, standard deviation.*

Chart 2. IO access procedure of the Helicopter Emergency Medical Service (HEMS)

E1 – Insertion point selection – correct reference
E2 – Disinfection and skin preparation
E3 – To prepare the drill with the appropriate needle
E4 – To handle the drill
E5 – Needle pre-insertion
E6 – Drill activation
E7 – Needle insertion
E8 – To remove the drill and the spindle
E9 – Reflux test
E10 - Medication
E11 – Lidocaine flush
E12 – Physiological solution flush
E13 – Start infusion

Table 3. Results of the evaluation of passages of the HEMS, difficulty perceived and insertion time.
Legend: SD: standard deviation; IQR: interquartile range.

	Age	Difficulty tot	Difficulty media	E tot	T Tot	ΔT	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
Mean	28.6	21.5	1.65	12.2	73.7	36.1	2.64	1.13	1.54	1.56	1.73	1.46	2.35	1.61	1.42	2.00	1.38	1.37	1.32
Median	27.0	21.0	1.62	13.0	72.0	36.0	3.00	1.00	1.00	1.00	2.00	1.00	2.00	1.00	1.00	2.00	1.00	1.00	1.00
SD	8.38	5.50	0.42	1.22	18.6	10.2	0.87	0.43	0.63	0.68	0.70	0.70	1.02	0.73	0.63	0.94	0.60	0.60	0.56
IQR	10.0	7.00	0.54	1.00	24.3	13.0	1.00	0.00	1.00	1.00	1.00	1.00	1.25	1.00	1.00	2.00	1.00	1.00	1.00
Minimum	20	13	1.00	8	46	17	1	1	1	1	1	1	1	1	1	1	1	1	1
Maximum	59	41	3.15	13	160	79	4	3	3	4	4	4	5	4	3	4	4	4	3

Discussion

In Italy, the formative programs of the Degree Course in Nursing are regulated by the Ministerial Decree n.270 of 20/04/21[13] which includes the hours of tuition in class and laboratory to acquire gestural skills, in addition to training.

In the first two years, acquisition of technical expertise is planned for oral, subcutaneous, intravenous and aerosol administration.

Within the medical and critical areas of nursing teaching modules, particular attention is paid by teachers about the retrieval of peripheral venous access. In emergency, endovenous ways assures rapidity of the effect, especially when the patient conditions are deteriorating[8,9]. However, the peripheral access technique largely depends on the patients' vascular heritage and their clinical conditions[14]. This difficulty increases during a cardiac arrest. It is evidenced that the chance of finding a venous access in a pediatric patient with cardiac arrest after 3 minutes is 17% for peripheral access, 77% for central venous access, and 83% for IO access[15,16]. This confirms the difficulty of ensuring an endovenous access in emergency situations and shows that IO access may be an optimal solution. Also, another study confirms that the spped of needle placement in adult patients ranges from 32 to 50 seconds, with a success rate from 79,5% to 97,8%, according to the infusion technique (manual or semiautomatic)[17].

Even if a difference among different retrieval techniques was not found in this study, the average IO access insertion time was less than 3 minutes; therefore, the obtained results are reasonably in line with the literature[8,9,17]. Considering the average time of complete procedure (i.e., until the beginning of the infusion), the time spent was less than 3 minutes. Considering the different levels of expertise, the literature evidences that the skills significantly affected the IO access insertion time[15,18]. As with regard to the success rate of the performances considered in the study, the data show statistically significant results between students and nurses, but the observed difference on success rate and error placement is lower than the expected[7,8,9]. This result may be due to the facility of the technique execution and the ease of use of the EZ-IO device used in this study, as supported by the literature[2,19,20]. Even if the sample had lower success rates than other authors, average insertion times seem to be shorter[15,21,22].

The difference in the setting may also have affected the success rate; in fact, many authors have used simulation corpses that certainly made the scenarios more realistic. In this study, several difficulty during insertio were found due to the use of a portion of the anatomical model. Therefore, use of a complete human model to promote the correct view of anatomical references is recommended.

According to the literature, a significant number of participants have limited experience and knowledge about IO access and this surely affects its frequency and use, even in the context of appropriate performance[19]. The perceived difficulty about the selection of the reference point, the correct needle placement and the subsequent medication is comparable with the literature; thus more attention on these factors during the training is advisable[15]. We did not find a significant correlation between "years of work experience" and IO access outcome; this can be due to the characteristics of the sample, where in fact, most of the interviewed nurses had less than 5 years of work experience.

Considering that we obtained data that are fairly similar to those coming from the literature, IO access training may be feasible in less than 5 hours. In this study, the theory lesson were limited to 30 minutes, so that the remaining time could be used for practical exercise[15,19,23,24]. Another reflection that arises is that this training can possibly be integrated within Degree and post-based Degree courses.

Conclusion

The study allows to confirm how the IO access can be rapid, safe, and reproducible by Degree Course students and nurses, after adequate lessons and trainings. It will be useful to understand what kind and how many professionals have to be trained about placement, management and removal of and IO access. Moreover, the certification of the teaching and skills maintenance should be necessary, as well the creation of guidelines and protocols to secure the IO access use. Future studies in the future are needed to verify the use of this technique at work and the knowledge and skills of the professionals. Given the emergency situation during which the IO access is used and the advantage that the nurses of critical patients would obtain, the introduction of this technique in university and post-base programs are necessary.

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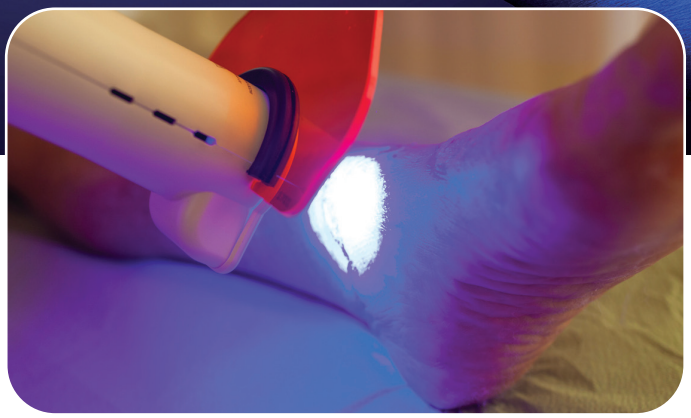

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Scoping Review

Interruptions during therapy preparation, administration and monitoring while caring for the paediatric population: a scoping review

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Abstract

Background: Nurses perform many actions during the therapy process. However, the time dedicated to the process of drug therapy is very important for the children's safety; indeed, assessing the factors that can impact on the whole therapy process represent an important objective.

Aim. The primary aim of this scoping review is to investigate the factors associated to the interruptions of the therapeutic process (i.e., preparation, administration and, monitoring) for inpatient paediatric population. The secondary aim is to investigate possible implementation strategies to prevent interruptions and, thus, prevent medical administration error (MAE).

Materials and method: A scoping review was performed, following the PRISMA guidelines using the keywords *'paediatric'* AND *'interruption to therapy administration/preparation/monitoring'*. The search was performed during April 2022.

Results: Out of 242 records retrieved, 8 full text studies met the inclusion criteria and therefore, included in the review. the included full texts were grouped according to the stage of the therapy process they addressed. The majority of the studies adopted an observational design and highlighted how interruptions can occur due to environmental reasons and people. All the included studies focused on the "negative" consequences of interruptions, although, they reveal that the nurses constitute a resilient profession, because they can implement adaptive strategies in extremely disruptive environments and organizations. However, development of

new strategies to reduce interruptions during the therapy process is highly needed to guarantee the safety of the children. **Conclusion:** we recognize that prioritization is an ongoing challenge, indeed the first step is a cultural change in order to implement new organizational and clinical models where "positive" disruptions are allowed and the "negative" ones are blocked or prevented.

Keywords: Interruptions, Therapy Process, Paediatric, Children.

Background

The therapeutic process consists in a series of related interactions that consecutively alter the nature of the relationship between therapist and patients, in paediatrics children and their parents[1]. In fact, the basic data includes the totality of interactions from the first hello to the final good-bye; thus, we cannot consider only the single act of administration as the whole process. Instead, the therapeutic process as a totality can be broken down in small parts in order to maintain better technical control over the process, and that's the most challenging part for clinicians and health professionals involved.

Nurses are the health professionals who play a pivotal role in the therapeutic process. The time dedicated to the treatment process is very important for the children's safety; indeed, evaluating the factors that can impact positively or negatively on the process represents an important objective[2]. Additionally, the paediatric context is characterized by its complexity and the presence of various actors, given the presence of the parents. Also, medication administration to infants and children requires complex calculations, individualized dosing and the use of off-label medications which has limited prescribing information available[3].

The preparation and administration phase are composed by very intimate actions that require a high level of attention; however, unfortunately, they are usually subjected to several interruptions. By interruption, we refer to an event that breaks the continuity of a primary task and causes a switch of the attention from the primary task, as the disrupting new event requires an immediate response; however, while the healthcare professional deal with this event usually continues the preparation of the primary task[3,4].

Generally, nurses operate in an unpredictable healthcare environment that is also characterized by involvement of significant cognitive load. Indeed, being interrupted and able to be multitask imposes heavy cognitive loads on individuals, with the result of impairing the attention and leading to errors[5]. Interruptions and multitasking are considered a source of concern that negatively affect the memory of the individual[6]. Healthcare professionals have to memorize several elements at the same time; however, when an interruption occurs there might be an important loss of information previously stored[7]. In the literature, Westbrook et al., (2010) reported a significant dose-response relationship between interruptions, and procedural failures and clinical errors in medication administration within the hospital settings, with an increase of 12.1% in procedural failures and an increase of 12.7% in clinical errors for drug administration. Their results showed that the more interruptions the nurses received, the greater the number of errors. Furthermore, the severity of errors worsened when the numbers of interruptions increased within a single drug administration process. In particular, the risk of a patient experiencing a major clinical error was doubled in case of four or more interruptions[8].

In 2000, the report *"To err is human"* of the Institute of Medicine already identified interruptions as a likely contributing factor to medical errors[9]. Thus, reducing interruptions in therapeutic process means reducing both the frequency and severity of errors.

However, medication errors are frequent in the health care environment[10]; for instance, an error is reported every five medication dosages[11]. In addition, the literature highlights that infants and children may have a three times higher risk of medication errors than the adults[12,13]. Accordingly, as reported in the study of McPhillips et al., (2015)[14] the authors noticed that the proportion of errors involving children under four years was higher than expected, compared to older children.

Interruptions can cause therapy errors resulting from near missing to a real damage, with potential long-term negative effects on the lives of the patient, their relatives and healthcare professionals, also leading to high financial burdens on the healthcare

system[15].

Nurses, compared to the other healthcare professionals, are more subject to interruptions during the preparation and monitoring of the therapy[16]. Additionally, an integrative review of the literature[17] investigating interruptions in paediatric nurses' work and the systems issues related to interruptions in nursing work environments. The literature is generally focused on interruptions that are strictly linked to therapy administration, and medical error administration (MAE). In the study of McGillis et al., (2009) information on sources, types, and causes of interruptions are provided and, interruptions resulted both very common in clinical practice and a main cause of the therapy errors; indeed, during one of the phases of therapy process, interruptions have negative effects on the performance and can affect the quality of the decision-making process, generating frustration, stress and job dissatisfaction[18].

Despite some interruptions are unavoidable during the care process and provide healthcare professionals with the necessary information (e.g., monitor alarms that report abnormal vital signs, or a parent who raises doubts about the child's therapy), it is worth to underline that interruptions of a complex process, such as the therapy, can significantly decrease attention, memory and perception[19].

Most studies focus on errors in the phase of therapy administration; it is interesting to analyse how the interruptions contribute to therapy errors, understand if there is a classification and what are the main containment strategies implemented. Thus, the primary aim of the present scoping review is to search for all the factors associated to interruptions of the therapeutic process (i.e., preparation, administration and, monitoring) for inpatient paediatric population. The secondary aim is to investigate possible implementation strategies to prevent interruptions and, thus, MAE.

Materials and Methods

The team involved in this scoping review was composed by children's nurses, an ergonomist, and a research nurse, who discussed the relevance of the research question and agreed on the research strategy and the inclusion criteria. Medline (through Pubmed) and Google Scholar databases were searched. A scoping review was performed following the PRISMA Extension for Scoping Review checklist (PRISMA-ScR)[20]. The research question was formulated according to the PEO (Population, Exposition and Outcomes) methodology as reported below:

P: paediatric population

E: interruptions during preparation, administration and, monitoring of therapy

O: any kind of outcomes

Keywords used were 'paediatric' AND 'interruption to therapy administration/ preparation/monitoring'. The search was performed between April 1, 2022, and April 30, 2022, (EP, KEA, AC). Keywords were the following: 'pediatr*' AND 'patients' safety' AND ('interruptions to therapy administration' OR 'interruptions to therapy preparation' OR 'interruptions to therapy process'), resulting in 242 records, that has been screened for titles and abstracts according to inclusion and exclusion criteria.

Inclusion criteria were indexed articles, written in English and Italian language, with a clear exposition of the objective concerning interruptions in clinical practice, in full text, and published not earlier than 2010. This timeframe was adopted because it was starting from 2010 that the proble of interruptions became increasingly relevant and studied internationally. The exclusion criteria were articles that faced business interruptions developed by healthcare professionals other than nurses, and book chapters or letters to readers.

First, the title of the article was read followed by a careful reading of the abstracts to verify whether the inclusion criteria had been met. Titles and abstracts of retrieved papers were screened for inclusion criteria by two independent reviewers (EP and AC). Full texts were then downloaded and screened for inclusion and exclusion criteria. A data-charting form was jointly developed by two reviewers to determine which variables to extract. Two reviewers independently completed the form for data extraction and discussed the results. Data extracted was type of patients and setting, study design, results, and outcomes considered (see Table 1).

	Authors (year) country	Study title	Patients and setting	Study design	Results	Outcome
1	McGillis Hall (2010) Canada	Interruptions and pediatric patient safety.	Nurses during the shift while performing routine tasks. Four units in a tertiary-care pediatric academic-affiliated teaching hospital participated in this study.	Mixed method (observative and focus groups)	A total of 5,325 interruptions were observed in this study; of these, 1430 (26.9%) took place on the surgical unit, 1373 (25.8%) on the complex medical and surgical unit in critical care and 1206 (22.6%) on the medical unit.	Most interruptions to nursing practice that were observed in this study could have negative consequences (88.9%); almost two thirds of the interruptions resulted in a delay of the original work that the nurse was engaged in when interrupted, whereas just over one quarter of the interruptions resulted in a loss of concentration or focus from the original work.
2	Lacey Colligan and Ellen J Bass (2012) USA	Interruption handling strategies during paediatric medication administration.	Nurses of the Division of Neonatology who followed case studies on discontinuation strategies.	Mixed method: interviews, simulation, observation	Four case studies of medication administration highlight four interruption handling strategies (engaging, multi-tasking, mediating, blocking) Nurses prioritize task execution based on both risk and workflow efficiency assessments. Specific interruption handling depends on both task and experience related factors.	Paediatric nurses have developed sophisticated strategies to manage interruptions and maintain patient safety and work efficiency during medication administration. To support a more resilient healthcare system, interruption management strategies should be supported through process, task support tools and education.
3	Junwen Zhao et al (2019) China	Interruptions experienced by nurses during pediatric medication administration in China: an observational study.	Convenience sample of pediatric registered nurses working in the 2 reference hospitals (general tertiary hospitals classified as three-A level)	cross-sectional observational study.	The frequency of interruptions in pediatric settings during medication administration is high, with 241 interruptions out of a total of 255 observations. The most common sources/causal factors of interruptions during medication administration included the environment, caregivers, physicians, other staff nurses, and communication issues.	Study findings indicate the importance of creating an interruption-free environment for safe medication administration to improve the quality of patient care. This study found that interruptions during medication administration lead to medical errors.
4	Fenella Gill, et al. (2011) Australia	An exploration of pediatric nurses' compliance with a medication checking and administration protocol	The study was conducted in an Australian metropolitan paediatric tertiary hospital:for the first partwas used a questionnaire, and for the second part a focus group, that consisted of in-depth interviews group setting.	Mixed method study (descriptive observational study + focus group)	Both from the interviews and from the focus group it emerges that the interruptions affect the application of the protocol of the correct management of the therapy.	Actions are needed to minimize both prescribing and administration errors.

5	Dadlez NM et al (2017) USA	Ordering Interruptions in a Tertiary Care Center: A Prospective Observational Study.	The study was conducted at an urban tertiary care academic children's hospital on 3 non–intensive care inpatient units. All 3 units are medical-surgical floors; Inpatient orders for all patients are primarily placed by pediatric interns, residents and physician assistants.	prospective observational study	Sixty-nine structured observations were conducted with a total of 414 orders included. The interruption rate was 65 interruptions per 100 orders during rounds, 55 per 100 orders in the afternoons and 56 per 100 orders in the evenings. The majority of interruptions were in-person (n =144, 61%). Interruptions from overhead announcements occurred most often in the mornings, and phone interruptions occurred most often in the evenings (P= .002). Nurses initiated interruptions most frequently. Attending physicians and fellows were more likely to interrupt during rounds, and coresidents were more likely to interrupt in the evenings (P=.002).	The majority of interruptions were in person or by phone and overall the individuals initiating the interruption most commonly were nurses. The vast majority of these interruptions were non-urgent. Interventions to decrease interruptions during medication administration have reduced the number of interruptions by 43% to 75%. Interventions have included marked no-interruption zones in medication preparation areas, having nurses wear a visible symbol to indicate the process of medication administration time, designation of specific protected medication rounding time, and scripting for nurses to defer interruptions.
6	Lépée C. et al. (2012) France	The use of a consultant-led ward round checklist to improve paediatric prescribing: an interrupted time series study.	The study was conducted on two paediatric wards, in London. Care was provided by 28 nurses, six medical consultants and 18 doctors in training posts (ranging from 4 months to over 10 years' experience in paediatrics). Consultant-led ward rounds were conducted every day clinically appropriate and clearly written and to perform medication reconciliation. The pharmacist did not routinely attend consultant ward rounds. This study was a service development project and NHS ethics approval was not required.	interrupted times series design with a concurrent control measurement.	In this study data were collected on two types of error: technical prescription writing errors ("technical errors") and prescribing errors involving clinical decision making ("clinical errors"). The primary outcome measure was the rate of technical errors. After adjusting for trends in the quality of the medical notes, the average baseline technical error rate was 6.9 % with a significant increase of +0.2 % per half-week (p00.002). After introduction of Check and Correct, there was a significant drop of −5.0 % (−37.7 % relative decrease; p<0.0001) in the technical error rate, with the error rate level remaining stable during the remaining post-intervention period. There was no significant auto-correlation, and the final model accounted for 60.4 % of total variance.	The adoption of a Check and Correct checklist for local paediatric use resulted in an improvement in technical errors in prescription writing. There was no change in the prevalence of clinical errors, as might be expected, since the checklist focuses on technical aspects of prescription writing. The control data also showed an improvement, but the positive impact of Check and Correct on technical errors remained after accounting for this. A Check and Correct prescribing checklist, adapted for local paediatric use, led to an improvement in the quality of prescription writing.

7	Stratton Karen M. et al. USA 2004	Reporting of Medication Errors by Pediatric Nurses	Staff nurses of 300 units in 50 hospitals currently in progress.	Cross-sectional study	Usable responses were received from 284 RNs (227 adult nurses and 57 pediatric nurses) from 33 acute care units (27 adult and 6 pediatric) in 11 hospitals in 2 states (40% response rate). Three hospitals were from a Midwestern rural consortium working for more than 10 years on quality management processes, the remaining eight hospitals were from urban areas in the Rocky Mountain region of the United States. Pediatric nurses estimated that 67% of all medication errors on their patient care units are reported. This finding is considerably higher than the 56% reported for all medication errors by adult nurses (p<.05).This report focuses on the responses from nurses on pediatric units. Analysis by type of unit was not performed because there were too few units of any particular specialty.with responses from adult units are used to enhance interpretation.	Findings from this study suggest that medication administration error occurrences are underreported. The overall average estimate of medication error reporting on pediatric units was 67%; Results of this study suggest that nurses working on pediatric units are more likely to report medication administration errors than nurses on adult units are.
8	Bonafide C. et al (2019) USA	Association Between Mobile Telephone Interruptions and Medication Administration Errors in a Pediatric Intensive Care Unit	Participants included 257 nurses and the 3308 patients to whom they administered medications.	retrospective cohort study	The overall rate of errors during 238540 medication administration attempts was 3.1% (95% CI, 3.0%-3.3%) when nurses were uninterrupted by incoming telephone calls and 3.7% (95% CI, 3.4%-4.0%) when they were interrupted by such calls1.21; 95% CI, 1.03-1.42; P = .02). Incoming text messages were not associated with error (OR, 0.97; 95% CI, 0.92-1.02; P = .22).	This study's findings suggest that incoming telephone call interruptions may be temporally associated with medication administration errors among PICU nurses. Risk of error varied by shift, experience, nurse to patient ratio, and level of patient care required.

Results

Out of the 8 items selected, four were from the USA, one from Canada, one from France, one from Australia, and one from China. In the following section we grouped the studies by the phases of the therapy process they dealt with, in order to analyse the issues linked to each phase. An overview of the studies divided on the basis of the therapy phases process is reported in Table 2.

Studies of McGillis (2010) and Colligan (2012) are focused on factors influencing the interruption management strategy choice[18,21]. The first one aimed to investigate the context of interruptions in nursing work through work sampling and focus groups with nurses in paediatric, acute care units in a teaching hospital in Toronto, Canada. An exploratory research design was used which involved observation of people in their natural working environment. Four units of a university children's hospital participated in this study. Overall, 5,325 interruptions were observed in the nursing work environment during the work observation study period. The observed interruptions were differentiated by source, cause, and type. The sources of interruptions to nursing work included the environment, other staff nurses, patients, family members, the individual nurse herself/himself, physicians, other health care providers, support staff, and others. Factors within the work environment itself accounted for a third of the interruptions, overall. Most interruptions to nursing practice that were observed in this study could have negative consequences (88.9%), whereas few could lead to a positive outcome (11.0%).

The results of this scoping review highlight the complexity of nursing work environments in paediatric settings and how this can have a direct influence on interruptions of nursing work and related outcomes in terms of patient safety. In general, the work environment and other nurses are the predominant sources of interruptions. Examining the results of the study together it is evident that these environmental and interruptions by fellow nurses take the form of intrusions and distractions, at a time when the nurse is engaged in assessments, procedures or documentation of patient care. From the point of view of patient safety, the interruptions are often negative, with delays and loss of concentration or attention.

While the study conducted by Colligan et al., (2012)[21] used semi-structured interviews in paediatric settings to identify the types of interruptions and understand the strategies for managing interruptions. This article introduces a taxonomy of interruptions and provides illustrative examples based on empirical observations and interviews. The complexity of interruptions and the ability of the nurses to handle them are highlighted. The question is asked how it is possible to create a system in which 'positive' interruptions are allowed and 'negative' interruptions are blocked. The first change required is cultural while recognising that prioritising tasks is a constant challenge. Lepee's study focused on the prescription phase[22].

A Check and Correct prescribing checklist, adapted for local paediatric use, led to an improvement in the quality of prescription writing. In this study, data were collected on two types of errors: technical prescribing errors ('technical errors') and prescribing errors involving clinical decision-making ('clinical errors'). The primary outcome measure was the rate of technical errors. After adjustment for trends in the quality of medical notes, the average technical error rate at baseline was 6.9% with a significant increase of +0.2% per half week. After the introduction of Check and Correct, there was a significant decrease of 5.0% in the technical error rate, and the level of errors remained stable during the remaining post-intervention period.

Other authors are focused on the phase of therapy administration[23,24]. The study design is cross-sectional observation. Forty-three nurses were observed for more than 180 shifts of therapy administration. an evaluation form previously validated by the authors themselves was used, which includes information on frequency, sources, and outcomes of interruptions. The frequency of interruptions in paediatric settings during medication administration is high. According to the observational data, this study found that nurses working in general paediatric units reported a higher frequency of interruption than nurses in neonatal intensive care units. This could possibly be due to the fact that a general paediatric unit has patients with age ranging from 0 to 18, resulting in the large variety of medications and medication dosages[25]. Therefore, relevant medication management strategies are required to develop and ensure a decrease in the frequency of interruptions in general paediatric units. The most common sources/causal factors of interruptions during medication administration included the environment, caregivers, physicians, other staff nurses, and communication issues. Study findings were consistent with previous research, with a third of interruptions experienced

by nurses attributing to the work environment[18]. In their retrospective cohort study, Bonafide al.[24] set out to investigate whether mobile phone call interruptions and incoming text messages are associated with subsequent medication errors among nurses in paediatric intensive care units (PICUs). In this cohort study it was shown that incoming calls on nurses' institutional mobile telephones occurring in the 10 minutes before medication administration were significantly associated with increased risk of error. The risk was higher during night shifts and among nurses with fewer than 6 months' experience, and it also varied by nurse-to-patient ratio and level of patient care required. This study's findings suggest that, although communication-related interruptions cannot be eliminated, interventions to reduce the frequency and adverse consequences of interruptions should include consideration of time of day, nurse experience, nurse to patient ratio, and level of patient care required.

This study of Gill et al. (2011)[26] was developed to explore nurses' self-reported compliance with the hospital protocol for the checking and administration of medications. First, a questionnaire was designed to collect data from nurses on their drug administration practices and to identify issues related to compliance with existing hospital protocol for the on their drug administration practices. he results of part one identified reported non-compliance with the medication administration protocol. The findings did not, however, account for why noncompliance occurred. In the second part, focus groups were organised to explore the following open questions. This study identified discrepancies between the medication administration protocol and nursing practice. Unclear aspects of the protocol, inadequate role modelling, and inappropriate perception of risk contributed to noncompliance. The concerning results beg the question of compliance with medication administration protocols in other settings. To effectively reduce medication errors, it is imperative that we understand what leads to those errors. Additional research across settings is necessary to achieve that aim.

In the prospective observational study conducted by Dadlez et al.[27] 1-hour-long structured observations on morning rounds and afternoons and evenings in the resident workroom. The primary outcome was the number of interruptions per 100 orders placed by residents and physician assistants. We assessed the role of ordering provider, number, type and urgency of interruptions and person initiating interruption. The interruption rate was 65 interruptions per 100 orders during rounds, 55 per 100 orders in the afternoons and 56 per 100 orders in the evenings. The majority of interruptions were in person. Efforts should be made to decrease interruptions during the ordering process and track their effects on medication errors.

In the descriptive study of Stratton et al.,[28] surveyed a convenience sample of paediatric and adult hospital nurses regarding their perceptions of the proportion of medication errors reported on their units, why medication errors occur, and why medication errors are not always reported. In this study, which focuses on paediatric data, paediatric nurses indicated that a higher proportion of errors were reported (67%) than adult nurses indicated (56%). The medication error rates per 1,000 patient-days computed from actual occurrence reports were also higher on paediatric (14.80) as compared with adult units (5.66). The results of this study indicate the need to improve the accuracy of medication error reporting by nurses and to provide a hospital environment conducive to preventing medication errors from occurring. Reasons that medication errors occur included both system factors such as staffing and medication administration procedures as well as patient needs and condition. The most important step in reducing medication errors appears to be in knowing the accurate rate of occurrence.

	Interruption regarding therapy preparation	
Authors (year)	**Who?**	**What?**
Lépée C. et al. (2012) France	Prescribing physicians	Implementing a checklist to an improvement in the quality of prescription writing
	Interruption regarding therapy preparation	
Authors (year)	**Who?**	**What?**
McGillis Hall (2010) Canada	Nurse, patient, family member, self, physician, other health care provider, support staff	Environment
	Interruption regarding therapy administration	
Authors (year)	**Who?**	**What?**
Lacey Colligan and Ellen J Bass (2012) USA	Paediatric nurse	Handling strategies during paediatric medication administration
Junwen Zhao et al (2019) China	Caregivers, physicians, other nursing staff	Working environment, communication issues
Fenella Gill, et al. (2011) Australia	Paediatric nurse	Discrepancies between the medication administration protocol and nursing practice.
Dadlez NM et al (2017) USA	Nurse, physician, physician assistant	Interventions to decrease interruptions during medication administration
Stratton Karen M. et al. USA 2004	Paediatric nurse, nurse	Reporting of medication administration errors.
Bonafide C. et al (2019) USA	Nurse	Association between mobile telephone interruptions and medication administration errors
	Interruption regarding therapy monitoring	
Authors (year)	**Who?**	**What?**
N/A	N/A	N/A

Discussion

As specified in the introduction, the primary aim of the present scoping review is to search for all the factors associated with the interruptions of the therapeutic process (i.e., preparation, administration and, monitoring) for inpatient paediatric population. While the secondary aim is to investigate eventual implementation strategy to prevent interruptions and, thus, MAE. Eight studies were included because they dealt with at least one of the phases of the therapeutic process. Results were classified based on the three different phases of therapeutic process: preparation, administration, and monitoring, since there isn't a similar partition in literature; those factors were further divided according to whether they were in person or made by environment. Interruptions concerning prescription drugs are dealt with by Lépée C et al.[22] In this study, we particularly appreciated how the introduction of a check list significantly increases the quality of the prescription moment.

Interruptions regarding therapy preparation were reported by five authors, three from the USA, one from Canada and another one from Australia. In the 2010 mixed method study from Canada the various factors causing interruptions were in person and environment, resulting in a delay of the original work that the nurse was engaged in when interrupted and a loss of concentration. In the 2012, mixed method study from the USA, Colligan et al.[21] reported that the principal causes of interruptions in their study were the patient's mother, colleague, ward clerk, without citing factors associated with the environment. They found that paediatric nurses have developed sophisticated strategies to manage interruptions and maintain patient safety and work efficiency during medication administration. Gill et al. (Australia, 2011)[26] don't specify the type of factors causing interruptions, asserting that they affect the application of the protocol of the correct management of the therapy. Dadlez et al. (USA, 2017)[27] found that the majority of interruptions were in person or by phone and overall, the individuals initiating the interruption most commonly were nurses, in addition to the fact that the vast majority of these interruptions were non-urgent. They developed various interventions, including marked no-interruption zones in medication preparation areas, having nurses wear a visible symbol to indicate the process of medication administration time, designation of specific protected medication rounding time, and scripting for nurses to defer interruptions. All those interventions allowed them to reduce the number of interruptions by 43% to 75%.

The part of the administration of the therapy is more studied than that of the prescription and preparation. This turns out to be the last stage in which an error can be intercepted. At this stage the nurse is certainly more exposed to interruptions: doctors, nurses, patients. To minimize interruptions, actions have been introduced such as tabard, user education, continuous staff training. These actions have had a significant impact described on areas such as that of the adult.

For the paediatric field we do not have any article that described how the implementation of these tools has contributed to the reduction of interruptions and consequently to therapy errors. The studies analysed on the part of the administration in the paediatric field are for the most part observational. The sample studied is represented by the nurses who work in the settings involved. Objectives of studies such as that of Zhao et al.[23] are describe the frequency, the source of the interruptions during the administration of therapy. No validated measurement instruments were used but only instruments created based on the context analysed. Only in the study of Zhao et al.23 a previously validated tool was used for a previous study conducted by the authors in 2016[29].

Nurses' response to outages is resilient as suggested by the article by Colligan et al.[21] It shows a first attempt to classify the interruptions and through four exemplary cases it shows how the response of nurses is a priority to the requests. Prioritisation of tasks depends on assessment of clinical and situational workload factors. All tasks are not created equal; some interruptions present a high priority task that must be addressed immediately and other interruptions present tasks that can wait. Paediatric nurses indicate that task-specific factors and personal experience affect their choices of interruption handling.

The process of administering therapy for close and extremely complex actions can lead to the occurrence of errors while you are interrupted especially by phone. The results of the study conducted by Bonafide et al.[24] suggest that phone call interruptions were associated with probabilities significantly increased to make mistakes especially in the presence of nurses with minimal periods of experience in the clinical field. Surprisingly, for interruptions regarding therapy monitoring no data were extracted, as no study referred to this specific phase.

Finally, from the articles analysed, however, we can deduce that the work of health professionals

to reduce the rate of interruptions must focus on 3 levels: (I) behavioural level: first of all, we must change our habits. Wrong behaviours are the greatest cause of interruptions during the activities of health workers (pharmacological process, handover patient identification, electronic file management, food distribution, etc.); (II) organisational level: we need to rethink our activities and procedures. We work in complex systems where activities and processes are hardly ever thought through with respect to human factors. Interruptions find their breeding ground within unorganised processes with delays and confusion in the performance and conduct of tasks; and (III) structural level: this is the most complex level in terms of time and resources where only knowing the improvement objectives is possible to plan future implementations. Poor design of hospital environments can generate latent criticalities that are difficult to eliminate once implemented. Good room design (natural and natural and artificial lighting, technologies, temperature and humidity temperature and humidity, air quality and space acoustics) can prevent interruptions, improving the well-being of operators and patients.

Conclusions

The therapeutic process is a very complex and articulated process, thus, educational interventions are needed to prevent errors and complications due to any interruption of the process. Clearly, as already stated by systematic reviews and meta-analysis there is no 'one-size-fits-all' solution in reducing medication administration errors, however the scoping review was focused on the interruptions to the process rather than the consequent errors. Indeed, identifying the causes of the interruptions and classifying them into evitable or not could be the starting point. Then, assessing the potential error linked to any type of interruption may allow a better management of the therapy process when taking care of children. In fact, in paediatric settings, efforts should be made to reduce interruptions to the minimum permissible during the various critical activities; in order not to create isolated areas such as aircraft cockpits, but structured and organised systems that respond to interruptions[27]. Moreover, there is a lack of validated tools for detecting interruptions in paediatric settings, thus further studies and researches are needed.

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