The Night
in the ICU

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THE NIGHT IN THE ICU

They say that in the world of the intensive care unit (ICU), there is no night. It can be qualified as a lesser day, but not really as a night. The hustle and bustle may be slower, patient flow and activity may be less, conversations may be negligible, and the staff on duty may be limited, but patient care continues, alarms are in place, and the usual "rhythm" of intensive care remains. You can still hear the beeping of medical equipment and see light emit through flashing monitors.

Nights in the ICU may not always be that eventful, but for the staff on duty, the expectation and alertness that is required remain the same as it would during the day. It is impossible to know, in the ICU, when things might change, and when a seemingly quiet night dramatically transforms into blaring alarms, footsteps of nurses rushing to the patient, and a frantic search for a senior doctor because of a life-threatening emergency. This can happen. Emergencies can strike critically ill patients any time, and that is probably what makes the Night in the ICU so daunting. Fear and anxiety are felt most during the night. The world sleeps but the Intensive Care Unit doesn't.

Our cover story, **The Night in the ICU**, explores what happens when night falls in the intensive care unit. What do physicians, nurses and patients feel, and how do they handle the anxiety, the fear and the challenges in the ICU at night?

Clara Similowski, Virginie Souppart, Nancy Kentish-Barnes and Elie Azoulay talk about the Night Falls in the ICU and the changing realities for patients, families and the ICU team. Andrea Meli, Silvia Coppola and Davide Chiumello provide an overview of the multiple characteristics of life overnight in a critical care ward.

Elif Özcan and Diederik Gommers outline design strategies to improve alarm management in the ICU while Roberta Roepke and Otavio Ranzani review the challenges and considerations of the decision making processes during night shifts in the ICU.

Julie Darbyshire and Paul Greig discuss the impact of sleep deprivation and fatigue on patients and staff in the ICU while Joanna Poole explores nocturnal activity in the ICU and the impact of night work on healthcare professionals.

Karoline Schoknecht and Iris Meyenburg-Altwarg present a nursing perspective and discuss the tasks and the stress and strains during night duty in the ICU. Tamera Sanchez-Sedekum and Toufic Khairallah propose strategies to help engage the night shift and enhance job satisfaction, commitment and retention of staff.

Our contributors also touch upon the COVID-19 pandemic as it continues to plague the world. I present an overview of the current situation in Europe and where we stand with COVID-19 while Fernando Zampieri highlights the importance of keeping best practices in critical care during COVID-19. Ahmed Ezzat and Francesca Rubulotta question whether COVID-19 is a black swan that the world will eventually accept and adjust to with time.

The world of intensive care is very different from the rest of the hospital. The night in the ICU can be tough for patients, ICU staff and families. The stress, the anxiety, the fatigue, the confusion, the complex decision-making, the sleep deprivation, exhaustion, depression, errors, burnout .. all and much more are routine during a night shift in intensive care. Our contributors have presented an overview of the challenges and have also outlined strategies to better manage and cope with these challenges.

As always, if you would like to get in touch, please email JLVincent@icu-management.org.

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COVID-19 MANAGEMENT

POINT-OF-VIEW

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Is the Severe COVID-19 Over in Europe?

Is the worst over? Have patients most at risk already been affected and died? Or has the SAR-CoV-2 virus mutated to a less severe form? Where exactly do we stand with COVID-19?

Undoubtedly, the COVID-19 pandemic has been a terrible experience - worse than expected for many worldwide. As we follow the COVID-19 situation, there is a tendency to focus on the many deaths as a way to quantify its severity. However, it is difficult to know exactly how many deaths are really due to COVID-19, and how many may in fact be caused by underlying health conditions, be the result of decisions to limit life-sustaining therapy, or be associated with shortages of essential treatment facilities or resources. Nevertheless, the large excess mortality when the year 2020 is compared to previous years, even years with higher death rates as a result of severe influenza epidemics, is undisputable; in Belgium excess mortality compared to 2019 was close to 30% over the period March to May, but has now returned to usual values.

The measures taken in Europe, including nationwide and local lockdowns, isolation of infected patients and their contacts, and social distancing, were unavoidable and essential to control the spread of the virus. The UK initially, and Sweden more recently, have paid the price of relying on the development of collective herd immunity. We now know that barely 10% of the population has antibodies to SARS-CoV-2 and are concerned that this natural protection anyway does not seem to last for very long.

The question everyone is asking now is therefore, "how long is the virus going to stay with us?" To answer this, we

> **❝ it was frustrating when some leaders considered that SARS-CoV-2 infection was just like a bad flu, because this was clearly incorrect ❞**

need to see how the disease is evolving. There are three key approaches for this:

1. **By evaluating the number of infected cases or the proportion of positive tests from all tests taken.** However, the implications of a positive polymerase chain reaction (PCR) test in a healthy individual are unclear. Moreover, increased testing will result in more positive cases being identified, so that comparisons over time are difficult.

2. **By counting the number of COVID-related deaths.** However, as discussed earlier, this measure is also difficult to interpret. For example, should an elderly person in a residential home who dies with some respiratory symptoms (as is often the case in such individuals), but who was not tested for SARS-CoV-2, be included in the coronavirus mortality statistics or not? Or someone with cardiac problems and a past history of myocardial infarction who dies minutes after hospital admission from cardiogenic shock but who had tested positive for SARS-CoV-2 on arrival - is this a cardiac death or a COVID-19 death?

3. **By counting the number of hospital admissions, and intensive care unit (ICU) admissions in particular.** This is the index I personally have followed most closely (and not only because it is of course also our focus of professional interest): after all, when we first went into lockdown, the main reason evoked in most countries was to avoid overwhelming our ICUs. In Belgium, we have hardly seen any COVID-19 patients in our ICUs for two months now and other European countries have had a similar experience. Indeed, we had a national video conference a couple
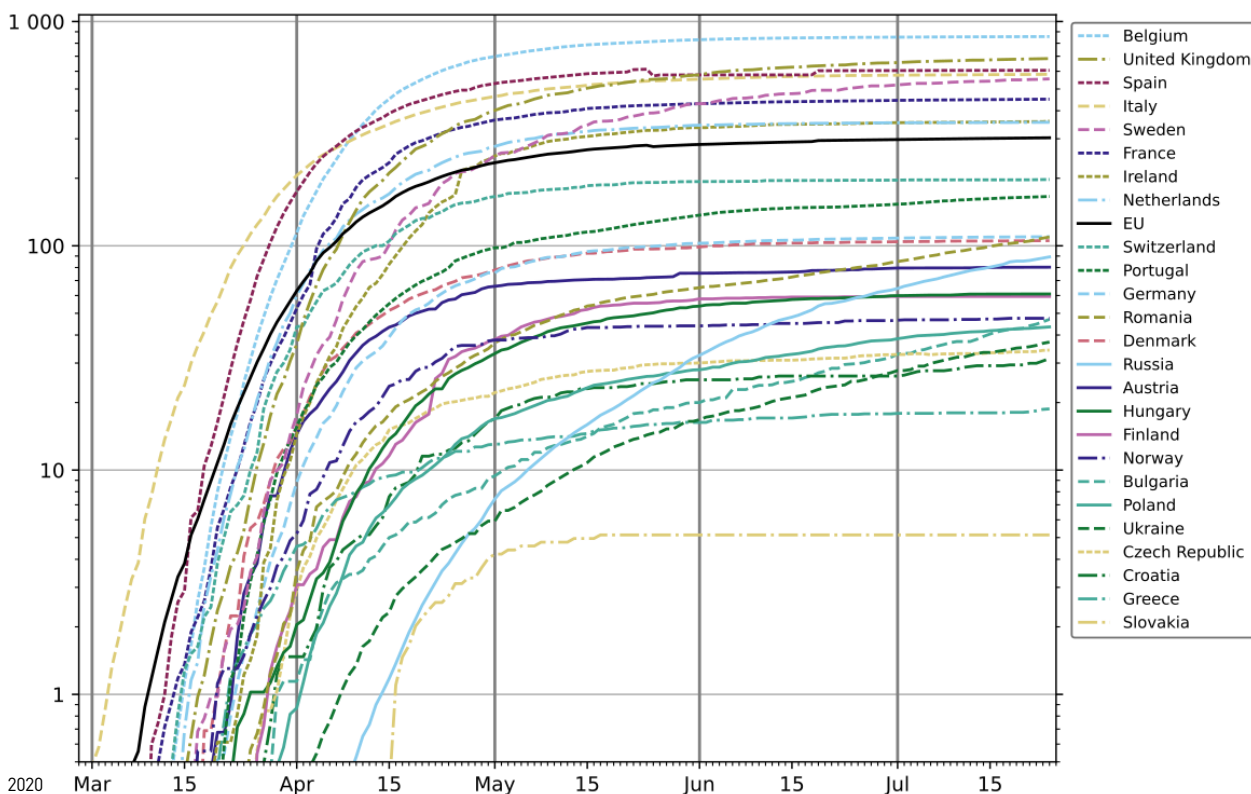
Figure 1. Deaths by COVID-19 in European countries per 1 million inhabitants. Last update: 2020-07-24. Source: ECDC, Eurostat.

of days ago about the progress of our clinical trials for COVID-19 treatments in Belgium and there was a mixture of happiness and relief because of the small number of severe cases in our ICUs and concern that it was now becoming impossible to enroll patients in the various ongoing clinical trials that have not yet included sufficient patients for valid conclusions to be drawn. At the end of the meeting, people were almost "hoping" for a second wave so that we would be able to finish the studies and by so doing help others! Research has also been hindered by the hydroxychloroquine situation, with people declining participation in randomised trials because they preferred to be sure that they received hydroxychloroquine… but that is another story.

Another interesting feature is that although the total number of cases is not declining very much, is in fact increasing a little in many European countries, the number of severe cases remains low. Is this because many of the patients most at risk have already been affected and died? Or has the virus mutated to a less severe form? Or is there some other explanation?

The COVID-19 story is clearly not yet over in Europe, but the number of severe cases and deaths is now low across the continent. At the early stages of this pandemic in Europe, it was frustrating when some leaders considered that SARS-CoV-2 infection was just like a bad flu, because this was clearly incorrect. But, there is some suggestion that this may now be the case…. the worst may be over. So, can we stop preventive measures, celebrate and get back to normal? No, we need to remain prudent, follow the statistics, and try to better understand how the pandemic is evolving while continue

to try and identify effective treatments and develop a vaccine. ■

Key Points

- It is difficult to know exactly how many deaths are really due to COVID-19.
- The UK initially, and Sweden more recently, have paid the price of relying on the development of collective herd immunity.
- Although the total number of cases is not declining very much, is in fact increasing a little in many European countries, the number of severe cases remains low. Why is that?
- It is now becoming impossible to enroll patients in the various ongoing clinical trials that have not yet included sufficient patients for valid conclusions to be drawn.
- Research has also been hindered by the hydroxychloroquine situation, with people declining participation in randomised trials because they preferred to be sure that they received hydroxychloroquine.

COVID-19 and the Potential Effects on the Cardiovascular System

COVID-19 affects the myocardium and myocarditis and cardiac injury is a common condition among hospitalised patients. Landiolol, a new ultra-short acting, intravenous most β1 selective blocker, can help reduce inflammation and provide therapeutic benefits.

Influenza, bacterial pneumonias, respiratory infections and viruses are well-established factors that cause cardiovascular disease (CVD) and are associated with high CVD risk (Madjid et al. 2020; Cowan et al. 2018). On the other hand, the underlying CVD disorder itself contributes to the increased incidence and severity of the infectious disease, thereby resulting in deteriorating the clinical outcome (Madjid et al. 2020).

COVID-19 and Cardiovascular Diseases: The Role of Inflammation

COVID-19 as a severe acute respiratory syndrome appears to affect myocardium and cause myocarditis. Cases of random autopsies have shown infiltration of myocardium by interstitial mononuclear inflammatory cells. Cases of severe myocarditis with reduced systolic function after COVID-19 have also been reported. Studies of cardiac biomarkers suggest a high prevalence of cardiac injury in hospital patients. Myocardial injury is most likely associated with infection related myocarditis and/or ischaemia and is an important predictor in COVID-19 patients (Madjid et al. 2020).

A report by Shi et al. (2020) demonstrates that cardiac injury is a common condition among hospitalised patients with COVID-19 and is associated with higher risk of in-hospital mortality. Of 416 patients, 10.6%, 5.3% and 4.1% had coronary heart disease, cerebrovascular disease and heart failure respectively. A total of 57 patients died, 42 of them had

cardiac injury. The mortality rate increased in association with the magnitude of the reference value of hs-TNI (high-sensitivity troponin I).

Guo et al. (2020) reported results about related factors and outcomes in 187 patients hospitalised with COVID-19 (43 died, 144 discharged). In this study, 35% had underlying CVD (hypertension, coronary heart disease or cardiomyopathy) and 28% showed signs of acute myocardial damage (defined as increased troponin T [TnT]). Mortality was significantly higher in subjects with high TnT compared to those with normal TnT levels (59.6% vs. 8.9%, respectively, P < .001). The investigators concluded that myocardial injury has a significant association with fatal outcomes in COVID-19 patients and is associated with impaired cardiac function and ventricular tachyarrhythmias. Inflammation may also be associated with myocardial injury.

Viral infections can cause acute coronary syndromes, arrhythmias and the development of heart failure. There are many mechanisms that cause the above, in particular the combination of important systemic inflammatory responses of the body plus localised vascular inflammation at the level of arterial plaque (Madjid et al. 2020).

COVID-19 Induces Arrhythmias

The abnormal systemic immune-inflammatory response of the body caused by the virus could further enhance the tendency to

develop arrhythmias, including malignant ventricular arrhythmias (Lazzerini et al. 2020). IL-6 in particular:

• Participates in myocardial injury, leading to tachyarrhythmias.
• Remodels the ionic channels of cardiomyocytes (immediate prolongation of QTc).
• Inhibits CYP450 and specifically CYP3A4, resulting in an increase of the bioavailability of QT-prolonging medicines (indirect prolongation of QTc).
• Causes hyperstimulation of the sympathetic system, increasing electrical instability of the heart, which results in tachyarrhythmias.

In addition, prolongation of QTc was observed in patients with high levels of C-reactive protein (CRP) (Lazzerini et al. 2020).

Landiolol and Reduction of Inflammatory Cytokines

Landiolol is a new ultra-short acting, intravenous most β1 selective blocker for the treatment of supraventricular tachyarrhythmias such as atrial fibrillation (AF), atrial flutter (AFL), and non-compensatory sinus tachycardia. Landiolol is a new kind of β1-blocker, and is a pure S-enantiomer molecule with a distribution volume of 0.3 l/kg − 0.4 l/kg. In a 70kg man, the fluids contained in his body are 42 litres, hence the volume of distribution of landiolol ranges from 21-28 litres. This is very important because landiolol does not store in tissues,

thus avoiding possible toxicities.

On the contrary, the volume of distribution of amiodarone is enormous, and variable (about 5000 litres in a 70kg adult). There are also concerns regarding toxicity with amiodarone (Alpert et al. 2014). In a study, landiolol presented minimal effect on the refractory period during action potential of a cardiomyocyte compared to esmolol which dose-dependently shortens the refractory period. This is because landiolol does not affect the Ca ion currents, therefore myocardial contractility is not affected (Shibata et al. 2011). This is clinically important when using landiolol in patients with cardiac dysfunction as per the guidelines (ESC 2016). Also, landiolol has a T1/2 of 4 minutes. It has a rapid start of action of 1 minute, with a short action duration of 10 to 15 minutes. It has a steady state at 15 minutes in continuous infusion and 2–5 minutes when a loading dose is preceded. CYP-independent metabolism is direct from pseudocholinesterases and plasma carboxylesterases. Excretion is carried out by the kidneys with 75% of the drug excreted within 4 hours and 99% within 24 hours (Domanovits et al. 2018). The metabolites of landiolol are inactive and the dosage of the drug is not affected by renal function nor does it affect renal function (Nasrollahi-Shiraz et al. 2016).

Compared to esmolol, landiolol has shown very high cardioselectivity (b1/b2-selectivity=33:1 vs. 255:1) (Iguchi et al. 1992). This translates to eightfold higher cardioselectivity for landiolol compared to esmolol. Unlike esmolol, landiolol has a limited impact on blood pressure and is shown to reduce heart rate without undesired drop in blood pressure (Krumpl et al. 2017).

In another study, where inflammation was caused by the infusion of LPS (lipopolysaccharides-endotoxin), the use of landiolol slowed its progression as measured by TNF-a, IL-6 AND HMGB-1 (High Mobility Group Box 1=indicator of inflammation progression). Landiolol also reduced heart rate by controlling sympathetic stimulation, without causing hypotension. The researchers conclude that landiolol may offer therapeutic benefit to patients with sepsis through its ability to inhibit the inflammatory response (Hagiwara et al. 2009).

A clinical trial published in 2011 by Sezai et al. (PASCAL Trial), suggests that landiolol hydrochloride may be an anti-inflammatory drug. Postoperative levels of IL-6, IL-8, and hs-CRP (high sensitive CRP) were significantly lower in patients who were treated by landiolol, suggesting that the anti-inflammatory effect of this drug might have reduced AF. Another clinical trial (PLATON Trial) published in 2015 in heart failure patients undergoing heart surgery found that patients treated with landiolol had significantly lower level of the inflammatory marker hs-CRP than control (no landiolol treatment).

Horikoshi et al. (2017) reported that perioperative landiolol administration suppressed the incidence of new-onset of AF as well as sinus tachycardia, and the plasma IL-6 elevation in patients undergoing oesophageal cancer surgery.

It is known that norepinephrine (NE) contributes to increasing levels of IL-6. Li et al. (2015) reported that NE is capable of inducing IL-6 generation in macrophages via b-ADR-ROS-NF-kB signal pathway. Yang et al. (2014) also demonstrated that stress-related hormone NE induced IL-6 expression in GES-1 cells. The induction was via the ß-adrenergic

receptor-cAMP-PKA pathway and mainly at the transcriptional level. Therefore, the administration of a beta-blocker supports the protection from the harmful effects of NE.

Landiolol's Cardioselectivity Favourable in Patients With COVID-19

In the heart where both β1 and β2 receptors are located, the binding of these receptors by catecholamines is associated with elevated heart rate (HR) and myocardial contractility, while in the arteries, veins and bronchi where only β2 receptors are located the binding of catecholamines causes dilation. This could be very useful for an athlete as he needs increased HR and contractility and greater dilation in the vessels to meet increased oxygen demands. However, for a patient with sepsis, it is important to reduce the HR in order to reduce oxygen consumption while maintaining contractility, as this can decrease stroke volume and reduce blood pressure. At the same time, it is necessary to maintain the binding of catecholamines to β2 receptors in coronary arteries and bronchi unaffected so that these tissues continue to be dilated and the patient continues to receive the maximum amount of oxygen, which would be affected by a beta blocker that has a β2 action (Sendon et al. 2004).

Landiolol is the first innovative drug for acute heart rate control for cardiovascular risk patients and offers a more advanced and improved treatment option.

Landiolol is marketed by AMOMED under the following brand names: Rapibloc®, Landiobloc®, Raploc®, and Runrapiq®. For more information regarding the product, please visit www.amomed.com. ■

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Keeping Best Practices in Critical Care During COVID-19

COVID-19 poses several challenges and has made it difficult to measure ICU performance. Sticking to evidence-based interventions can go a long way in improving outcomes and resource utilisation.

How it Started

Taking care of a COVID-19 patient comes with an initial surprise: there is no standard mindset to guide the physician's work before entering a COVID-19 patient's room. After some initial hesitation, most physicians have dubious feelings. It is a mix of both relief ("it is just another sick patient, I have treated people before") and fear ("what should I do next?").

There were few reports early on in the pandemic. Scattered information from "happy hypoxaemic" patients, coupled with suggestions that early intubation was of key importance, the fear of aerosols, the multiple suggestions that anticoagulation should be done due to an abnormally high number of thrombotic events and even other proposed pharmacological treatments (from hydroxychloroquine to tocilizumab, passing by corticosteroids and other drugs) appeared in discussions, forums and some case reports. They were sometimes demanded by patients and families and even politically propelled. This all contributed to shifting the discussion from keeping standards of care to a search of finding a single treatment that would halt the disease.

As soon as COVID-19 blew up in Brazil in May, I was reallocated to what we call a "routine intensivist" (an intensivist that goes almost every working day to the ICU) to a dedicated 10-bed COVID-19 ICU in my former teaching hospital (Hospital das Clínicas from the University of São Paulo). This large teaching hospital, built more than 50 years ago, became a dedicated COVID-19 hospital. Many ICU beds were created, peaking

close to 300. I was privileged to work under few resource constraints, but eventual drug shortages and irregular availability of some specific supports (such as continuous renal replacement therapy [RRT] and high-flow nasal catheters [HFNC]) were expected. Concerns were beyond patient care, including staff protection and wellbeing, and resource management.

How is my Unit Doing?

A constant concern of the intensivist is whether they are doing the right thing for their patients. In a scenario where ICU admissions are many and mortality is high, the impeding sense of despair is inevitable. Under normal circumstances, measuring and optimising ICU care is a long-term process, with trends in standardised mortality ratio and standardised resource use being tracked and adjustments being made (Salluh and Soares 2014; Rothen 2017; Zampieri 2020). This is impossible in a pandemic, let alone a pandemic of an unknown disease in a new ICU that has just opened, with a multidisciplinary team that never worked together before.

Traditional markers of performance seemed misleading. Crude mortality is not a useful parameter, specially if you are receiving patients late or only the sickest ones (which are eventually granted an ICU bed). Waiting for standardised mortality ratio and standardised resource use to become available was not feasible, because these measures take time and because they rely on well calibrated illness severity scores (which were unavailable; it was not to be expected that traditional illness severity scores, such as SAPS 3, would perform

well for a single disease) (Rewa 2018). Need for readmission is also problematic, because pressure for beds was constant and because you are discharging patients to a ward staff that is as inexperienced with COVID-19 as you. Length of mechanical ventilation is also cumbersome, because few data were available. Although this data should all be measured, they should not (and were not) interpreted as direct performance measurements in this situation.

Rational Implementation

The key to delivering best care was, once again, to develop and implement a routine that guaranteed a minimum evidence-based acceptable care. This is the key point: "minimum." It became clear that while we had few to no evidence on how to manage the COVID-19 disease, we had a good deal of evidence on how to manage patients with multiple organ failure, including respiratory failure. That became our focus in the new unit. Simply do what we know as supported by evidence and rest assured that, on average, we would be doing the best for most patients. We adopted the "zentensivist" approach with open arms (Siuba 2020). What a graceful surprise we had when we realised that we could do a lot by focusing in doing well what we knew and by being more patient and less reactive. Summarising previous evidence as you prepare for an unknown disease can be relieving for the staff and allows one to drift attention away for elusive therapies or magic bullets. A brief summary of what was known before the pandemic, caveats on applying evidence on COVID-19 considering resource

Concern	COVID-19 Imposed Challenges	Approach
Family meetings and definition of directives	Families were unable to visit patient. Interface with staff also compromised.	Daily calls. Video conferences whenever possible. Document all family contacts in charts.
Intubation timing	Concern on aerolisation with NIV and CNAF early in the pandemic. "Early" versus "delayed" intubation.	Use of NIV/CNAF under controlled scenarios (isolated room) (Iwashyna 2020) Intubation guided by ROX Index (Roca 2019) or by respiratory effort (tolerate hypoxaemia if no other organ failure).
Ventilator setting	Low and high elastance profiles expected to occur, with unknown ventilatory management differences at the time.	Mechanical ventilation set as for any other ARDS patient regardless of elastance (plateau pressure below 30 cmH$_2$O, tidal volume of 4-6 mL/kg), PEEP guided by PEEP table.
Sedation	Expected long duration of mechanical ventilation, with higher incidence of critical illness polineuromiopathy. Occasional shortage of drugs (including fentanyl).	Daily awakening followed by spontaneous breathing trial as soon as possible. Limited use of neuromuscular blockade outside first 48-72 hours.
Ventilator weaning	Unknown "optimal" extubation failure rate. Expected that patients would have difficult weaning. Absence of evidence of when it is safe to release tidal volume in these patients (and ARDS lato senso).	Encouraging spontaneous breathing trials regardless of PO$_2$/FiO$_2$ ratio. Allowed extubation even with low (below 120) PO$_2$/FiO$_2$ ratio if no delirium and/or instability For patients with delirium and hypoxaemia, discuss tracheostomy.
Pharmacological treatment (not corticosteroids)	Many drugs proposed to be effective, with unknown clinical benefit (lopinavir/ritonavir, nitazoxanide, hydroxychloroquine, azithromycin...).	Use limited to research protocols. Not used as routine care.
Corticosteroids	Concerns on prolonged viral shedding and risk of secondary infections in this population. Evidence on ARDS suggested benefit of dexamethasone for ARDS patients. Older evidence suggested benefit of corticosteroids for prolonged ARDS.	Use of dexamethasone assuming COVID-19 should not be different than other ARDS causes. Adopted RECOVERY dosage as soon as press release available (RECOVERY 2020).
Anticoagulation	Potential benefit suggested as many patients presented with active thrombosis. Unclear net benefit.	Use of prophylactic heparin for all patients if no contraindication. Monitor of deep vein thrombosis with sequential ultrasound. Use of heparin for patients with signs of disseminated intravascular coagulation.

Stress ulcer prophylaxis	Concern of higher risk of bleeding for patients under mechanical ventilation, receiving corticosteroids.	No routine use of proton-pump inhibitors as per SUP-ICU trial (Krag 2018).
Secondary infection management	The expected long ICU stay would pose these patients to higher risk of infection.	Adoption of a wait-and-see strategy (cultures and vigilance) for patients with signs of infection that are not unstable. Short courses of antibiotics. Removal of all unnecessary devices as soon as possible.
Renal replacement therapy	Incidence of acute kidney injury seemed high in critically ill COVID patients. Machine availability to initiate renal replacement therapy could be a limiting factor.	Use of renal replacement therapy only after failure of medical management of AKI (no early dialysis) Family meetings before initiation of RRT whenever possible.
Extracorporeal membrane oxygenation (ECMO)	Unclear if COVID-19 would be a disease that would benefit from ECMO (as apparently happened with H1N1) or not. ECMO may improve ARDS outcomes in some scenarios, but there were concerns on COVID-19, specially regarding circuit patency.	ECMO as a rescue therapy seldom considered. Contact and referral of ECMO team for selected cases.
Tackling adverse events	Expectation that patients would require prolonged ICU stay would pose them to cumulative risk for adverse events, such as device removal, infections from unnecessary devices, airway management complications, etc.	Debriefing after all adverse events to identify bottlenecks and opportunities to avoid future events. Use of fish-bone strategy. Avoid "blaming" culture.
Drug shortage	Due to high demand, it was expected that some shortage of critical drugs (sedation, neuromuscular blockades, antibiotics) could occur.	Discuss with pharmaceutics and establish a priori replacement for some critical drugs, e.g. (drug→ replacement): 1. Propofol → Midazolam 2. Fentanyl → Morphine 3. Cisatracurium → Rocuronium → Pancuronium 4. Ceftriaxone → Cefuroxime → Amoxicillin
Staff burnout	Carrying for severely ill patients for a prolonged period, under pressure, afraid of getting sick and underpaid seems the perfect recipe for burnout.	We knew it would occur. We also knew we could do little to nothing about the very roots of burnout.
Data collection and research	Hard to allocate staff for data collection and research in this scenario.	Allocate a data collector regardless of the scenario to avoid flying blind. Use data to encourage staff. Use research as an opportunity to improve care and increase the sense of value inside the unit.

Table 1. Adapting evidence and measuring processes of care during COVID-19.
AKI - acute kidney injury; ARDS - Acute respiratory distress syndrome; CNAF - high-flow nasal cannula; ECMO - Extracorporeal Membrance Oxygenation; NIV - non-invasive ventilation; PEEP - postive end-expiratory pressure; ROX Index - ratio of pulse oximetry/FiO$_2$
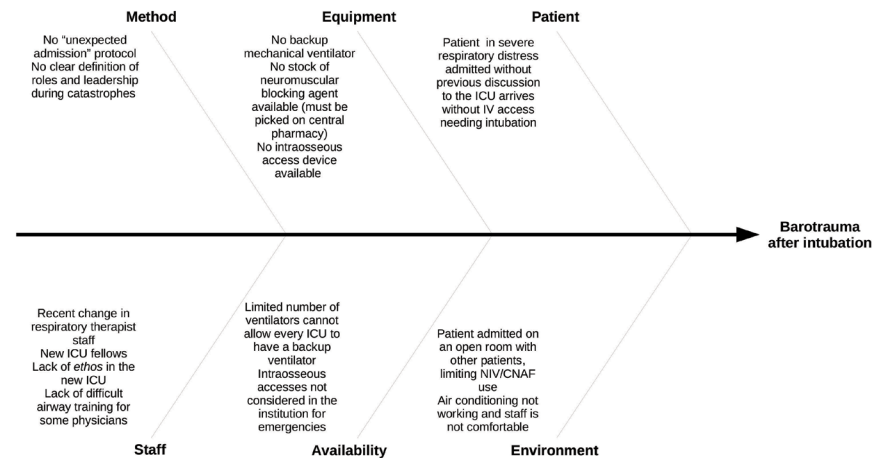
Figure 1. A fish-bone example of a fast-track approach to tackling an adverse event. Many contributors to the event can be approached and improved (such as lack of a clear protocol for unexpected admissions, need for a backup ventilator, among others). Other factors are structural and go beyond ICU walls and, therefore, may not be easily tackled. Some problems also have no immediate solution, such as lack of difficult airway training for all. This can be solved partially be arranging working scale in a way an airway proficient physician is always in-house.

optimisation and the proposed solution are shown in **Table 1**.

Improving patient safety also required us to establish a "tracking" algorithm for unexpected events. Tracing back the roots of a problem following a structured approach (like a fish bone diagram) can be helpful to find opportunities to perform simple interventions and, also equally important, to understand that not all adverse events can be completely solved solely by changing ICU behaviour. You have to accept that you cannot change everything and that some structural problems will prevail despite the best efforts. One example is shown in **Figure 1**, based on a real case experienced during the pandemic. Barotrauma may occur after intubation and it is tempting to attribute it to operator inexperience, improper airway management, poor sedation/blockade, exces-

sive bag-mask ventilation, etc. However, the root cause of the problem may be much more complicated and include a complex chain of events that are not limited to the ICU itself. Tracing these problems can not only help improve immediate aspects of care but also provide feedback to the institution and decrease staff burden or feeling of guilt.

Finally, we also anticipated that some outstanding success cases could be problematic. This seldom discussed aspect of medical care is entangled with the hot hand fallacy. Some interventions performed as an exception attempt to improve a very sick patient's condition would eventually be seen by staff as effective if the patient survived. This could result in widespread intervention use in other scenarios with unknown clinical benefit (generalisation bias). Situations like this would be (and were) inevitable.

When "off the grid" interventions seemed successful, one should temper their hardihood and calmly explain to staff that this was an exception, not a rule, and avoid creating new directions of protocol based on previous successful cases. Debriefing successful cases should be done with the same scrutiny as debriefing unsuccessful ones.

Final Remarks

The goal of any ICU remains the same, whether during a pandemic or not: produce survivors with the best quality of life possible at the fastest speed achievable by applying the most current evidence while using the smallest amount of resources. Sticking to evidence-based practices and reducing a hyper-reactive state allows one to remain focused on what is known and beneficial and may be able to improve both outcomes and resource utilisation. ∎

Key Points

- COVID-19 has resulted in significant challenges for doctors in intensive care.
- The search for a cure has shifted the discussion from maintaining standards of care to a search of finding a single treatment.
- Under normal circumstances, measuring and optimising ICU care is a long-term process but this becomes impossible during a pandemic.
- While we had few to no evidence on how to manage the COVID-19 disease, we had a good deal of evidence on how to manage patients with multiple organ failure, including respiratory failure.
- Improving patient safety also required us to establish a "tracking" algorithm for unexpected events.

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Is COVID-19 the Black Swan?

Nassim Taleb, in his book, "The Black Swan: The Impact of the Highly Improbable," describes the term Black Swan as a rare, unknown event, which with hindsight is rationalised. Taleb talks about the human tendency to always find simplistic explanations for unknown events, what he calls the Black Swan theory. Is COVID-19 a black swan?

Introduction

Physicians working with critically ill patients are exposed to emerging diseases and have been challenged relatively frequently in these recent years. Grumbles of chatter surfaced planning and managing Ebola, Severe Acute Respiratory Syndrome (SARS), Zika virus, H1N1 influenza and now coronavirus (COVID-19). In many ways, this portrayal was largely underestimated at its start at the end of 2019. Governments and Institutions such as the World Health Organization (WHO) saw no merit in panic, nor the need to acknowledge the sequelae in light of globalisation, commerce and aviation on spread at the beginning of 2020.

Writing from a British junior doctor's perspective, the virus did not attract enough global attention, nor the gravitas to its own title at the start. At face value, it appeared as yet another health-scare distant from the shores of Europe. Even then, thanks to human arrogance, pride and unawareness, the threat did not seem entirely real. By February, this latest unwelcome celebrity had become a household name, wreaking havoc within Italy. By now, the virus was worthy of a COVID-19 identity and much attention was drawn to Italy opting for

lockdown, using the military and police to enforce this seemingly undemocratic draconian measure. Two months later, more than 4 billion of the world's inhabitants are in some form of lockdown and nearly 600,000 global deaths and in excess of 18 million infected. The UK, as many other nations, has been in lockdown and thousands of NHS staff are redeployed and adapting, much quicker than in the past, to evolve into COVID-19 doctors, nurses, physiotherapists and the like.

The News and Redeployment

Leading up to the escalation of British measures, there was increasing front line discussion about the reality of the threat. Trusts had promptly disseminated campaigns to warn staff of what is to come to the United Kingdom. Doctors and nurses were essentially no different, nor immune to this virus and as a result several died in this pandemic. Study and annual leaves were cancelled and research suspended due to the closure of most laboratories and cancellation of conferences. Publicly, the Prime Minister, who would later check in to the Intensive Care Unit (ICU) at St Thomas' Hospital, essentially although more eloquently stated we have to ride this out and people will die, lots of them. Even, then this mismatch in public perception and that of NHS staff could not be greater. Frontline workers, which according to NHS reports were 70% represented by women, were now bracing for a tsunami. The epicentre was a few weeks away when

simulation and training started in a more systematic manner. Those few weeks of incubation period had after all fooled the world once before at the point of spread from China to Italy. The first patient was declared in Italy on February 20, and yet we identified a COVID-19 case at Imperial College on March 9, and he was admitted 10 days before isolation. There was a clear overlap in the timing and course of this disease confused by the discordance between the science and politics of a lockdown decision.

As an academic general surgical registrar, I would now be told I will not rotate to my next surgical placement and that my new multi-centred robotics project would be placed on hold until further notice. I would receive news of my redeployment to the intensive care unit (ICU), having rotated for four months through ICU in the past. The emotions at the time were those of excitement, purpose wrapped in fear, anxiety and concerns for my family, whom I could infect. Another feeling, commonplace amongst junior doctor colleagues is that of competence. All our working lives, we have been drilled into the merits of subspecialty, safety and working within limitations. Junior doctors have a duty to do no harm to the patients. The feeling at that point was that of being called up to go to war, where the rulebook was yet to be written and discovery was the only reality. Colleagues would cancel weddings, (myself included), vacations, and family visits. Doctors and nurses who were called

to work would move out of their family homes, and would send their pregnant wives away in fear of the unknown. Personally, my wife, a first year doctor elsewhere in the UK would be redeployed to a COVID ward a week earlier, despite their peak reportedly arriving a couple of weeks after the capital. She would experience three of her colleagues infected with COVID-19, only then to be informed she had been redeployed a second time to ICU.

Déjà vu in ICU

I was back in ICU, having never thought I would be required to use my skills and knowledge there. I had attempted to ensure I was fit tested for FFP masks and relied on the individual helpfulness of colleagues in ICU to show me the basics of ventilation usage. The emotions on the first day were those of apprehension and surrealism. Even as a clinician, COVID appeared all too distant, yet ICU was full of intubated patients. The handover was a reminder that no age group is immune, nor would a healthy background act as a guarantor against this invader.

It appeared all too different from surgery. The pace, smell, language - all appeared foreign. Having said that, an unspoken yet shared sentiment amongst redeployed staff was that of resilience, dedication and responsibility. We knew we may be useless but we would proactively be useful. The bureaucracy of staff grade no longer mattered. This is a clean slate and we are all learning to adequately manage COVID-19 patients. Seeing patients succumb in such a way to this virus is upsetting and despite putting a brave face on, is life changing in ways only time will tell.

Personally, my first week left me with nightmares, dreams of cardiac arrests and interrupted sleep. Particularly challenging is seeing colleagues you work with intubated days later. Having said that, there is a silver lining. For once, there is no shame in saying "I do not know." Staff are united, and this includes nurses, doctors,

physiotherapists and allied health professionals. I know each more personally and like a new family, rely on their sharing and caring to remain resilient during this marathon. Every day, junior doctors sit and have charitable community meals, a show of public solidarity to our so called sacrifices, which most frontline workers would rather describe as a duty. In many ways, departments have taken on this new wave of staff and skillfully turned them

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into a productive workforce who receive weekly teaching, verbal appreciation and admiration.

COVID-19 has forced us away from the specialist clinician towards our physician ancestors reminding us our bachelors in medicine are wide and varied, in medicine and surgery alike. As we continue to understand this disease, I have learnt to operate ventilation machines, supporting teams in proning, and along with colleagues, personally developing myself to better understand ICU and COVID-19 to help my patients. I am becoming a more mature clinician in an environment where flexibility and adaptability are essential. As a team, nurses are empowered to educate doctors about critical care principles, and doctors seek to support nurses and cover their rest breaks. As a team we have

experienced patient recoveries and remain optimistic our global knowledge towards COVID-19 will continue to build in a race to curing it.

A Black Swan

In Nassim Taleb's book, The Black Swan: The Impact of the Highly Improbable, he describes the term as a rare unknowable event, which with hindsight is rationalised. Taleb talks about the human tendency to always find simplistic explanations for unknown events, what he calls the Black Swan theory. Is COVID-19 a black swan? I believe it is far from it; rather we as humanity have been a sitting duck and undoubtedly, a change in dogma is inevitable. As for me, I worry for my patients and my team but am optimistic this reconciled unity, backed by family and friends and the public will carry us across the finishing line.

Now we are all almost back to our routine and all seems like a distant story. Several lessons have been learned and this experience will remain unique in terms of really being at the frontline of an unknown battle. ■

Key Points

- Coronavirus was largely underestimated at its start at the end of 2019. Governments and Institutions such as the World Health Organization (WHO) saw no merit in panic.
- By February 2020, this latest unwelcome celebrity had become a household name, wreaking havoc within Italy.
- The UK, as many other nations, went into lockdown and thousands of NHS staff were redeployed.
- Doctors and nurses were essentially no different, nor immune to this virus and as a result several died in this pandemic.
- Study leaves and annual leaves were cancelled and research suspended due to the closure of most laboratories and cancellation of most conferences.
- No age group is immune, nor would a healthy background act as a guarantor against this invader.
- As a team, we have experienced patient recoveries and remain optimistic our global knowledge towards COVID-19 will continue to build in a race to curing it.

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COVID-19 Global Response – Strengths, Weaknesses, Success and Failure

An overview of the global response to the COVID-19 pandemic – the success of South Korea, the so-called herd-immunity experiment of Sweden and the not-so-brilliant COVID-19 management in the U.K. and the U.S.

South Korea's Successful Three-Phased Response to COVID-19

COVID-19 has created havoc around the globe. Some countries have managed to cope well with the crisis while others have not been as successful.

An emerging COVID-19 success story is that of South Korea. South Korea's response to COVID-19 stands out because it was able to flatten the curve quickly without closing businesses, or issuing stay-at-home orders. South Korea did not have to implement strict measures that were adopted by many other high-income countries.

When it comes to epidemic preparedness and response, South Korea has demonstrated success on three fronts: detection, containment, and treatment. Also, an important strength of South Korea's response has been an excellent collaboration between the government and the scientific community.

Here is a quick overview of the country's timely response:

Detection: Hundreds of innovative and high-capacity screening clinics were built in South Korea. There was close collaboration with the private sector to ensure the supply of tests. Nearly 600 testing centres were established to screen people for COVID-19. Testing capacity reached almost 15,000 to 20,000 tests per day.

Containment: Infected patients were isolated, and patients in quarantine were provided support to ensure compliance. Also, contact tracing was effectively implemented, with hundreds of epidemiological intelligence officers deployed to trace contacts. They used a variety of data sources, including credit card transactions and television footage.

Treatment: In South Korea, Daegu was the site with the largest cluster of infections. 2400 health workers were recruited for this region alone. In addition, temporary hospitals were built across the country and shortages of personal protective equipment (PPE) were managed through centralised government purchasing.

Overall, South Korea's government acted quickly and effectively. This was probably because the country had learned from its flawed response to the Middle East Respiratory Syndrome (MERS) outbreak in 2015. The government had implemented several reforms to the health system in order to be better prepared for such a crisis.

The country's health system centres on hospital-based care. The number of hospital beds per capita is much higher in South Korea compared to other high-income countries, at 12.3 beds per 1000 population. This is two times the average of OECD countries. It is this increased capacity that allowed hospitals to respond quickly to COVID-19 while continuing to provide care to non-COVID-19 patients. Healthcare use in South Korea leads all other OECD countries and stands at 16.6 consultations annually per capita.

Also, South Korea has an efficient national health insurance system, significant human resources, a strong infrastructure and good relationships with key institutions such as the President's office, the Ministry of Health and the Korean Centers for Disease Control and Prevention. This is a major reason why South Korea's response to the COVID-19 pandemic has been exceptional and decisive.

During the MERS outbreak, South Koreans lived in fear. The government lost nearly $2.6 billion in tourism revenue and spent almost $1 billion on diagnosis, treatment and other activities in response to the outbreak. After this disastrous performance, the country implemented several policy changes and worked towards improving its pandemic preparedness and response. When COVID-19 hit the world, South Korea was already prepared, and its people were sensible and wore masks, cooperated with contact tracers and listened to public health officials. All these factors make South Korea an example to follow.

Sweden's Herd Immunity – Fact or Fiction?

During the initial days of the COVID-19 pandemic, Sweden adopted the same strategy as most other countries around the globe. It aimed to flatten the curve and slow down the transmission of the virus so that the country's healthcare system would not be overwhelmed. There was, however, one difference in Sweden's approach. Much of its implementation and preventive measures relied on voluntary and stepwise action by its people. There was no legislation and no compulsory measures that were enforced on its people.

The fact that Sweden did not impose strict measures attracted everyone's attention. International media was very interested, and several different narratives circulated in the news. Some claimed that life was normal in Sweden, and some said that Sweden had adopted a herd immunity strategy. Others claimed that Sweden was not following any expert advice, while some said Sweden was not following WHO recommendations. There were claims that the Swedish approach had failed, and at the same time, others suggested that the Swedes trusted their government completely. As with most other news during the pandemic, there was no surety as to which claim was accurate and which was just a story.

Whatever Sweden's approach, one thing that this scenario clearly highlights is how international media constructs and represents a pandemic like COVID-19. The Swedish example highlights the need to fact check and source critique and also demonstrates the limitations of using culture as an explanation for behaviour. The fact that the media was constantly talking about Sweden's approach to the pandemic forced Swedish representatives to waste time and effort into correcting misinformation.

The obsession with "the Swedish experiment" has resulted in significant backlash from the Swedes. Journalist Paul Rapacioli claims that Sweden and Swedish values have been used as a weapon during this time. Also, most of the claims that were being made were inaccurate. For example, it was being reported that life in Sweden was completely normal. But this was not true. Most international media focused on Stockholm, which is the city centre. Stockholm may have had people going on about their business normally, but central Stockholm does not represent all of Sweden. Also, the city of Stockholm carried out extra checks and cafes in April (over the Easter weekend) to ensure people were careful. Overall, this "impression"

> **Sweden was still trying to flatten the curve. The only difference was that it had not implemented draconian measures to do so**

that Sweden was normal was misleading and inaccurate.

Then there was this hue and cry about Sweden's "herd immunity" strategy. All around international media, there were claims that Sweden was using a risky coronavirus strategy that will backfire, that Sweden's carelessness will lead to more deaths, that Sweden was suffering badly etc. Swedish Public Health Agency, Folkhälsomyndigheten (FHM) and the Swedish government both denied this multiple times, but nobody seemed to listen. The fact is that Sweden was still trying to flatten the curve. The only difference was that it had not implemented draconian measures to do so.

In its defense, the Swedish government explained that it was not following the herd immunity strategy but was simply being realistic because keeping people inside for 4 or 5 months was neither practical nor healthy. There was never any evidence of this secret herd immunity plan. It was all hype created by media.

Claims that Sweden was not listening to experts and the WHO also circulated in the media. While this may be true, it is important to understand that WHO recommendations are not universal, and while Sweden followed the recommendations that were related to public health measures, there were others that were not applicable to the country. Claims that the Swedish approach failed or that the country has changed its strategy can't be verified because the country maintains it never was following a herd immunity strategy in the first place.

Whatever Sweden did or did not do, the important thing is that there has been a lot of misinformation about the country's approach to the COVID-19 pandemic. Everyone is quick to criticise Sweden's handling of the pandemic, but an area that needs to be more closely scrutinised is media reporting, fake news, sensationalising and misleading information.

Why the U.S. and U.K Failed to Tackle the COVID-19 Pandemic?

In October 2019, the Global Health Security Index published a scorecard that ranked countries on how prepared they were to tackle an outbreak. The ranking was based on how quickly a country was likely to respond and how well its healthcare system was likely to treat patients and protect healthcare workers. Out of 195 countries, the U.S. and the U.K were ranked first and second, respectively.

So what happened with COVID-19? On paper, both these countries were supposedly the most prepared to deal with a pandemic, but these two turned out to be the biggest failures in tackling the coronavirus outbreak.

A major reason why the scorecard turned out to be so inaccurate is that it did not account for the political aspect. Decisions by both President Donald Trump and Prime Minister Boris Johnson have been severely criticised. Both are non-believers of science; both do not value the importance of public health investment, and both do not take the recommendations of health authorities seriously.

President Trump shut down a White House office that was dedicated to pandem- ic preparedness, and that was set up by President Obama. The White House also cut off CDC's Public Health Science and Surveillance programme. Similarly, in the U.K., the government was aware that the country could face a shortage of ventilators and PPE in case a pandemic ever struck but

> ❝ **the Global Health Security Index ranked the U.S. and the U.K as the top two countries most prepared to tackle an outbreak** ❞

did not take this issue seriously and put it on hold for two years because it had to deal with Brexit.

In January, when the WHO warned all countries that they were at risk of COVID-19 and advised them to get prepared for containment, active surveillance, detection, isolation, contact tracing and prevention of infection spread, both the U.S. and the U.K. failed to take this seriously.

Both countries ignored the WHO's guidance and took no urgency action. They did not set up any contact tracing systems and allowed the virus to pass through their country, completely uncontrolled. Then there was the excessive promotion of hydroxychloroquine as the ultimate cure for COVID-19. President Trump went so far as to suggest that injecting disinfectants might cure the illness. From leadership at the top to the American people, there was opposition to wearing a mask. People defied stay-at-home orders.

Instead of looking at success stories such as South Korea, New Zealand or Singapore, both U.S. and U.K. continued to follow their own strategy with very little success. Despite being ranked at the top of the prepared- ness index, the U.S. and the U.K were two countries that did the least to prevent COVID-19 deaths. Their lack of effective response shows how a country's political decision-making can have an impact on the health and wellbeing of its people. ■

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The Night Falls in the ICU: Changing Realities for Patients, Relatives and the Interdisciplinary Team

Night has fallen in the intensive care unit, and the medical team is smaller. What do physicians, nurses and patients actually feel? An overview of the night falls in the ICU - from the perspective of an ICU team.

Brief Description and Comparison with the Day-Time Atmosphere

During the day and at night, intensive care units (ICU) have their own temporal rhythm. In our ICU, each day is divided into two sets of twelve hours, marked by a changeover in ICU teams, which changes patterns of care for patients and their relatives. The monitoring alarms, which are so specific to intensive care, ring out at different frequencies and with varying intensity, intertwining and combining in an unpredictable manner. The alarms come from the patients' beds and the machines that they are attached to and on which their lives depend. They also come from the patients themselves, as they seek for medical and nursing attention. Nursing staff recognise the alarms and react to them in different ways, more or less quickly, more or less stressfully, depending on their meanings. "There are lots of alarms and you have to learn to identify them, but they are all important," (verbatim account by a nurse responsible for general care). There seem to be fewer alarms at night, but they are still present and go off at irregular intervals. Late in the evening, the lights are dimmed, but never completely turned off, immersing the unit in murky atmosphere. The atmosphere becomes similar to that of a night-flight, with the same impres-

sion of confinement. The dimmed lights and gentle hum of machines encourage drowsiness. Time is suspended and the place soon induces a sense of time lag.

The atmosphere can be particularly challenging for the patients, who often suffer from some degree of delirium and very easily lose track of time. Caregivers themselves can be taken by surprise by the clock. The notion of space is also compromised by the limits of the rooms in the unit. Loss of spatial and temporal bearings is thus exacerbated by a claustrophobic atmosphere, in which a reduced team focuses on a common objective: patients' well-being. The nursing staff try to give the patients context by regularly explaining to them the reason they are in the unit; giving them the date, year and time of day or night; and saying what visits they have had, thereby providing the information they need to understand their situation.

At the beginning of the evening, nurses on the day shift interact with the incoming night team, handing over all the information required to ensure continuity of care during the night and to bring everyone up to speed. The night shift then takes over. Compared to daytime, the number of staff is reduced. Lights are dimmed, conversations are hushed, and there is less dialogue. The throb of daytime activity, with its constant

comings and goings, gradually fades into the singular night-time atmosphere. Everything seems to slow down, becomes calmer, and you can almost hear the silence.

An Oppressive Yet Calming Atmosphere

An endurance race for the ICU team

Night has fallen, and the medical team is smaller. In charge of the unit, there is one experienced "senior" physician, a resident in training, and a medical student. Nurses and nurse assistants provide the best standard of nursing care. The organisation and the pace of work change. For the nurses, the night is organised around the rounds of the patients carried out once every three hours. In addition to the patients already in the ICU, the 24-hour on-call doctors' night is also governed by emergencies. Sometimes rest is possible, but will always be incomplete, and disrupted. Being on duty for the entire nychthemeron is a real challenge for doctors. However, some do defend the pattern although it appears exhausting at first glance, insisting that this apparently stressful pace helps them acquire a better knowledge of the patients and consequently improves medical skills: "it is the idea that the person on call at night has already worked the day and knows the patients, which ensures a certain continuity of care,"(verbatim account by a doctor). This intense workload is also justified by the severity of the patients' conditions and the speed at which they can change. Of notice, a smaller number of people taking care of the patient during the day implies a decreased risk of attrition of knowledge concerning the patient.

At night, the smaller size of the ICU team generally results in a reduction of the number of urgent orders and tasks that are constant during the day: "the atmosphere is more relaxed at night, there are fewer people, and fewer urgent requests than during the day,"(nursing assistant's verbatim statement); "there is no-one to interfere with your night, while during the day, it's

a mess all the time, it's bustling and noisy all day long,"(nurse's verbatim statement). Nurses are able to do their rounds in the unit at night without being interrupted, or at least less often, than during the day. This calm atmosphere is particularly appreciated by nursing staff, who feel they can better focus on their primary duties.

Moments of respite are rare during the day because there is always another task to attend to, duties being non-stop and continuously overlapping. At night, in the absence of emergencies, the workload may be lighter, making time seem longer. Concentration then becomes a real challenge for the nursing team, especially from 3 am onwards. Some nursing staff use power-nap strategies to help them stay responsive. Alternatively, others keep

> ❮❮ the throb of daytime activity, with its constant comings and goings, gradually fades into the singular night-time atmosphere. Everything seems to slow down, becomes calmer, and you can almost hear the silence ❯❯

themselves constantly busy to stay alert. Speed becomes less important than the ability to keep going through the night while maintaining the same standard of performance and dynamism. Nurses and doctors have to tackle the issue of resisting how the night affects their physical and mental abilities.

As a result, throughout the night, the ICU team constantly makes compromises between the specific demands of the night

and the unchanged demands of their work requiring that they provide the best care to their patients and the best information and comfort to their patients' relatives, who can nowadays be present during the night as during the day. These compromises result in strategies aimed to adapt care objectives, for example, when possible, minimising interventions during the night.

Adapting the ICU team's objectives

At night, patients undergo less diagnostic procedures, doctors make fewer complex diagnoses and carry out fewer tests, which are usually limited to emergencies: "anything that can be performed later without damage is not done at night,"(verbatim account by a doctor). At night, non-urgent medical or nursing procedures are easily postponed. Ensuring that the patient gets some sleep despite the environmental constraints of the unit is among the most important nursing roles. Bedridden, plugged into various machines and almost completely incapable of moving, ICU patients struggle to get rest. For them, night-time is not the calm resting time that it is supposed to be. The silence is systematically broken by alarms, caregivers' work, and the other patients, all creating a permanent background noise. One night, a patient's screams of pain in response to leg cramps kept all the other patients awake, fretful and worried. Another night, the simultaneous admission of several critically ill patients in the unit made it as busy as during the day and deprived all of any hope of rest.

Patients have to be given treatments during the night, further disrupting their sleep. To minimise the impact of sleep deprivation and to preserve the patient's circadian rhythm, nurses sometimes postpone certain procedures that can be put off until later to let the patient sleep (Toupin 2009). "Sometimes we skip certain procedures to avoid disturbing the patient and interrupting their sleep, as it is very difficult to get enough sleep in here,"(nursing assistant's verbatim statement).

The reduced number of visits and the calm atmosphere can, paradoxically, be oppressive for patients, who find themselves confronting existential questions and feelings of solitude.

The nocturnal anxiety of patients and their relatives

Death is a common event in ICU. The unit itself is associated with death, and night-time often accentuates the patient's fear of death. Feelings of loneliness, fear of abandonment, the inability to sleep, the administration of drugs that can provoke hallucinations, can all exacerbate nocturnal anxiety. Anxiety manifests itself in the excessive use of buzzers to call the nursing staff, escape attempts and violent behaviour: "they get up, they tear everything off, they get out of bed, they ring the alarm," (verbatim account by a nursing assistant). At the start of the evening, while providing care and settling the patients for the night, nursing staff try to prevent anxiety attacks. Mouthwashes, eye care, massages and repositioning the patient in the bed are accompanied by the nurse's comforting words, explaining each gesture describing the patient's surveillance throughout the night, listing who will be present and in charge of what (Toupin 2005). The presence of loved ones can also help to prevent anxiety. If loved ones are present, nursing staff can include them in basic care. The nursing staff also reassures patients' relatives, who can manifest their concern by staying through the night. In these cases, the nursing staff may alert patients' loved ones to their own need for sleep, in order to avoid exhaustion and protect their mental health.

A Reduced Team: Between Solitude and Solidarity

The reduced size of the ICU team at night can induce a feeling of loneliness among the nursing staff, closely linked to their empowerment and accountability, together with more intense feelings of solidarity and complicity.

Increased autonomy and accountability of healthcare personnel

ICU physicians are used to emergencies and adopt a serene and stoic attitude, even at night, however serious the situation. Projecting confidence helps the doctors to insure against the risk of communicating their stress to the whole team: "you are like the conductor of an orchestra, if you can show that you are confident and relaxed, it calms everybody else," (verbatim account by a doctor). The ICU duty doctor increased responsibility and accountability are both gratifying and stressful: "The most difficult aspect of working at night is that you are the only one to make some urgent decisions," (doctor's verbatim statement). The absence of interdisciplinary discussions

> ◀◀ **speed becomes less important than the ability to keep going through the night while maintaining the same standard of performance and dynamism** ▶▶

at night does indeed make decision-making trickier. In difficult situations, nurses call the on-duty doctor who, in turn, can contact the on-call senior doctor. However, calling on someone is far from automatic, because no one wants to wake a colleague for no good reason: "at 4 am you ask yourself - should I really wake them for this?" (verbatim account by a doctor).

One of the most difficult decisions for physicians at night is whether to admit a new patient to the ICU. This decision involves ethical issues, as the physician must determine whether the patient's medical profile actually corresponds to intensive care, whether intensive care admission is truly indicated, or whether, on the contrary, intensive care admission would be medically futile: "but the problem is that you

have no-one to talk to about how to limit therapeutic obstinacy, and these decisions must be team-based," (doctor's verbatim statement).

Free and liberating time

In the absence of an emergency, the reduced number of medical procedures and the preservation of patients' sleep free some time for the nursing team which can be used to rest, to get ahead with administrative tasks, to study, to think about a case, or simply to enjoy eating and talking to workmates: "sometimes we really are able to sit down and eat," (verbatim account by a nursing assistant). Free time at night is much more conducive to informal discussions and forging closer ties with other members of the team: "You may be able to create stronger bonds; you have more time to establish a relationship with your colleagues," (nurse's verbatim statement).

The peaceful aspect of the night shift also loosens patients' tongues and make them more likely to confide in the nurses and forge ties with them: "often the night, before going to bed […] they need to talk about it" (verbatim account by a nursing assistant). The lack of physical availability of the nurses and the lack of psychological availability of the patients during the day tend to fade at night, and the time spent preparing the patient for the night may be conducive to more intimate conversations. Night nurses may therefore place more importance on care than on cure.

Team spirit

Free and liberating time during the night enables the nursing staff to forge ties, discuss professional practice, and talk over difficulties with a patient or his or her relatives, thereby finding support within the group. Mutual aid, a common feature in the ICU, is even more marked at night because it is expressed more spontaneously and more naturally. Nurses often don't even need to ask for help with a task, as all of the available staff are ready to join in. For example,

when cleaning a room, the whole team focuses on this one task, which can then be performed very quickly: "team work is even more important due to the reduced number of staff. There are just as many patients, but fewer nurses, so we really need to be able to count on each other. It is that little bit of extra effort which is rewarding,"(nursing assistant's verbatim statement). Communication between nurses is more direct, as there are fewer people and no intermediaries.

Conclusion

At about 5 am, the night is nearly over. Soon the team working on the day shift will gradually arrive and take over, following a hand-over on the previous twelve hours from the team on the night shift. The lights in the unit start dazzling once again as does the bustle. The oppressive, yet calm atmosphere of the night leaves its place to the day-time rush. Reality changes again for the ICU team, the patients and the families and they all interact in a different way. ■

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Key Points

- Intensive care units have their own temporal rhythm during the day and at night.
- Monitoring alarms ring out at different frequencies.
- Number of staff is reduced, lights are dimmed, conversations are hushed and there is less dialogue during the night.
- Patients undergo less diagnostic procedures, doctors make fewer complex diagnoses and carry out fewer tests.
- Night-time often accentuates the patient's fear of death.
- The reduced size of the ICU team at night can induce a feeling of loneliness among the nursing staff.
- The oppressive, yet calm atmosphere of the night eventually leaves its place to the day-time rush.

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The Night in the ICU

An overview of the multiple characteristics of life overnight in a critical care ward, the relationships between caregivers, patients and family, and how this complex reality is embedded in an artificial and often unfriendly environment.

Introduction

Whether it is a matter of keeping on with the hard work - as day and night would be an endless succession, as they actually are – or dragging an entire ward through shallow waters until the morning after, the night shift in the intensive care unit (ICU) has always stood under shady lights. In this article, we aim at analysing the multiple characteristics of life overnight in a critical care ward, the relationships between caregivers, patients and family, and how this complex reality is embedded in an artificial and often unfriendly environment.

From Dusk Till Dawn

Frequently, the hardest task is to keep stable a precarious balance, as being on the ropes. Indeed, while emergency calls and abrupt changes in clinical conditions never rest, intensivists and nurse staff are there to respond: but at what price? The price of necessity, of course, which nonetheless has been demonstrated to carry a heavy load of acute fatigue and sleep deprivation (Gaba and Howard 2002). Partial sleep deprivation – as the one typically caused by night shift, in contrast to total sleep deprivation – is defined as a night of reduced and/or interrupted sleep (Weinger and Ancoli-Israel 2002). If you sum partial sleep deprivation to chronic tiredness related to long working hours, the predictable consequence is a deteriorated clinical performance (both mental and physical) (Maltese et al. 2016; Weinger and Ancoli-Israel 2002). Call it a name: shift work sleep disorder (SWSD) (American Academy Of Sleep Medicine 2001). As a matter of fact, this impairment goes well beyond the mere technical proficiencies: attention, cognition, motor skills and mood are only some of the domains that are affected by sleep deprivation (Mansukhani et al. 2012). Thus, an exhausted staff is an inaccurate one, and the risk of errors is raised (Rubulotta, Scales, and Halpern 2016; Smith-Coggins et al. 1997).

Are we meant to abolish night shifts then? Needless to say, that is not the case. Fortunately, tiredness does not necessar-ily translate into clinical consequences concerning patient safety. In fact, although a variable grade of decrement in clinicians cognitive and psychomotor performance is proven (and enhanced by longer working shifts), no effect on patient mortality nor increase in relevant clinical events has been observed (Mansukhani et al. 2012; Parshuram et al. 2015). Several methods to reduce sleepiness and insomnia while improving performance in night shift workers have also been studied (Richter et al. 2016). Of these, exposure to bright light (Griepentrog et al. 2018), short (20 to 30 min) naps (Rajaratnam, Howard, and Grunstein 2013), and the intake of caffeine at the beginning of the shift (Schaefer, Williams, and Zee 2012) have shown beneficial effects on vigilance and attitudinal test performance. Still, working hours have to be efficiently regulated (especially in a high-intensity environment) (Lockley et al. 2004), if we want to avoid a tipsy, somnolent captain to pilot our plane (Cassin and Barach 2012).

The Role of the Night Staff: Who, Where, When?

Intensivist physicians improve patient outcomes, while leading to more efficient use of resources (Burchardi and Moerer 2001; Vincent 2000). It has been demonstrated that so-called high-intensity staffing ICUs are able to cut down both patient mortality and hospital length of stay (Pronovost et al. 2002). Indeed, combining high-quality assistance with useful cost-effectiveness performance is always desirable, especially when the most expensive

department of the hospital is in the spotlight. Anyway, whether the above mentioned beneficial results are a consequence of the intensivist presence 24 hours a day is yet to be proven. In fact, we might conceive the night shift as a limbo where we need to freeze the ward and lead it safely to the morning after: does this practically require a highly-trained specialist? We are currently far from answering this question, but concerning this matter, several studies have focused on the contrast between on-call intensivists versus full day and night coverage with senior physicians. The results are intriguing, since these studies fail to observe a higher length of stay or mortality in patients admitted to ICUs that did not have intensivists all around the clock (Kerlin et al. 2013; Kerlin et al. 2015; Wallace et al. 2012). That being so, it may then sound curious that the vast majority of European ICUs and more than one-third of ICUs in the United States actually have intensivist physicians overnight (Diaz-Guzman et al. 2012; Vincent et al. 1997). We have to point out that the cited results come from rather small, single-centred studies, and that once more the one size fits all mentality is presumably misleading. Differences in enrolled patient characteristics, severity of illness, type and resources of the included ICUs, nurse-to-patient ratio and tremendous contextual dissimilarities result in a very low potential for generalisation (Burchardi and Moerer 2001; Guidet, Soares, and Rowan 2016). Hence, systematic and evidence-based insights must come to light before any definitive statement can be written, and the debate is currently wide open.

Environmental Stress: The Noise of Time

The target of every intensivist is, most of the time, to restore patient physiology. Yet, the context in which we operate is often distant from being physiological. Alarms, mechanical ventilation, monitors, nursing, night rounds, bright lights: ICU is really noisy, day and night unceasingly. Circadian rhythm is rapidly disrupt, and changes in patient sleep pattern and hormone secretion (cortisol and melatonin above all) are widely described (Coppola, Caccioppola, and Chiumello 2019; Korompeli et al. 2017; Simons et al. 2018). Especially during night time, arousals, preponderance of stage 2 sleeping pattern, decreased deep sleep and rapid eye movement (REM) phases are common (Pisani et al. 2015; Telias and Wilcox 2019). As a consequence, altered sleep in the ICU has been linked to increased risk of delirium, prolonged ICU

> ❝❝ **working hours have to be efficiently regulated, especially in a high-intensity environment, if we want to avoid a tipsy, somnolent captain to pilot our plane** ❞❞

length of stay and augmented mortality (Ely et al. 2004; Weinhouse et al. 2009). Yet, ascribing all the sleeping disorders typical of the critically ill patient to environmental noise appears to be confusing (Horsten et al. 2018). In fact, ICU sleeping disorders show definitely a variable and multifactorial causality (i.e. the illness itself, drugs and sedatives, poor pain control). Nonetheless, great attention has converged on the interventions aimed at reducing the noise in the ICU. Above all, it has been highlighted that non-pharmacological interventions (i.e. patients wearing earplugs and eye masks overnight) resulted in benefits on perceived sleep quality (Huang et al. 2015), even when associated to relaxing background music (Hu et al. 2015). Besides, melatonin administration − with and without environmental interventions − showed positive effects on restoring circadian rhythm, on improving the quality of sleep, and on cutting down the amount of prescribed sedatives and hypnotics (Huang et al. 2015; Lewis et al. 2018; Mistraletti et al. 2015).

Differently, it has been observed that attempting to reduce the noise per se (including alarm levels, light brightness, number of patient-caregivers interactions) seems to bring marginal effects on patient sleep pattern (Boyko et al. 2017) stressing once again the multifactorial genesis of ICU sleep disorders. Moving another step backwards, we may now address the environmental effects of the intensive care atmosphere on the caregivers. Does all this noise have a consequence on staff health and well-being? It surely does, and many of the mentioned circadian alterations have been described in ICU nurses and physicians as well (Griepentrog et al. 2018; Richter et al. 2016). Indeed, several consequences included in the overall SWSD class - reduced work performance, processing errors, accidents, reduced quality of life - are direct or indirect consequences of passing the night in a hostile habitat, even while working in it (Ahasan et al. 2001) Ergonomics - defined as the study of people's efficiency in their work environment − will have to be at the centre of future research and application, particularly in highly-stressful ambient as ICUs (Ahasan et al. 2001). Beyond any doubt, we − patients, doctors, nurses − are simultaneously protagonists and sufferers of the same nocturnal, unphysiological reality.

Time to Fit an Extra Seat at the Bedside?

Families of critical ill patients undergo a deep, sudden disruption of their lives (Beesley et al. 2018). In order to mitigate the complex impact of life-threatening situations, open ICU policies have proven favourable both towards patient and family needs (Beesley et al. 2016; Alberto Giannini 2017; Marra et al. 2017). Perceiving the closeness of relatives attenuates patient stress and has shown beneficial effects in terms of reducing the incidence of delirium (Rosa

et al. 2017). Besides, participation of the family during ICU procedures appears to play a considerable role in patient-caregivers-relatives relationship (Bijttebier et al. 2001). Indeed, the creation of protocols that establish a routine and safe participation of relatives during ICU procedures (both in election and in emergency) has been encouraged, as it also provides the family with an active role in overall patient care (Beesley et al. 2016). Twenty-four hours visiting policy has been associated to a better acquaintance of ICU staff, to a facilitated commute to the hospital, and to a reduced level of anxiety in patients visiting a French ICU (Garrouste-Orgeas et al. 2008). At the same time, physicians and nurses perceived an enhanced family trust towards them, while unease in visiting the patient and delay in ward organisation appeared not to be increased (or just marginally) by family presence. On the other hand, scarce – if untraceable – literature is available on the role of family presence during the night in the ICU. One exception is maybe represented by paediatric critical wards, where departments are at times variably organised to host parents at the bedside. Nevertheless, quoting a recent survey on family stress in paediatric critical care: "…it's hard sleeping [at the hospital] with the beeps and stuff…at the same time, it's really hard to be away, too, to get the sleep"(Hagstrom 2017). Thus, it is conceivable that an overnight company of close relatives also in adult ICUs could be as favourable as during daytime. As an example, a patient who is able to interact with his relative at the bedside could find

relief in a situation of extreme anxiety and insomnia, a combination frequently observed in our wards. The gap between reality and good intentions is currently very wide, but a step-by-step approach to fulfil patient needs – besides the clinical, technical ones – has to be the leading

> **❝❝ reduced work performance, processing errors, accidents, reduced quality of life - are direct or indirect consequences of passing the night in a hostile habitat, even while working in it ❞❞**

light, provided ICUs are (pragmatically and mentally) equipped to do so (Giannini 2010).

Conclusions

The night shift in the ICU is an everyday challenge, exhausting and unpredictable as walking on thin ice. It brings with itself (and probably emphasises) all the complex aspects that concern a laborious relationship between all its characters - namely patients, staff, family – and the surrounding, often inhospitable environment. Improving the liveability of ICU wards – as with open visiting policies, spaces dedicated to relatives to stay overnight, reduced alarm

tones, dim lights - might then result in a better relationship between all the figures involved, eventually ensuing an overall improved, human-friendly habitat. Moreover, empowering the figure of relatives, letting them participate during procedures and assigning them a role – even symbolical - in patient care might be of relevance in lowering both patient and family stress. Nonetheless, several aspects concerning overnight work in the ICU reality have to be fully elucidated. Above all, addressing the impact of sleep deprivation on healthcare workers and the hypothetical low effect of their interventions at night on patient outcomes, is it really mandatory to have an intensivist all around the clock? Is it finally time for re-scheduling? Perhaps on-call specialists would be enough to manage safely an ICU until the morning after, but what shall we define enough in critical care?

Conflict of Interest

The authors declare no conflict of interest. ◼

Key Points

- We might conceive the night shift as a limbo where we need to freeze the ward and lead it safely to the morning after.
- The vast majority of European ICUs and more than one-third of ICUs in the US have intensivist physicians overnight.
- One size fits all mentality is presumably misleading and differences in ICU result in a very low potential for generalisation.
- Patients, doctors, nurses are simultaneously protagonists and sufferers of the same nocturnal, unphysiological reality.

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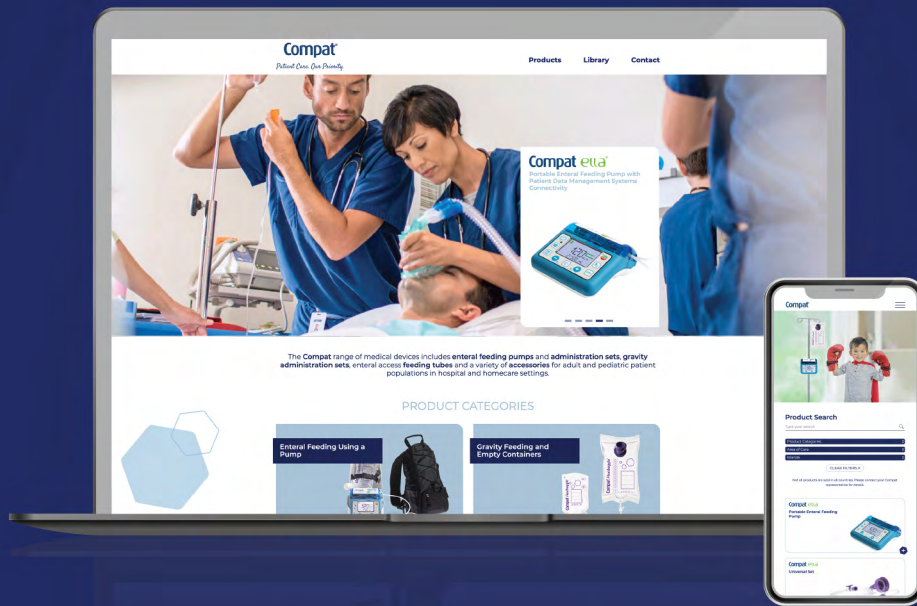
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Nine Nurse-Recommended Design Strategies to Improve Alarm Management in the ICU: A Qualitative Study

We asked intensive care nurses how they experience medical alarms in the critical care context and how they can help ideate strategies for better alarm management. Our study revealed that excessive medical alarms are one of the sources of discomfort at the workspace for critical care nurses and nurses' wellbeing is fundamental in providing better patient care. However, eliminating discomfort requires a collaborative approach in which nurses can provide valuable knowledge on existing and desired utilisations of medical alarms from their rich experiences within the critical care context.

Introduction

Critical care nurses are continuously exposed to sound in their workspace and have to rely on them for performing time-sensitive tasks that are crucial to ensuring patient safety. Missing important alarms, failing to extract crucial information from the sounds of organ-support devices, or misinterpreting the content of conversations can lead to loss of precious lives. While sounds in general have a functional role in our lives, excessive noise causes concern in the high-performance workspaces (Bluyssens 2014; Edworthy et al. 2018; Sousa et al. 2017; van Kamp et al. 2016). Nurses who are exposed to constant and excessive noise can suffer from fatigue, anxiety, and post-traumatic stress syndrome (Cvach 2012; Kristensen Edworthy and Özcan 2017; Horkan 2014; Sendelbach and Funk 2013; Topf and Dillon 1988). Moreover, especially excessive number of alarms has consequences on patient safety. It is reported that close to 600 patients may lose their lives in the span of one year due to audible alarms missed by healthcare professionals (The Joint Commission 2014).

Our paper focuses on understanding the experience of medical alarms from the perspective of critical care nurses. Critical care nurses are the backbone of intensive care units and they have first-hand information about how environmental factors affect the quality of patient care and patient experience of ICU stay. In this paper, with an observational study and interview with nurses, we aim to qualify the experience of nurses with sound sources, especially medical alarms. Based on our findings we propose quick fixes and long-term strategies to tackle sound-induced problems originating from patient monitoring technology, in the clinical setting.

What sounds can we expect to hear in intensive care units?

According to Konkani and Oakley, sound sources in the ICU can be categorised as operational (i.e. sounds that are generated by clinicians or medical equipment) and structural (i.e. sounds that are inherent to the hospital building such as ventilation, doors and central heating). The most prominent operational sound sources can be further

divided into four more specific categories: conversations (amongst clinicians, patients and visitors); medical equipment alarms (i.e. patient monitoring alarms, technical alarms); caregiving activities (i.e. cleaning patients, administering medicines) and incidental sounds (i.e. door closing, phones ringing, objects falling) (Konkani and Oakley 2012). Another study related the sound producing events to patient treatment in the ICU (Birdja and Özcan 2019) such as patient monitoring sounds (mainly medical alarms) and life-support sounds (alarms as well as machinery sounds such as hissing of the mechanical ventilator). The 67-hour recordings of sound events at the intensive care department of the Jeroen Bosch Hospital (the Netherlands) gave insight into the distribution of aforementioned sound source categories found in intensive care units. With the patient involved noise (31%) excluded, the most prominent contributors to the critical care sounds were sounds caused by intensivists and nurses (57%) and alarms (30%), where the machinery sounds of life supporting devices had a relatively minor

contribution (13%). Although in this study different categories were identified than the aforementioned, it did illustrate that most of the noise created in the critical care soundscape may be attributed to (modifiable) human actions.

How can the soundscape of critical care change for better workflow that ensures patient safety and comfort as well as clinician work satisfaction and morale?
The issues healthcare has with medical sounds, especially with audible alarms and general noise, is well acknowledged in the literature. Existing literature quantifies acoustic quality of noise, defines sound categories (e.g. alarms, speech, interaction sounds), and enumerates types or function of medical alarms (Cvach et al. 2014; Drew et al. 2014; Konkani and Oakley 2012; Ryherd, Waye and Ljungkvist 2008). These results are then projected to establish strategies to improve the quality of healthcare, for example the night routine and sleep experience of patients (Birdja and Özcan 2019). Thus, provided innovative solutions, technical or legislative, are based on quantitative approaches with little input from nurse's actual experiences of the sound environment. Very few studies considered the human experience of critical care sounds (Deb and Claudio 2015; Sowan et al. 2015). In a survey, Sowan et al. (2015) investigated nurses' perception and attitude towards clinical alarms in a cardiac intensive care unit. Among others, nurses' concerns were found to be the following: alarms are too many, distracting and therefore ignorable; the indication for urgency is not well configured for visual and audible alarms; the technology behind monitoring systems is unreliable and there is lack of training on alarm settings. Studies such as ours allow nurses raise their voice and actively take part in the improvement of alarm systems (Özcan, Birdja, Edworthy 2019). As a result, the system designed and the technology chosen will adapt to nurses' actual needs in the workspace

rather than top-down decisions taken by hospital management or policy makers that feel empowered with the possibilities of technology but may overlook its unwanted effects.

Observations in the ICU and Interviews with ICU Nurses
We were interested to discover ICU nurses' experience of clinical sounds, with specific focus on alarm sounds and alarm management with the help of qualitative research methods (observation, sensitising participants and in-depth interviews). Accordingly, we intended to uncover psychological,

> ❝❝ **non-actionable alarms defy the purpose of alarm systems and train nurses to ignore, mistrust, and misinterpret alarms** ❞❞

social and cultural reasons why certain clinical sounds fail to be part of the core values of critical care. Through the questions in the interview and observations, we explored nurses' work culture, tacit knowledge, experienced feelings, and architectural setup and protocols observed in the intensive care units. Therefore, this research approaches the problem holistically by looking at context, daily life activities and emotions of nurses and their coping strategies with sound and noise in general.

Method and Data Analysis
We conducted two observations at the Adult ICU of Erasmus Medical Centre Rotterdam (the Netherlands) in order to be prepared for the interviews with nurses focusing on the sound events in the intensive care units. Two researchers observed at two different times during the day; one in the morning and one in the afternoon. We also conducted seven interviews with (former) ICU nurses.

Four male and three female nurses participated with 13.6 years of experience on average (years of experience ranging from 1.5 years to 25 years) to provide us with first-hand insights into alarm experience. All interviewees were sensitised (i.e. made sensitive to sound) using booklets and audio recorders. The nurses were asked to record any sound that made any impression on them during the week before the interviews took place and took notes and made drawings on the booklets explaining what they heard, when, where and why a particular sound was worth mentioning. Furthermore, nurses were asked to answer one question a day. The sensitising booklet contained questions such as 'describe the different sound moments throughout your work shift,' 'record the most remarkable sounds at the ICU' and 'what are in your opinion related factors towards alarm management?' These continuous questions required nurses to become extra aware of clinical sounds that belonged to their own workspace. Participants brought their booklet to the interviews.

Semi-structured interviews in the context itself allowed direct questions about real time events and mental triggers for nurses to explain about their experience with the recorded sounds in the unit. Nurses were encouraged to think along with the researchers for optimal interactions with medical alarms. The questions were the following:
- What is good alarm management in the view of ICU nurses?
- Which factors enable/disable them to perform good alarm management?
- How do ICU nurses experience alarm fatigue in practice?
- Which factors can in their opinion influence alarm fatigue positively/ negatively?

Data was clustered into insights and big themes by going through the content of the booklets and the interview transcriptions. Finally, nurses' suggestions for better alarm management resulted in nine

strategies which are clustered under five big intervention domains.

Big Themes Representing Nurses' Negative Experience of Alarms

Non-actionable auditory alarms

Not all alarms that a nurse hears are medically actionable. Many of the alarms a nurse hears fails to represent a task that they immediately have to take care of. These alarms can eventually start causing a 'boy who cried wolf' effect and hereby cause alarm fatigue. Non-actionable alarms defy the purpose of alarm systems and train nurses to ignore, mistrust, and misinterpret alarms. Furthermore, nurses can actively switch off alarms in advance of a treatment or because the majority requires no action. If nurses let the non-actionable alarms sound for an extended period of time, tension amongst nurses arises due to lack of sound hygiene or personal consideration in the unit.

Patient/nurse induced alarms

Certain alarms are caused by a movement of a patient or when a patient is touched, and/or equipment is handled by nurses or doctors. In such cases the alarm does not represent what is happening to the patient. A sound that should usually be associated with a problem with one of the patient's vital signs, can now actually mean a patient is responding as expected to medication. Alarm systems and the attention they ask of the nurse do not consider how much information a nurse already has.

Limitations of sensors

Sensors that are used for monitoring patient vitals may get disconnected or may malfunction. For example, the oxygen saturation sensor on the patient's finger gets disconnected very frequently. Though it is important to know that all sensors are attached and they do function, alarms also occur when nurses know the sensor has come off during treatment. The systems the sensors belong to are not context aware or they fail to recognise the tasks or procedures nurses are involved in.

Incomplete information from the patient monitor

The patient monitor triggers an alarm based on a range of vitals that are measured. Since each of these values has a set of boundaries, the alarm will often go off when just one of these values exceeds a boundary. The nurse, however, needs more nuanced information about the combination of several values to be able to judge the urgency of the problem. Nurses cannot monitor patients from a distance with the help of auditory information and are forced to make sense of the visual content in the display.

> ❧❧ **nurses' low performance was found to be influenced by a combination of alarm fatigue, working conditions and staff individuality** ❧❧

Personal preferences in alarm management

Nurses can influence the number of alarms they hear by changing the boundaries at which the monitor triggers an alarm for a certain value. Each nurse has their own approach to these settings. A nurse's approach may depend on their professional experience (novice or experienced), hearing sensitivity, or their personality traits (disciplined or nonchalant).

The issues nurses rose during the interviews are in line with the existing literature (Cvach 2012; Edworthy et al. 2018; Özcan and Birdja 2018; Guillaume et al. 2003; Hellier, Edworthy, and Dennis 1993; Mondor and Finley 2003; Momtahan, Hetu and Tansley 1993; Sanderson et al. 2006). However, the most interesting finding was the nurses' personal preferences in alarm management and especially how this could further mitigate the factors contributing to alarm fatigue. To our knowledge there

is particularly one study that emphasises on nurses' individual differences (Deb and Claudio 2015). Nurses' low performance was found to be influenced by a combination of alarm fatigue, working conditions and staff individuality. In our case, nurses expressed individual needs for managing alarms and displayed almost cultural differences in their attitude towards alarms and sounds in general. This finding also legitimised our choice to inquire nurses' opinion for improving alarm management by giving the voice and platform to people who actually utilise medical devices and therefore have in-depth knowledge on the use context.

Nine Nurse Recommended Design Strategies for Better Audible Alarm Management

In the focus groups with nurses, nurses expressed more possibilities, i.e. nine different design strategies, to improve the aforementioned five big themes representing alarm issues. These individual strategies can be found in **Figure 1** within the context of ICU set-up. The multiplicity of the ideas is an indication that nurses, while doing their daily tasks, also think of ways to improve their situation. Below, we categorised the suggestions into five themes representing all nine design strategies.

Human-sensitive technologies

1. Create easy ways to react to alarms on devices (mute/acknowledge): The equipment nurses use does not optimally provide different ways to manage alarms while they are treating patients. Interfaces of devices should encourage properly muting and acknowledging alarms when they tend to unnecessarily go off during treatment. The way monitoring or life-support devices communicate with nurses via their user interfaces should be better optimised for the nurse's workflow and encourage them to properly manage alarms. For instance, (1) the mute button needs to be more accessible in the user interface

design at the bedside, (2) it should be easier to check off/turn off alarms in case nurses have acknowledged an alarm but are unable to go to the monitor. This will help them keep the disturbances from audible alarms to a minimum.

2. Improve quality of sensor connections to patients' body: Many alarms occur due to malfunctioning sensors or sensors that get accidentally disconnected due to movements of the patient. These alarms are bothersome because they do not represent a medical problem but do require action. This leaves an opportunity for an improvement in the design of these sensors. Sensors and their connections should be more robust to cause fewer technical alarms or they should be better fitting to the anatomy of the patient body. The way that sensors are connected should be designed with more attention to the patients' comfort to avoid the patient becoming irritated or confused and attempting to remove them.

3. Reduce the amount of alarms/sound level of non-informative alarms: One of the key factors that influence alarm fatigue is the sheer amount of false alarms. There are several alarms that provide no valuable medical information to the nurse or require a medical action, but still go off and disturb the nurse - e.g. sounds during the start-up of a device. The meaning and need for these alarms should be evaluated. With this evaluation it can be decided if the (little-/non-informative) sounds can be reduced or have a lower sound level. As new technologies such as Artificial Intelligence are developing, it would be interesting to see how alarm devices could become smarter in recognising and notifying useful alarms.

Sound design
4. Make auditory information informative: Many of the alarms have a similar sound and do not provide more information than an alarm boundary has been exceeded. Therefore, nurses have to look at other information to understand the meaning of

the alarm. There is an opportunity to increase the level of information that sounds on the ICU carry. Alarms that nurses currently work with merely summon them to further investigate the situation while they could convey a much richer meaning for a more proactive workflow.

5. Design pleasant alarm sounds: This research showed that intensive care nurses think that many of the current alarms do not have a pleasant sound. This causes frustration and negative feelings about sounds. Designing sounds that are less startling and more pleasant to listen to can help reduce alarm induced stress and fatigue.

Alarm culture
6. Redesign the alarm safety net: There is a difference between nurses in how they manage alarm settings. Their different alarm setting styles can be dependent on their sensitivity to sounds, experience with alarm settings, being neat and resistant to stress. Some nurses tend to set boundaries
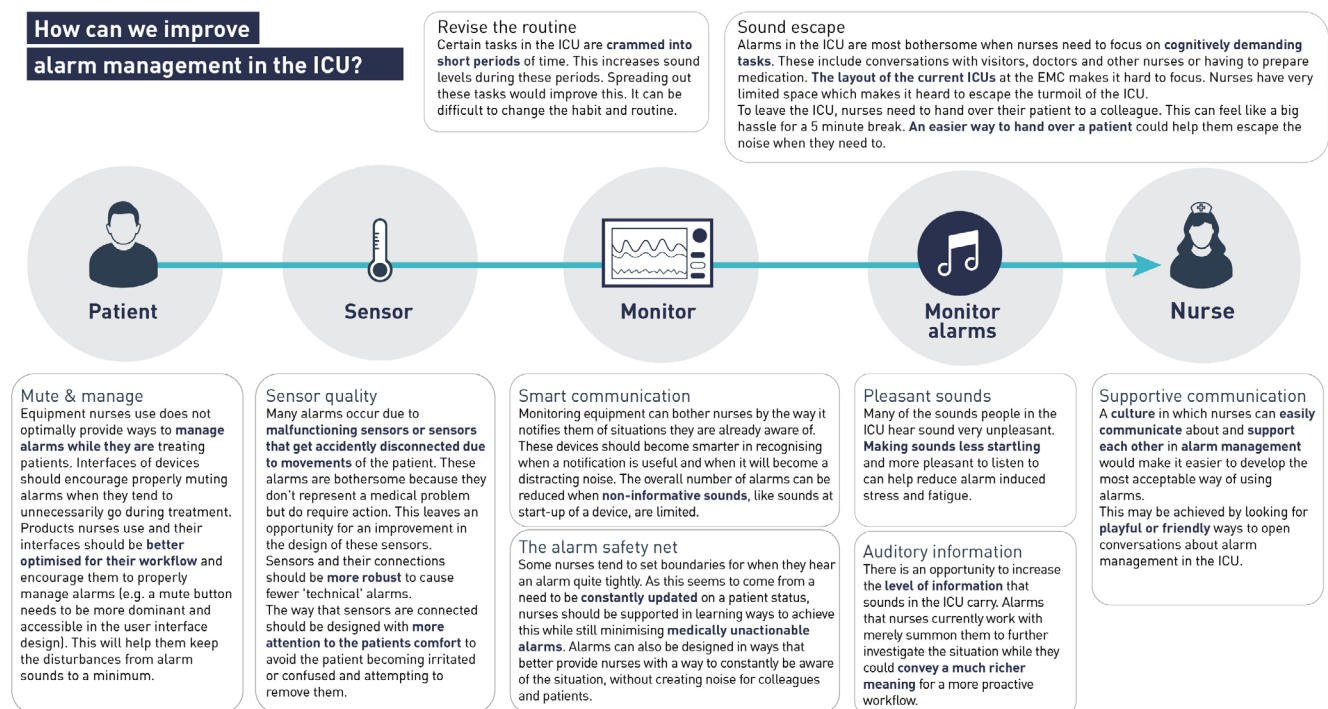

Figure 1. Nine nurse recommended design space for better alarm management.

for when they hear an alarm quite tightly. As this seems to come from a need to be constantly updated on a patient status, nurses should be supported in learning ways to achieve this while still minimising medically non-actionable alarms. Alarm systems can also be designed in ways that better provide nurses with possibilities to constantly be aware of the situation, without creating noise for colleagues and patients. This would also induce a harmonised alarm culture when nurses interact with alarm systems.

7. Make supportive communication about alarm management accepted in the intensive care culture: Alarm settings are partly driven by regulations, medical professional advice and personal preference. It can be a struggle for nurses to discuss with their colleagues their different views on alarm settings. A culture in which nurses can easily communicate about and support each other in alarm management would make it easier to come to the most acceptable way of using alarms. This may be achieved by looking for playful or friendly ways to open conversations about alarm management on the ICU.

ICU set up and workflow
8. Provide a quick and easy sound escape for IC nurses: Alarms in the ICU are most bothersome when nurses need to focus on cognitively demanding tasks. These include conversations with visitors, doctors and other nurses, doing administration or having to prepare medication. The layout of the unit can make it hard to focus. Nurses have very limited space which makes it hard to escape the turmoil of the ICU. To leave the ICU, nurses need to hand over their patient to a colleague. This can feel like a big hassle for a short minute break. An easier way to hand over a patient and finding a designated place for a quiet time could help them escape the noise when they need to.

9. Revise the routine to distribute the workload & sound moments: Certain tasks on the ICU are crammed into short periods of time. Especially in the morning, in which nurses have their hand-over, patient treatment and check-up rounds of medical professionals. This increases sound levels and work pressure during these periods. Spreading out these tasks would improve this. However, our research also showed it can be difficult to change the habit and routine in the ICU.

Conclusion

We have presented nine design strategies under four themes: human-sensitive technologies, sound design alarm culture, and ICU set up and flow. These themes of design strategies address different stakeholders (hospital management, policy makers and regulatory agencies, device manufacturers, and patient-nurse community) that need to make a collaborative effort for better alarm management (Özcan, Birdja and Edworthy 2018; Özcan, Rietdijk and Gommers 2019). For example, device manufacturers would be demonstrating their sensitivity to human-technology interactions by providing better user interfaces, developing new sensors and better sounding and informative alarms. In relation to device manufacturers, hospital management could offer tenders that contain sound clauses representing nurses' needs. The management could also facilitate open platforms for nurses to discuss their needs around alarm settings and also to acknowledge the need for certain type of behaviour around sounds. Changing the ICU layout or offering tranquility rooms would help reduce stress around excessive noise. Policy makers could also pay more attention to professional needs within the critical context and readjust regulations that are often focused on patient safety and work-efficiency but not on nurse well-being. Thus, we invite all stakeholders to consider what nurses have to say to improve their work condition. Each of the proposed strategy is subject to further in-depth study to discover exact problems and corresponding technological, cultural, design, and architectural solutions.

Conflict of Interest

Authors declare no conflict of interest.

Key Points

- An observational study and interview with nurses that aims to qualify the experience of nurses with sound sources, especially medical alarms.
- Not all alarms that a nurse hears are medically actionable. Many of the alarms fails to represent a task that needs an immediate response and can eventually start causing a 'boy who cried wolf' effect and cause alarm fatigue.
- Alarm systems and the attention they ask of the nurse do not consider how much information a nurse already has.
- Nurses can influence the number of alarms they hear by changing the boundaries at which the monitor triggers an alarm for a certain value.
- In the focus groups with nurses, nurses recommend nine different design strategies under four themes: human-sensitive technologies, sound design, alarm culture, and ICU set up and flow.

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Making Decisions During ICU Night Shifts: Challenges and Considerations

We review the decision-making processes during night shifts focusing on the perspective of residents and fellows. We explore nighttime decisions about extubations, ICU discharge, withholding/withdrawing and night shift cross-coverage.

Taking a night shift in the ICU can be challenging, particularly from a resident/fellow perspective. Across the globe, it is observed that night shifts are characterised by the following specific scenario: less resources, less in-house specialist consultants and few and often less experienced staff. There is frequently less supervision from seniors and consultants. Besides that, chronic and acute sleep deprivation affects our cognitive and motor performance (Maltese et al. 2016; Rubulotta et al. 2016). You fear the patients will decompensate and require urgent interventions that you may not feel comfortable performing (or have not yet performed) on your own. A great number of unplanned ICU admissions happen at night and important early treatment decisions will need to be made before you can handoff your shift.

Nighttime Extubation

Night shifts can create a circumstance of decreased surveillance that potentially impacts patient safety. There is evidence that nighttime procedures and decisions are associated with undesirable patient-centred outcomes. Thus, in the bedside round at 22:00, your team agreed patient "A" could be extubated, because they passed a spontaneous breathing trial and you should decide to perform it now or the next morning. Earlier extubation has several theoretical advantages, such as a decreased need of sedatives, less delirium and weakness, prevention of ventilator-associated complications, decreased ICU and hospital length of stay. However, overnight extubation might be riskier for some patients. A large retrospective multicentre cohort showed that nighttime extubations are associated with higher ICU and hospital mortality, and patients who received >12 hours of mechanical ventilation also had higher reintubation rates when extubated at night (Gershengorn et al. 2016). Limitations of that study include incomplete information on patients' status about decisions to withhold/withdrawn care and unplanned extubations, which is more likely to occur at night.

Their findings contrast with previous results, where nighttime extubations did not show higher reintubation rates, length of stay or hospital mortality compared to those extubated at daytime, although most of the nighttime extubations were cardiac surgical patients (82%), a population that benefits from fast-track extubation protocols (Tischenkel et al. 2016). Current evidence suggests that decision to extubate at night may depend on specific patient characteristics, staff availability and expertise and might not be advisable in all patients. While elective surgical patients probably benefit from extubation as soon as possible, more complex medical patients or those on mechanical ventilation for more than 12 hours could experience harm from overnight extubation.

Nighttime Discharge

Nighttime ICU discharge has been associated with worse outcomes, possibly leading to higher readmission rates and excess hospital mortality (Vollam et al. 2018). The reasons implicated involve premature decision discharge, poor surveillance at wards and inadequate handover affecting continuity of care. Returning to your night

shift: after the bedside round, you receive a call from the emergency and there is some pressure for an ICU bed because a trauma patient is arriving and there is a patient with sepsis in the emergency room. You have only one ICU bed available. Should you consider to discharge patient "B," fully recovered from a septic shock but with clear borderline dependency on care and frail? Organisational factors are also important. Elevated ICU occupancy and pressure for ICU beds could influence decision to discharge and have been associated to readmission (Chrusch 2009). The quality of post-ICU care must also be considered before discharging a complex patient to the ward at nighttime. Medical and nursing staff availability and presence of rapid-response teams, that could detect early deterioration and need for intervention, are important factors in decision making. Additionally, the possibility to discharge to step-down units instead of general wards is another alternative to increase safety during this process.

Decision to discharge is complex, based on clinical judgement and organisational and logistic factors. It's likely not the timing alone, but the patient status when leaving the ICU and where is the proposed destination, that determines outcomes. Consideration of all these factors together with a shared decision among the healthcare workers on both places (inside/outside ICU) is especially important when discharging at night.

Nighttime Withholding and Withdrawing Decisions

Another important decision, to withhold medical support, can be a reason for concern in the nightshift, especially for a resident or less experienced physician dealing with a patient whose condition is rapidly deteriorating overnight. Discussions of goals of care with patient or their surrogates and decision on limitations of medical treatment are usually done by attending physicians, but they can

unexpectedly (and not rarely) arrive at nighttime.

End-of-life decisions and palliative practice are influenced by country and cultural characteristics, religious beliefs, local legal aspects and professional individual experience (Sprung et al. 2008; Sprung et al. 2019). Surveys have demonstrated that years since graduation, seniority and background (intensivists vs. non-intensivists) affect physicians' preferences on life-support decision making (Cook et al. 1995; Spronk et al. 2009).

◀◀ nighttime extubations are associated with higher ICU and hospital mortality ▶▶

Although end-of-life practice is improving, with limitations of life-prolonging therapies occurring more frequently and fewer deaths without limitations of medical support (Sprung et al. 2019), there is still poor documentation of these decisions on medical charts despite its importance for legal purposes. Information on decisions to withhold or withdraw specific therapies, those who participated in the discussion and if the patient was involved in the decision are inconsistently reported in medical records (Spronk et al. 2009). We believe adequate documentation should be available for all team-members to ensure continuity of care, thereby better informing nightshifts. It is common that the traditional handover does not cover all the information needed or already taken about end-of-life decisions and you might face the anxiety of taking this decision overnight. Or, maybe worse, making decisions that do not match previous settled goals according to patient's preferences. In our opinion, end-of-life care decisions during nightshifts is a place for further research.

Night Shift in Cross-Coverage

Nightshift can demand even more when a physician that is not involved in daytime care is taking over for the nighttime, providing cross-coverage, which is common in residency training. Longitudinal follow up is essential not only to know important details of a patient history, but to understand patient's personal values and to develop trusting relationships with patients and families. Thus, longitudinal follow up supports, in theory, better treatment decisions that match patient and family preferences. By disrupting continuity of care, cross-coverage has been associated with increased risk in medical errors and adverse events, presumably leading to worse outcomes (Petersen et al. 1994). In contrast, longitudinal follow up might be responsible to reinforce certain personal cognitive biases and create blind spots during the routine daily care. In an interesting study to evaluate this hypothesis, Amaral and coworkers reported an association between greater nighttime cross-coverage with decreased ICU mortality (Kajdacsy-Balla 2014). The potential reasons were greater number of nighttime decisions when fellows were in cross-coverage compared to fellows that participated in the morning rounds. Fellows during cross-coverage at night ordered more diagnostic CT scans, initiated antibiotics and modified ventilation and extubation plans, as compared with the plan-of-care defined by the daytime team. The hypothesis is that different providers can offer a new perspective on the case and balance physicians' anchoring bias in decision-making process. It is not completely clear, though, how cross coverage could influence patient's outcomes, but a balanced "second look" may actually benefit patients.

Conclusion

Independent of your decision on extubating patient "A" or discharging patient "B," we believe night shifts are an important part

of the daily life of the majority of inten-sivists, particularly residents and fellows. Night shifts are also an opportunity to learn and develop autonomy during the training period. There is no easy solution and likely correct answer to these nighttime decisions, but being aware of the caveats and challenges involved and knowing the standard operating procedures in place in the unit you are working on, are a good start to improve decisions, share responsibilities and decrease the personal concerns during nightshifts.

Conflict of Interest

None to declare. ∎

Key Points

- A night shift in the ICU can be challenging, particularly from a resident/fellow perspective.
- Night shifts usually have less resources, less in-house specialist consultants, few and often less experienced staff, and frequently less supervision from seniors and consultants.
- Decision to extubate at night may depend on specific patient characteristics, staff availability and expertise and might not be advisable in all patients.
- Nighttime ICU discharge has been associated with worse outcomes, possibly leading to higher readmission rates and excess hospital mortality.
- End-of-life care decisions during nightshifts is a place for further research.
- Night shifts are an important part of the daily life of the majority of intensivists, residents and fellows and provide an opportunity to learn and develop autonomy during the training period.

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Sleep Deprivation and Fatigue Management in the Intensive Care Unit

The impact of sleep deprivation and fatigue on patients and staff in the intensive care unit and how improved sleep, reduced noise disturbances, and more organised shifts could be beneficial for both patients and clinicians.

The World Health Organization (WHO) recommends that average daily sound levels in patient care areas should be around 35dBA, with peak sounds no louder than 40dBA (Berglund and Schwela 1999). The reality in the intensive care unit (ICU) is that average daily levels are between 42-69dBA, with a mean of 53dBA, and peaks can be as loud as 120dBA. Units are generally quieter overnight, but sound levels can still average 51-64dBA. There is evidence that noise levels in the ICU are increasing over time (Busch-Vishniac 2016), and that the WHO recommended level may be unachievable in the ICU (Darbyshire and Young 2013).

The idea that people need a restful environment when they are unwell is not new. In 1859, Florence Nightingale wrote "Unnecessary noise is the most cruel abuse of care which can be inflicted." Patients admitted to intensive care are at high risk of poor outcome. Approximately 20% of patients admitted to intensive care units experience delirium during their stay. This figure rises to 75% for patients who are ventilated and sedated (Page and Ely 2011). Although the number of patients surviving to hospital discharge is increasing, long-term health of those patients who go home remains worse than the average population. Specifically, they are at higher risk of cognitive and mental health problems with almost a fifth of surviving patients reporting symptoms of anxiety,

> ❝❝ although lowering average sound levels seems difficult, reducing the startle effect with a view to lowering stress levels in staff and patients alike may lead to a more restful environment ❞❞

depression, and post-traumatic stress disorder a year after discharge (Hatch et al. 2018). It is plausible that reducing disturbance in the ICU may have a positive effect on the patient experience of intensive care.

Improving sleep for patients would seem to be a sensible place to start. Humans, like every living thing on this planet, have a natural circadian rhythm. We have evolved to rest during hours of darkness, and most healthy adults need between 7-8 hours of sleep each night. In the ICU, this is hard to achieve. Several studies have demonstrated that patients admitted to the ICU have severely disrupted sleep (Elliott et al. 2011; Bourne et al. 2007). These patients sleep in short, fragmented bursts, often only for a few minutes at a time. This means that they don't experience a normal sleep cycle and tend to suffer both from limited REM (rapid eye movement) and slow wave (or deep) sleep (Jeffs and Darbyshire 2019). It is thought that REM sleep helps the brain make sense of the world, and that deep sleep aids recovery (Lockley and Foster 2012), so disturbance and poor sleep are thought to be avoidable triggers for delirium in the ICU. Changing sleep patterns for patients in the ICU might therefore have an effect on their longer-term outcomes. Sleep is affected by pain, discomfort, and medication as well as the environment.

It follows then that improving opportunities for sleep and good quality rest

time should be an important part of patient care. Assessing patients regularly for signs of pain and delirium should be routine in the ICU (National Institute for Health and Care Excellence, Guideline 103, 2010) and prescribing appropriate analgesia and addressing other potential causes of delirium should be part of this assessment. There are clear benefits to recognising and treating delirium early (Milbrandt et al. 2004) and there is some evidence that sleep aids (eye masks and earplugs) can be protective against delirium (Litton et al. 2016).

Noise is a known stressor that affects staff as well as patients. It is likely that high noise and disturbance levels in the ICU hinder staff and may contribute to errors that compromise patient safety.

Normal speech volume is around 50-55 decibels. For speech to be easily intelligible, conversation volume needs to be about 15dB higher than the background level. In an enclosed space, such as a hospital ward, which also has acoustic properties that amplify rather than absorb noise, sound levels associated with continuous conversation will escalate quickly (Lombard 1911). This means that anyone in the environment has to work harder both to be heard and to hear. If it is harder to understand colleagues talking to you, you will be putting more effort into paying them attention and, by definition, this will monopolise your limited cognitive capacity. Concentrating on one task makes individuals prone to developing 'tunnel vision,' whereby they can no longer notice other events (Simon and Chabris 1999). Even distractions an individual is not consciously aware of can affect performance measurably (Greig et al. 2014), and most people overestimate their ability to multi-task. This is a particular hazard for staffing a department where care must be delivered 24 hours a day, as many of these vulnerabilities are compounded by fatigue.

There have been a number of initiatives trialled to reduce noise disturbances in

the ICU (Li et al. 2011; Boyko et al. 2017; Johansson et al. 2017; Darbyshire et al. 2018; Riemer et al. 2015). Many interventions focus on reducing activity and patient disturbance overnight or during 'quiet periods' during the day. Overall, sound level reductions have been limited, but other benefits such as reduced stress levels in nursing staff have been identified.

That overall sound levels have not changed significantly is perhaps not surprising. Environmental sound is measured as an average over a 24 hour period. With high peak sounds up to 16 times every hour (Darbyshire and Young 2013), it is

> **◀◀ 12 hour shifts are common, despite a wealth of evidence that this increases the risk of error and workplace accidents ▶▶**

easy to see how these can affect a mean value. In the hospital environment, simple volume averages may not be the most appropriate measures of noise. Humans interpret sounds as they hear them, and disturbance is not limited to volume. Context and quality of sounds are also important. Alarms share sound characteristics with a human scream or a baby's cry (Darbyshire et al. 2019) and are designed to attract attention. Patients in the ICU are likely to be in a state of hyper-vigilance. This will accentuate their likelihood of arousal which makes them more susceptible to disturbance from sound (Matthews 1990). Although lowering average sound levels seems difficult, reducing the startle effect with a view to lowering stress levels in staff and patients alike may lead to a more restful environment.

Working overnight places a significant

physiological and psychological burden on staff. It is arguable whether people can ever fully adapt even to 'permanent' night shift work. The ICU is a 24 hour environment and shift work is essential. In the short-term fatigue affects risk-assessment and decision-making abilities and, whilst people are reasonably good at judging how tired they feel, generally individuals are poor at judging how fatigue affects their performance. After 18 hours awake some responses can be as impaired as when drunk. It would be unthinkable to work under the influence of alcohol but it is common for clinical staff to care for patients after only a few hours sleep. It is known that shift-workers sleep very poorly during the daytime, perhaps only managing around five hours on average (Johnson et al. 2002). In the long-term, fatigue can also affect staff health and morale, with effects on cardiovascular outcomes, depression, and burnout (Ryherd et al. 2008; Topf and Dillon 1998; Tompkins 2009).

The Health and Safety Executive in the UK publishes guidance for industry about fatigue management, noting for example that shifts be '…not longer than 8 hours if work is monotonous, requires concentration or vigilance, is isolated, is safety-critical, and/or there is exposure to work-related physical or chemical hazards' (Health and Safety Executive 2006). Arguably all these risk-factors apply to routine ICU work, and yet 12 hour shifts are common, despite a wealth of evidence that this increases the risk of error and workplace accidents (Dall'ora et al. 2016; Folkard and Lombardi 2006). Two 12 hour night shifts carry the same risk as six 8 hour shifts, and it is worth remembering that bus drivers in the UK would not be permitted to these hours (gov.uk/guidance/drivers-hours-passenger-vehicles). It is hard to argue that ICU staff carry less responsibility.

As well as the risk to patients, there are personal risks to working fatigued. A recent survey of anaesthetic trainees

in the UK noted that falling asleep at the wheel whilst driving home after night shifts is not uncommon (McClelland et al. 2017), and globally there are reports of hospital workers being killed in motor-accidents attributable at least in part to fatigue (idealmedicalcare.org/sleep-deprived-doctors-dying/). Motorists who have caused accidents driving whilst fatigued have also been held criminally responsible for consequences (Rajaratnam and Jones 2004).

It is unrealistic to expect a dramatic change to working hours, but that does not mean risks cannot be better managed within the existing constraints of staff numbers and unit demands. The way shifts are organised affects the risks of fatigue, and controlling the way people transition from days to nights and back again is crucial. Shifts should always be organised so that people's days lengthen. It is much easier to cope with a transition from days, to long days, to nights, then take a few days off. Rapid cycling between shift type is also desirable. Full weeks of nights are not recommended and an ideal pattern would see staff work no more than three or four night shifts at a time (CAA 2002). ■

Key Points

- The WHO recommends that average daily sound levels in patient care areas should be around 35dBA, with peak sounds no louder than 40dBA.
- Noise levels in the ICU are increasing over time and WHO recommended level may be unachievable.
- Noise is a known stressor that affects staff as well as patients.
- Working overnight places a significant physiological and psychological burden on staff.
- The way shifts are organised affects the risks of fatigue, and controlling the way people transition from days to nights and back again is crucial.

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Night Service in the Intensive Care Unit of a University Hospital

This article draws attention to the extensive range of tasks and the stresses and strains during night duty in intensive care units. To this end, the range of activities of night duty nursing staff is presented using the example of the Hannover Medical School.

Night Service – An Important Service in the Multiple-Shift System

In order to ensure continuous patient care over 24 hours, work in the hospital area in a multiple-shift system is essential. In addition to early and late shift work, as well as other intermediate services during the day, night shift work is an integral part of the nursing staff's roster. In intensive care units (ICU) in particular, nursing staff perform a number of night shifts, since, in contrast to normal wards, a comparable personnel key must also be available there at night.

At present, the nursing staff lower limits regulation (PpUGV) regulates the care relationship between nursing staff and patients in Germany. According to this ordinance, nursing-sensitive hospital areas are considered separately, as there are correlations between the numbers of nursing staff and the occurrence of adverse events with regard to patient protection and the quality of care. In addition to the hospital areas of geriatrics, cardiology, neurology, trauma surgery and cardiac surgery, special regulations also apply to intensive care medicine. During the day,

a maximum of 2.5 patients may be cared for by one nurse in the ICU, while at night a maximum of 3.5 patients may be cared for by one nurse.

Those not involved are often unaware of the nursing activities that take place at night in ICU. The following text gives an overview by presenting the spectrum of activities in night service at the Hannover Medical School (MHH) as an example.

Areas of Responsibility in Night Service

In the ICU of the MHH, night duty usually begins at 7:45 pm. In addition to the ten-hour shift, employees are required to take a 45-minute break, so that the shift ends at 6:30 am.

At the beginning of each shift, the patients are first divided up in a short handover before a detailed handover at the patient's bed takes place. The nursing staffs then carry out a bed location check, during which the extensive technical equipment is checked and a patient inspection takes place. Among other things, monitoring the alarms on the monitors and checking

the infusion pumps and the ventilator, as they are having outgoing drains and secretion suction.

The complexity of the treatment cases at the MHH University Hospital differs significantly from that in hospitals providing standard care, and there is a broader range of treatment options. For this reason, intensive care nurses often care for multimorbid patients who are receiving dialysis therapy, are dependent on a heart-lung machine or need additional heart-supporting machines.

As the shift progresses, continuous monitoring of several patients simultaneously takes place. Despite a direct assignment of patients to each nurse, attention must of course also be paid to all other patients in the ICU. The trained specialist personnel continuously check the vital parameters and urine excretion as well as other disease-specific parameters of the patients and react to the alarms of the monitoring units. Any change in the general condition must be detected as soon as possible and requires immediate intervention.

Further tasks include the administration of medication as prescribed by a

doctor. Many drug therapies must also be administered continuously by infusion during the night. In the inter-professional patient data management system (PDMS), the responsible nursing staff has access to the treatment plan of each patient within the ICU. In addition to the data transfer from the medical devices, the laboratory values are transferred in this program and medical orders are immediately visible to the care team. In an hourly overview all arrangements are displayed. For example, medication orders, blood samples as well as microbiological examinations and other instructions for implementation appear there. In addition to the support provided by the documentation program, there is a continuous inter-professional personal exchange between the various experts.

By now, many other activities have been shifted to night duty. As a rule, there are fewer interruptions during the night due to planned examinations and visits by relatives. Therefore, at the beginning of the night shift, the nursing professionals provide basic and treatment care for sedated patients. In addition to personal hygiene, this includes responsible tasks such as changing dressings and repositioning the breathing tube.

At the MHH, a routine blood collection is carried out in the early morning hours in the ICU, for which the nursing staff prepares the required tubes and carries out the collection independently. In addition, a blood gas analysis is carried out at intervals of six hours, and more frequently if necessary. The nursing staffs are significantly involved in the evaluation of the results and immediately inform a responsible medical colleague in case of changes and critical results. During the night, as during the day, a permanent evaluation of the therapy takes place, so that the ventilation parameters, the drug therapy and the running rates of the perfusers are continuously adjusted.

At the MHH, the disposable material is also changed at night, which has a limited period of use due to hygiene

regulations. For example, the night shift changes the entire ventilation material, the suction system and the tube feeding system for enteral nutrition. In addition to these hygiene guidelines, work in the ICU is characterised by a high standard of hygiene. Patients are often treated with multi-resistant pathogens where special isolation measures are required.

> ◀◀ **the nursing staffs are significantly involved in the evaluation of the results and immediately inform a responsible medical colleague in case of changes and critical results** ▶▶

Emergencies can also occur during the night when a patient's health deteriorates acutely. Nurses must intervene quickly and act jointly with the medical profession. It is not uncommon for patients to be transferred from the normal wards or for emergencies to be admitted via the emergency department. In some cases, it is then necessary to transfer patients to the normal wards in the university hospital so that a patient with a critical state of health can be admitted.

Every action on the patient must be documented as in all shifts. The patient data management system described above is also used for this purpose.

The night shift ends for the nursing staff with a handover to the early shift.

Burdens for Nursing Staff and Patients

The description of the range of activities in the ICU of the MHH shows how demanding the work in night duty is. Nurses get into conflict with the biological rhythm of the body by working during the night.

When other people are usually asleep, the nursing staffs on night duty are awake. During the course of the day, carers have to sleep, while others go about their work and private lives. This altered rhythm can lead to fatigue and drowsiness (Ahasan et al. 2001). This increases the probability of mistakes at night. In one study it was shown that medication application errors and needle stick injuries occur more frequently during night work (Scott et al. 2006). Therefore it requires an enormous concentration of nursing staff, which is disturbed in particular by the high noise levels in ICU due to the technical equipment and the extended working hours of the night shift. In addition, the personnel key is lower during the night than during the day shift. As a result of the legal regulation already mentioned, nurses in ICU in Germany are generally responsible for 3.5 patients, although the condition of the patients does not change compared to the day. In one study it was shown that a low care key increases the risk of nursing staff suffering burnout (Aiken et al. 2002).

Working at night has other health effects for nurses and other professionals. Various research studies have shown that shift workers with working hours experience sleep problems during the night and that there is a correlation with the occurrence of diabetes mellitus type 2 (Pan et al. 2011). In addition, there is a dependency between night work and suffering from cardiovascular diseases and mental disorders such as depression (Moreno et al. 2019).

Another factor that can be caused by working at night is a reduction in the quality of life of those affected. The disturbed day-night rhythm can have an impact on interpersonal relationships, as the activities of daily life in our society are concentrated during the day. When friends and family members work regular hours, social interactions are more difficult (Ahasan et al. 2001). There are also barriers caused by the opening hours of government offices and service providers or the practice hours

of doctors, so that many nursing staffs are forced to shorten their sleep in order to be able to keep appointments. In addition to this aspect, carers are often restricted in their leisure activities by weekend services and working on holidays.

The night shift has an impact not only on the nursing staff but also on the patients. Patients' nocturnal rest is interrupted several times or in some cases permanently by sounds or light influences, which can have long-term consequences on the state of health and, for example, promote the occurrence of delirium. In particular, patients are disturbed by interventions on themselves or on their fellow patients (Bihari et al. 2012). Often diagnostic measures such as computer tomography, ultrasound examinations as well as catheter changes and operations have to be carried out at night because there was no capacity available during the day. These measures not only disturb the patients' night rest, but also mean a high workload for the nursing staff.

Although patient disorders can be reduced by consideration of the nursing staff, nightly nursing interventions cannot be avoided by necessary arrangements. Even disruptions caused by emergencies can only be eliminated by structural changes. When admitting patients at night, a night rest of the fellow patients in a multi-bedded room is not guaranteed.

However, in addition to the negative aspects listed, there are also advantages from working at night. Many nursing staff appreciate the undisturbed work during the night shift, as there are usually fewer interruptions to work processes due to examinations and telephone calls. In addition, visiting hours for relatives in ICU of the MHH usually end at 7:30 pm before the late shift is handed over to the night shift. The increased numbers of hours worked results in several days off in a row for the nursing staff, which are also allocated during the week (Ahasan et al. 2001).

Conclusion

During the night, many activities are carried out in the ICU of the MHH that go far beyond monitoring patients. On the basis of the description of the range of tasks, an overview of the activities in night service was given. It illustrates that night work is very stressful for both nursing staff and patients so it requires special consideration from many sides. On the one hand, the planning of night services should take into account the individual wishes of carers, so that they can combine their profession and their social activities. Nursing staff themselves must also take the effects on their own bodies seriously, so that working at night does not put a strain on their health. On the other hand, the care professionals must pay particular attention to the patients' night's rest, so that planned interventions on the patient

are carried out in the early evening hours if possible.

Despite the aforementioned burdens of night duty, work in a multiple shift system is absolutely essential in everyday hospital life. In order to recognise the work of carers, it is advantageous to provide more information about their activities and to professionalise the profession. In Germany, it is extremely important that the nursing profession is more appreciated and recognised by society. In addition, the financial allowances for night work are also too low. ■

Key Points

- Night shift work is an integral part of the nursing staff's roster.
- Intensive care nurses often care for multimorbid patients who are receiving dialysis therapy, are dependent on a heart-lung machine or need additional heart-supporting machines.
- Continuous monitoring of several patients simultaneously takes place.
- Night work in the ICU requires an enormous concentration of nursing staff, which is disturbed by the high noise levels in ICU due to the technical equipment and the extended working hours of the night shift.
- The disturbed day-night rhythm can have an impact on interpersonal relationships, as the activities of daily life in our society are concentrated during the day.
- Night service also affects the health of the nursing staff. Diseases such as insomnia, diabetes mellitus type 2, cardiovascular diseases and mental illness are related to night duty.

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ABSTRACT DEADLINE
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Shadowing the Nightwatch: Nocturnal Activity in the ICU

An article exploring the experience of an intensive care registrar overnight and the evidence supporting admissions, fatigue, judgement and morality in the circadian cycle.

At night, ICU feels like a fortress that has been put to bed for the night, and as a registrar, you have a role blended from sentinel, secretary, detective and a Valkyrie.

Crenelated walls of beds jut out into the ward; soft rhythmic hissing of ventilators are reassuring, and there's a constant low level litany of beeps. It feels like being inside an organism, listening to its heartbeat. The lights are low, but you'll hear hushed voices and footsteps, and computer screens sparkle at you; occasionally the blood gas machine whirrs or a phone rings from a relative wanting an update. The phone's irksome cousin, the alarm from the dialysis machine clotting, also makes itself known.

The Entrée

You'll have handover in an office somewhere and then do a round – trying to gracefully and noiselessly glide round your flock and check the plan is complete for the day; yet not disturb the patient. Noise and interrupted 'sleep' have become hot topics in the ICU.

In quarter-master role one checks fluid balances, blood gases; the tally of input output, vital signs and feedback from our nursing colleagues. Sometimes medications need adjusting or fluid prescribing. Our pharmacist colleagues may have helpfully annotated the drug chart. It is often here,

in the pre-witching hour calm that I've found myself having time to tidy them.

Typically, as it heads towards the embers of the day – 9/10 'o' clock, the first seeds of delirium germinate. On rare occasions this is being pleasantly mistaken for a hotel maid; but more commonly patients are distressed, agitated, and committed

> ❝❝ **delirium is a risk factor in itself for mortality as well as consuming nursing resources, extending hospital stay, and increasing risk of harm from hastily-removed devices or deficient monitoring** ❞❞

to removing any and all lines, drains and any other perceived manacles. There are certainly circadian cues that contribute to confusion – we know that sensory input is a way of calibrating patients to the here and now (Madrid-Navarro et al. 2015); and "sundowning" became a coined phrase amongst nursing homes for the elderly – this is more correctly a syndrome associated with pre-existing dementia (Canevelli et

al. 2016). I have often wondered if this not-infrequent phenomenon contributes to tales of possession or body metamorphosis at night. Even so, it is not to be underestimated. We know that delirium is a risk factor in itself for mortality as well as consuming nursing resources, extending hospital stay, and increasing risk of harm from hastily-removed devices or deficient monitoring (Diwell et al. 2018).

From a biochemical point of view, there are various theories about delirium being alterations in regulation of cerebral blood flow, a disrupted blood brain barrier, NO signalling, mitochondrial dysfunction, and of course, incongruous sensory input like constant new staff, unnatural light, constant sound, and polypharmacy with hypnotic and sedative drugs (Maclullich et al. 2008). Practically speaking, verbal reassurance can be enough, or reviewing organic reasons such as infection, pain or urinary retention reveals a cure. For delirium tremens – in my experience a suspicious and paranoid form of delirium – benzodiazepines prophylactically or acutely, are favoured. During chronic alcohol abuse, the GABA receptor is heavily modified. In abrupt cessation, inhibitory chloride currents from GABA receptors are attenuated, resulting in constitutive overactivity (Brousse et al. 2012). Henceforth, GABA agonists such as chlordiazepoxide or lorazepam are the

sensible choice. Personally, in that setting, I have found it works well. Pharmaceutical manipulation of other delirium is hotly contested and a capacious subject.

Midnight

The other side of midnight varies. We all aspire to a peaceful night watch. It is also the period when our own body clocks have succumbed to the nadir of cortisol signalling.

When it comes to ICU admissions, those either admitted or discharged between 00:00 and 08:00 have the highest mortality (Halpern 2015). This has made nocturnal discharges unfavourable as one would expect. However it is also easy to see why; unplanned admissions, emergency surgery (by definition overnight, life threatening) and only those patients unwell enough to be visited by the ravaged night on-call teams will tend to be brought to the attention of critical care.

Fatigue

One of the current questions with respect to nightwork is, "is it unnatural? are error rates larger?" I know myself that many units, unless urgent, prefer to perform procedures in daylight hours. It is unanimously agreed, we avoid surgery overnight.

Surgeons are some of the best studied with respect to fatigue and performance. Laparoscopic surgery skills are significantly impaired (at least on models!) on the first nightshift (Leff et al. 2008). In paediatric trainees, working on calls were equivalent to a significant blood alcohol level as assessed by driving tasks, and verbal and motor recall (Arnedt et al. 2005). Self-reported measures of impairment were more likely to be incorrect versus controls – suggesting poor judgement.

When it comes to anaesthetists, it has been shown those individuals working nights were more likely to be working on less sleep (Gander et al. 2008). Although averaged out across a set of shifts, this seemed to amount to <1 hour of acute

deprivation per day-period; however across 12 days this cumulative deprivation impaired memory and attention far more than previous laboratory studies would suggest. A heavy workload in that preceding 24 hours before a nightshift was also a risk.

Meanwhile both caffeine and napping have been shown to improve performance (Mednick et al. 2008; Lovato and Lack 2010); napping potentially more strongly (60-90 minutes in this study!), and has been incorporated into the Association of Great Britain and Ireland's Fight Fatigue Guideline. Even short naps of 5-15 minutes duration are shown to improve alertness for 1-3 hours (Association of Anaesthetists). Anecdotally, I work well after brief naps, and find them valuable in the sometimes less fraught 4-6am period, prior to the arrival of a road traffic accident trauma from morning rush hour.

> ❝ when it comes to ICU admissions, those either admitted or discharged between 00:00 and 08:00 have the highest mortality ❞

There are other, more sinister aspects to nightwork on medical professionals – increased risk of metabolic disease such as diabetes, cardiovascular pathology and early death (Abu Farha and Alefishat 2018). An American study also found concerns relating to effects on small children with parents who have altered chronobiology (Reinke et al. 2015).

Adrenaline

An alternate reality/superimposed state of being the intensive care registrar at night is descent to the ED to help manage a head injury, overdose, cardiac arrest or

equivalent. I am typically unhappy initially to receive these calls, and head wearily like Persephone for her stint in Hades; only on arrival to feel myself click into action. Many of us will recognise that adrenaline wakes us up and can initially offset fatigue – one would expect little less from a fight or flight system. However, interestingly most of the documented evidence comes from old experiments in the 1950's and 1970's. People were forced to sit down and watch radar monitoring for hours. Adrenaline correlated best with performance – and there was no gender discrepancy either (O'Hanlon and Beatty 1976).

When it comes to assessing how critical care should be delivered at night, a lot of attention has been given to debates about continuity of care (evidence now arriving that trained intensivist rather than same intensivist is key) (Halpern 2015), and whether senior/consultant led care is vital. Most UK units operate with remote supervision overnight, with consultants attending in extremis or for particularly knotty scenarios. At the least however, they are just a phone call away. I have always felt well-supported. We also know that with increasing age, sleep deprivation becomes more frequent with respect to nightwork, and also more cumulatively detrimental (Gander and Signal 2008). It is of note in the airline industry.

Decision-making

Lastly, and potentially least directly relevant but a closet worth exploring, is the effect of circadian cues, or even chronotype on morality. A landmark study demonstrated that not only were people more likely to cheat on tasks in the evening (and we could think of this as something like hand hygiene) and I certainly know my enthusiasm for tasks dwindles in the swansong of my shifts. Morality was affected by chronotype (Gunia et al. 2014)- by chronotype one refers to whether a 'lark' or 'night owl.' Sleep deprivation too, contributes to moral reasoning in military officers (Olsen et al. 2010); in

particular, the higher the morality in the rested state, the more is lost under duress.

Another disturbing feature was a study on the judiciary, indicating that favourable outcomes were related to how recently fed or rested a particular judge was (Danziger et al. 2011). I must say that I have always hoped for this, when booking the viva part of postgraduate exams, or interviews.

Conclusion

Overall, whilst on occasion it feels like Charge of the Light Brigade (charging into a closed ravine with gunfire), being the night registrar has its perks. The unit can feel very hushed and hallowed at night; you are aware of how vulnerable sleeping patients are, and feel like their shield. There can be more downtime in which to speak to nurses or tidy a few loose ends. There is a degree of autonomy; testing the elasticity of one's boundaries, and for me, the higher acuity patients often occur at night. I feel less like I'm orbiting the hospital, on a nightshift, and more plugged in to what the surgeons and the on-call medics are doing. You'll endlessly roam the corridors to find patients in wards you never knew existed (like Theseus, you may need string), but occasionally see another medic, which is a comfort. It is these brief moments of connection, and the blithe feeling of triumph, when you have successfully packaged up your patient, arterial line, ventilator, oxygen cylinder, nurse and porter, and arrive back into the safety of the unit, that you do feel like a returning conqueror. It satisfies the deepest hunter-gatherer instincts within me. Nights are unpredictable and hard. I am almost sure that when Machiavelli said "No enterprise is more likely to succeed than one concealed from the enemy until it is ripe for execution," he was talking about an emergency laparotomy. Despite this, they represent some of my most fruitful learning experiences in medicine. Learning to adapt our biology, or at least our psychology, to do least harm, would be a valid pursuit. ■

Conflict of Interest

None declared

Key Points

- Noise and interrupted 'sleep' have become hot topics in the ICU.
- When it comes to anaesthetists, it has been shown those individuals working nights were more likely to be working on less sleep.
- Napping improves performance and has been incorporated into the Association of Great Britain and Ireland's Fight Fatigue Guideline.
- There are other, more sinister aspects to nightwork on medical professionals – increased risk of metabolic disease such as diabetes, cardiovascular pathology and early death.
- When it comes to assessing how critical care should be delivered at night, a lot of attention has been given to debates about continuity of care and whether senior/consultant led care is vital.

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INFOGRAPHIC

THE NIGHT IN THE ICU

NIGHTTIME SLEEP IN THE ICU KEY ISSUES

➡ ICU patients' nighttime sleep is abnormal and fragmented with **reduced periods** of REM sleep.

➡ Findings from a study with medical and surgical ICU patients showed that **38%** of the patients experienced difficulty falling asleep, and **61%** reported a greater than usual need for sleep.

➡ Another study showed that **70%** of ICU patients with cancer experienced a moderate or severe level of sleep disturbance. **More than half** of the survivors had worse sleep patterns compared with pre-hospital patterns.

➡ Poor sleep has been identified as **one** of the most stressful aspects of an ICU stay.

➡ Light in the ICU is often at high levels at night, which **disrupts sleep**.

➡ Circadian rhythms are **temporally disturbed** in most ICU patients.

➡ Sleep deprivation is common and is also a risk factor for ICU **delirium**.

➡ Lack of sleep **increases** patient vulnerability and is characterised by increased sensitivity to light, noise, and activity.

Sources: sciencedirect.com/science/article/pii/S0964339715000439; ncbi.nlm.nih.gov/pmc/articles/PMC3149788/

CRITICAL CARE ALARMS

1 The average number of alarms per patient each day can be over **900** (one critical alarm every 92 seconds).

2 More than **40** different devices may be operating at the same time in the ICU.

3 Approximately **85% to 99%** of alarm signals do not warrant clinical intervention.

4 Studies show that **hospital noise levels** have increased by 0.38 dB/year during the day and **0.42dB/year at night** which is much higher than WHO recommended levels.

Source: longdom.org/open-access/prevalence-of-alarms-in-intensive-care-units-and-its-relationship-with-nursingstaff-levels-jpcic-1000118.pdf

PROTOCOLISED APPROACH TO SLEEP HYGIENE

✓ Dim the lights.

✓ Turn bedside alarms down.

✓ Close doors.

✓ Schedule assessments, diagnostic tests, and lab draws after 6 am.

✓ Offer patients earplugs, eye masks, and headphones.

Source: acphospitalist.org/archives/2017/11/simple-steps-help-prevent-icu-delirium.htm

BENEFITS OF AROUND THE CLOCK INTENSIVIST COVERAGE

■ Higher rate of diagnoses and procedures.

■ Improved survival.

■ Improved patient outcomes.

■ Lower complication rates.

■ Shorter ICU stays.

■ Reduced risk of death.

Source: atsjournals.org/doi/full/10.1164/rccm.201005-0826ED

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Engaging the Night Shift Nurse With Activities & Educational Opportunities

Providing different modalities and strategies helps engage the night shift and can enhance job satisfaction, workforce commitment, and recruitment and retention of nurses.

Caring for critical care patients during the nightshift hours has many unique challenges. In order to provide high quality nursing care at the bedside, continuing education is essential for every healthcare professional, regardless of the shift they work, according to a study (2019) in the American Journal of Critical Care (AJCC). Historically, nurses on the night shift find it challenging to learn during hours when they usually sleep, and Powell (2013) discovered that educational opportunities impact job satisfaction. According to Becker (2013), turnover rates for nightshift nurses are three times higher than for nurses who work dayshift hours.

One of the challenges with nights is the lack of available resources and leadership during these twilight hours. Managers, supervisors and educators usually work normal dayshift hours, Monday through Friday. When nurses had issues that needed leadership input, they would have to wait until daylight hours for them to be addressed. The same goes for resources, as professional development and other departments are not usually represented during night hours. As we realised the need to improve our nursing engagement on nightshifts, resources and leadership availability were offered for this specific staff population.

Yearly nursing opinion surveys were completed at a 650-bed Level 1 Trauma Center in Central Illinois. Low satisfaction scores related to professional development offerings specifically tailored for the night shift nursing professional were reported. Along with this dissatisfaction regarding lack of educational opportunities, job satisfaction scores for the night shift were down as well. To address these concerns, the Professional Development Department established a Carpe Noctem committee. Opportunities for night shift were offered including Dine and Discover teaching sessions, traveling Basic Life Support (BLS) cart, quarterly skills stations, new product in-services, simulations, celebration events, emotional intelligence sessions, and a professional development fair.

Carpe Noctem Committee

To improve nightshift engagement, the Carpe Noctem committee was established in 2016. This committee includes nightshift department supervisors and professional development staff. The committee member supervisors were surveyed to determine what specific educational activities the nurses would like to have offered on their specific units at night. Based on this information, the Professional Development Department established ways to address these needs. The challenge was to ensure this could be completed while containing costs and utilising current resources in the medical center. Incentives were provided for professional development staff to organise and provide education at night by receiving a work-from-home day. Subject matter experts in the medical centre were invited as speakers for events. Any refreshments provided came from the medical centre catering services. The committee had fundraisers and established their own monetary fund and the Professional Development Department provided funds for more costly events.

Nightshift Considerations

Research on addressing the engagement of nightshift workers is very limited. A comprehensive literature search completed by a medical librarian resulted in 16 articles dating from 1982-2019. Carney (2015) completed a study involving 19 affiliated United States Midwest hospitals to understand the unique problems of nightshift workers compared with dayshift workers. From the study results, they determined in order to be a nightshift friendly organisation, they needed to establish leadership presence at night, professional development that did not interrupt sleep schedules and equal perks for all shifts.

Several issues needed to be addressed to effectively provide education during the night shift. Limited coverage affected nurses' ability to leave the unit to participate in educational activities during their

shift. Patient-to-nurse ratios for nights are higher, making it more challenging. Bringing education to each unit allowed for fewer patient care interruptions. It was also discovered that more novice nurses work this shift with fewer nurse experts available. A variety of interactive teaching methods was found to be most effective. The timeframe to provide education and engagement was also considered. According to the National Sleep Foundation (2020), the adult circadian biological clock has the strongest desire to sleep from 2 to 4 a.m. This time frame may not be conducive to retention of knowledge, so the focus was on kinesthetic learning for any education during this time. Most engagement was offered from 11 p.m. to 2 a.m.

Dine and Discover Teaching Sessions

One of the first educational offerings established is a monthly Dine and Discover. Thirty-minute educational sessions are offered at three different times during the night shift. Food is provided to encourage attendance, and 0.5 continuing education unit (CEU) is given. Some of the topics covered were sleep management and wellness, first five minutes of code blue, workplace safety, patient fall prevention, surviving the night shift, legal aspects of nursing, chest tubes, hypothermia, and telehealth.

Travelling Basic Life Support (BLS) Cart

According to the American Heart Association (AHA) (2015), high-quality BLS is crucial to improve patient outcomes and mortality. Data from the defibrillators and the skills competency manikins showed that compression and ventilation skills were not high quality. To ensure nursing staff had the ability to practice and retain BLS skills, a once-a-month travelling cart with voice-activated manikins was started. Professional development BLS instructors travel with the cart from 1 to 4 a.m. and visit the nursing units. Nursing staff was able to complete the hands-on skills portion of the AHA Heart

Code BLS, ACLS or PALS course and had access to additional educational assistance.

Quarterly Skills Sessions

Another need for nights was an opportunity to provide skills education and certification renewal on hospital equipment. Nightshift staff historically would have to come in early before their shift, stay after their shift, or come in during the day hours to complete needed education. Hands-on skills stations are provided throughout the year during night hours by professional development staff to ensure proper training. Examples of skills provided are restraint use, blood glucose monitoring, intravenous pump use, automated external defibrillators (AED) operation, electronic medical record documentation/mobile inpatient electronic health record, and emergency crash cart usage.

> ❝ the nursing staff are significantly involved in the evaluation of the results and immediately inform a responsible medical colleague in case of changes and critical results ❞

New Product In-services

Change is inevitable in healthcare and this includes medical products that nurses need to provide care. As product vendors' change or new products are adopted, providing education on proper use of the products is vital for the safety of the patient. Providing education by rounding on the units during nights ensures nurses have the education they need to use the products. Examples of product-oriented education that has been provided are blood warming equipment, bag mask valve device, indwelling urology catheter kits, and non-invasive respiratory masks.

In-Situ Simulations

In-Situ (meaning in the normal location) Code Blue Simulations were created to provide the nightshift staff the opportunity to be part of an activated unannounced Code Blue, using the current activation process on the units and public access areas of the hospital during the daytime; however, many of the nightshift staff are inexperienced or in orientation and have not been exposed to a pre-arrest or cardiac arrest situation, especially outside of the intensive care units and emergency department. The Family Birthing Center also provided unannounced in situ simulation of an unexpected infant delivery from a high-risk mother during night shift quarterly or when there was an influx of new nurses to the department. It is crucial to provide the staff opportunities and experiences of a Code Blue to improve team communication and patient survival. These simulations showed multiple knowledge and system gaps that needed to be addressed. Many process improvements were created to improve the educational and system gaps.

Team Building and Celebration Events

Building team dynamics is crucial for healthcare professionals as teamwork is necessary for the delivery of effective high-quality care. Nursing has been known to have different team dynamics between day and night shift staff. In order to improve these relationships as well as night shift team camaraderie, entertaining events were planned. Friendly competitions of hospital games and "escape room" were planned to celebrate Hospital Week. For summer, a barbecue was held outside, and staff were able to attend during their meal break. Each fall, the final night of Daylight Saving Time results in healthcare workers having to work an extra hour for their shift, as clocks are turned back. To make this night less stressful and to celebrate nightshift employees, a Lag Night celebration occurs with a meal served to every staff member. Professional development staff, along with hospital leaders, served

the meal and delivered meals to units that were actively involved with patient care. An opportunity to receive flu immunisation was also offered during this celebration.

Personal, Professional and Leadership Growth and Opportunities

To ensure that nurses on nights have opportunities to develop leadership skills, emotional intelligence sessions were offered. Having great emotional intelligence has shown to be vital for personal and leadership success, according to Bradberry and Greaves (2009). Sessions were offered every three weeks with six sessions from 12:30 to 1:30 a.m. Another opportunity provided was an educational session on how to create a more positive workplace environment, followed by a group discussion. To ensure nurses on nights are informed and connect with leadership, yearly education on the outlook of the medical center is offered during night sessions, and leader rounding is scheduled as well. To encourage professional growth, a yearly professional development fair is held during the night shift. The fair includes information on national certifications, local academic institutions offering BSN or MSN degrees, professional development resources and classes, with each unit able to be represented.

EKG Virtual Reality (VR) Course and Intraosseous (IO) Access Virtual Reality (VR)

Self-paced learning and the modality of the education being delivered are crucial to adult learning. Using VR technology allows staff from all shifts to access to education 24/7. The EKG VR course was created for learners and new employees in critical care or emergency medicine as an option to opt out of an eight-hour in-seat EKG course that is held only during the day. Many learners are able to take the EKG VR course to help prepare for the arrhythmia portion for ACLS or PALS certification courses. The IO course is currently being created to help prepare for the IO cadaver lab or as a refresher for IO placement. Another VR course that is being trialed is fire in the operating room.

Conclusion

Since increasing these educational and engagement opportunities specifically for night shift, job satisfaction and professional development scores have improved. Since implementation of night shift satisfaction scores in 2017, the scores increased from 4.06 to 4.2 in 2018 and to 4.25 in 2019. This demonstrated that implementation of nightshift offerings in 2017 was making an impact and scores improved for 2019 (**Figure 1**).

Future strategies will be to continue these sessions, because attendance at the sessions has been strong and nightshift staff satisfaction scores and engagement scores continue to increase. Another needs assessment will be performed to determine current educational and system gaps and review 2020 nightshift staff satisfaction scores. ∎

Acknowledgments

Key Points

- Caring for critical care patients during the nightshift hours has many unique challenges.
- One of the challenges is the lack of available resources and leadership during these twilight hours.
- In order to provide high quality nursing care at the bedside, continuing education is essential for every healthcare professional, regardless of the shift they work.
- Building team dynamics is crucial for healthcare professionals as teamwork is necessary for the delivery of effective high-quality care.
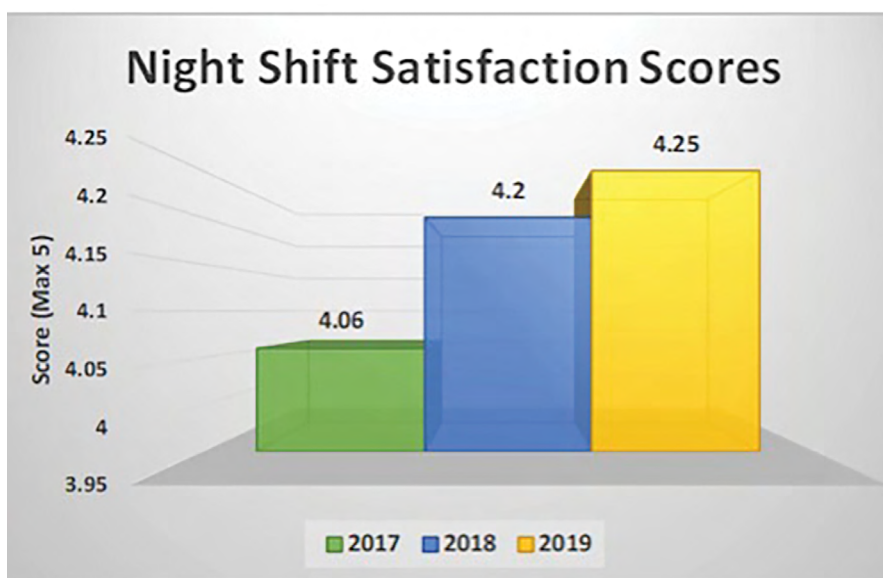
Figure 1. Nightshift Satisfaction Scores

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MANAGEMENT

Human Factors in Critical Care Medicine

The lack of non-technical skills is associated with poor performance and patient harm in medicine.

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Human Factor (HF) is an established scientific discipline that studies the interrelationship between humans, equipment, and work environment. Core aspects of HF, widely known as non-technical skills (NTS), include three dimensions 1) cognitive (situation awareness, decision making), 2) interpersonal (communication, team working, leadership), and 3) personal resources (managing stress and coping with fatigue) (Flin et al. 2008). Additional important NTS include empathy and resilience.

The study of HF began in the aviation industry about 40 years ago after studies suggested that deficiency in NTS may have been significant in fatal accidents. The world of aviation with its emphasis on safety has directly influenced our current approach to anaesthesia, critical care medicine, and healthcare safety in general. NTS are as important to promoting patient safety as the technical knowledge and expertise required to clinically treating patients' physiological abnormalities. NTS training was developed recently in healthcare as a result of many reports showing that the lack of NTS might lead to medical errors and patient harm. In fact, the main objective of HF is to optimise the interaction of humans with their work environment and technical equipment in order to maximise patient safety and efficiency of care.

Situation Awareness

Situation awareness (SA) is defined as the perception of the elements in the environment within a specific volume of time and space, the comprehension of their meaning and a projection of their status in the near future (Endsley 1995). The basic components of SA are 1) perceiving (an active process of collecting data and gathering information by observing the environment and monitoring all the sources), 2) understanding (combining data with knowledge and experience, interpreting information collected from the environment to identify the match or mismatch between the situation and the expected state), and 3) projecting (anticipating future events). Accurate SA is very important for subsequent decision-making, teamwork and task management, and it is therefore crucial for providing optimal performance during care and treatment of critically ill patients (Endsley 1995).

Decision-making

Decision-making(DM) is the process of choosing a course of action in a scenario that offers multiple alternatives to meet the needs of a given situation. The two main styles of decision-making are intuitive, or type I, and analytical, or type 2. The intuitive decision style is the ability to make quick decisions when time is short, based on previous experience. An intuitive decision style is developed through practice; it is a rapid, subconscious and automatic process. The analytical decision style is developed in a thorough, slow, systematic and logical manner and it is generally more reliable. It is characterised by spending time reviewing all the details and making sure all decisions comply with formal guidelines and requirements, and it implies a subsequent analysis of advantages and disadvantages for each option. The DM process includes evaluation of the situation and multiple alternatives, choice of one of these alternatives, implementation and communication of the decision made, and finally, re-evaluation (Croskerry and Nimmo 2011). In a life-threatening emergency and in an intensive care unit (ICU) setting, meta-cognitive strategies could include a personal reflection on human factors principles within the clinical situation, attention to self-awareness about potential cognitive errors and taking a moment to pause before rushing into new decisions (Reason 2000).

Communication

Communication is the exchange of information between people through speaking, writing or by other medium. The process includes a sender, a receiver and the channel (medium). It can be classified as verbal (oral or written) and nonverbal. Nonverbal communication can include signs, symbols, gestures, body language and facial expressions. It can complement, repeat, reinforce,

substitute, regulate, or even contradict verbal communication. Clear communication means that information is conveyed effectively between people.

Effective communication among team members is widely recognised as one of the most important factors in delivering high-quality healthcare, especially in a complex setting such as an intensive care unit, where different professionals interact with each other (Vermeir et al. 2015).

The Joint Commission reported that communication errors were at the top of the list of root causes of sentinel events in hospitals, contributing to 65% of events. Most communication errors occur during the handover of patient care between different groups (Siewer and Hochman 2015). Error-reporting systems now frequently focus upon poor communication as an antecedent to error in critical care medicine; interventions to improve communication in the intensive care unit have resulted in reduced reports of adverse events, and simulated emergency scenarios have shown effective communication to be correlated with improved technical performance (Reader et al. 2007).

Teamwork

Teamwork is the process of working collaboratively with a group of people in order to achieve a goal. Intensivists and non-intensivist physicians, critical care nurses, advanced practice providers, pharmacists, respiratory care practitioners, rehabilitation specialists, dieticians, social workers, case managers, spiritual care providers, each one of them provide unique expertise and perspectives to patient care, and therefore play an important role in a team that must address the diverse needs of patients and families in the ICU (Donovan et al. 2018). The principles that characterise a successful health care team include 1) shared goals, 2) clear roles, 3) effective communication, 4) measurable processes and outcomes, and 5) effective leadership (Mitchell et al. 2012; Schmutz and Manser 2013).

A growing body of literature links the quality of teamwork to the quality and safety of health care delivery. Work in this area has focused on three domains: (a) the quality and safety of care, (b) patient experience, and (c) clinical patient outcomes (Rosen et al. 2018).

Leadership

Leadership can be defined as the ability to lead a team, considering the particular needs of each team member, following high standards of clinical care. Valuable leadership skills include the ability to delegate, inspire and communicate effectively. Other leadership traits include honesty, confidence,

> ❛❛ **effective communication among team members is widely recognised as one of the most important factors in delivering high-quality healthcare, especially in a complex setting such as an intensive care unit** ❜❜

commitment and creativity. The leader should also prioritise the importance of the team goal over other individual member goals, and he should motivate team members and establish a positive environment. The role of the leader is to keep the big picture and the control of the situation. The team members will unavoidably be consumed with their actions, but this must not happen to the leader. The leader cannot let himself engage in any particular task that would narrow his attention span; the leader sets the priorities for any given moment, delegates the tasks, and respectfully takes feedback from others (Riskin et al. 2015).

Managing Stress

Work-related stress is the response people may have when presented with work demands and pressures that are not matched to their knowledge and abilities and which challenge their ability to cope. Because workplace stress can influence physical and emotional well-being, and reduce efficiency and quality of life, dealing with stress is a big challenge for many healthcare professionals. Causes of occupational stress include long hours, excessive workload, dealing with death and dying, interpersonal conflicts with other staff, unfair management practices and lack of support from supervisors and managers. Stress may be associated with irritability, job dissatisfaction, depression, and sleep problems, and also with absenteeism and job turnover. Effective interventions to prevent work stress and to improve job satisfaction of employees are of the utmost importance. Stress management training can reduce the degree and intensity of current stress reactions as well as help to develop skills for preventing additional, harmful stress reactions. Therefore, healthcare institutions and management should include stress evaluation tests and coping models for improving job satisfaction and productivity. Stress is normal and, as human beings, we have multiple strategies for coping with stress. Therefore, working in a highly stressful department like intensive care and frequently managing life-threatening emergencies will not be an issue, unless the amount of stress exceeds our coping mechanisms for dealing with that stress. The key factor is, therefore, self-awareness of your own coping anti-stress mechanism (Koinis et al. 2015).

Coping With Fatigue

The link between health care workers' fatigue and adverse events is well documented, with a substantial number of studies indicating that the practice of extended work hours contributes to high levels of worker fatigue and reduced productivity.

Fatigue can lead to memory lapses, delayed judgment, diminished reaction time, lapses in attention or inability to stay focused, ineffective communication, irritability, and lack of motivation. To reduce the occurrence and impact of health workers' fatigue, the Joint Commission recommends that all health care organisations should consider inviting employee input when creating work schedules to reduce fatigue, adopt a fatigue-management plan with scientific strategies for reducing fatigue, educate staff on the importance of sleep and sleep hygiene, and consider fatigue a potential cause when reviewing adverse events (Noone and Waclawski 2018).

Empathy

Empathy is an essential element in providing quality patient care and consists of the ability to understand and share the feelings of another. Expressing empathy is highly effective and powerful; it builds patient trust, calms anxiety, and can improve health outcomes. In fact, a meta-analysis of studies that evaluated various contextual influences on patient outcomes found that physicians who adopted a reassuring, warm and friendly approach were more effective than those employing a detached concern (Di Biasi et al. 2001). Despite the clear importance of empathy in clinical settings, many physicians experience difficulties in empathising with their patients. Empathy towards co-workers is also a key skill in the workplace. It can help in resolving conflicts, in building more productive teams, and it contributes to the improvement of the relationships among colleagues.

Resilience

Resilience is the process of adapting well in the face of adversity, trauma, threats or significant sources of stress. It is an important skill in critical care medicine because it plays a role in the ability to withstand both everyday workplace stressors and serious incidents without becoming psychologically harmed. Low resilience is associated with burnout, low compassion satisfaction, high secondary traumatic stress and more frequent use of maladaptive coping mechanisms, including self-blame, behavioural disengagement and substance use (McCain et al. 2018; Baid 2018).

Non-Technical Skills Assessment and Training

There are several tools in literature to evaluate NTS that should be applied in critical care medicine. Training, including simulation, to develop NTS, has been successfully introduced in the past years with significant benefits (Flin and Maran 2004; Hagemann et al. 2017). Simulation has multiple well-documented advantages including meeting educational needs, improving individual and team performances, identifying latent patient safety threats and infrastructural defects. Furthermore, simulation can facilitate introducing protocols and guidelines and assessing their application. Several patient safety incidents appear to be related to deficiencies in human factors and ergonomics. Simulation provides an ideal approach not only for addressing deficiencies in human factor skills, but also in analysing and addressing key environmental and organisational issues and how these interplay and affect outcomes in-patient care pathways. Simulation is especially important in ICUs as patient care is complex and multi-disciplinarian, therefore increasing the likelihood of medical errors. There are barriers to setting up a simulation programme, mainly related to costs and clinical workload.

Conclusion

There is scientific evidence that the lack of NTS is associated with poor performance and fatal errors in critical care medicine. The principles and practice of HF can help intensivists and all the multidisciplinary ICU teams to deliver high quality of care to patients and to work in a nicer and more productive environment (Carayon 2006; Carayon 2010).

Conflict of interest

None

Key Points

- Human Factors (HF) is an established scientific discipline that studies the interrelationship between humans, equipment, and work environment.
- HF include situation awareness, decision making, communication, team working, leadership, managing stress and coping with fatigue, empathy and resilience.
- The main objective of HF is to optimise the interaction of humans with their work environment and technical equipment in order to maximise patient safety and efficiency of care.

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For full references, please email editorial@icu-management.org or visit https://iii.hm/11zt

AGENDA

For a full listing of events visit https://iii.hm/133l

SEPTEMBER

7-9
ERS 2020 - European Respiratory Society International Congress
Virtual conference
https://iii.hm/14a7

12-13
ESICM EuroAsia 2020
Hybrid conference
Taipei, Taiwan
https://iii.hm/14a8

14-15
BACCN 2020 - British Association of Critical Care Nurses Conference
Virtual conference
https://iii.hm/14a9

15-18
e-ISICEM 2020
Virtual conference
https://iii.hm/14aa

19-22
EuSEM 2020 - The European Emergency Medicine Congress
Virtual conference
https://iii.hm/14ab

OCTOBER

2-5
ANESTHESIOLOGY 2020
Virtual conference
https://iii.hm/14ac

16-19
EAPS 2020 - European Academy of Paediatric Societies
Virtual conference
https://iii.hm/14ad

NOVEMBER

2-6
38th Vicenza Course on AKI & CRRT
Virtual conference
https://iii.hm/14ae

13-15
e-SMART - 31º SMART 2020 - Anaesthesia, Resuscitation & Intensive Care
Virtual conference
https://iii.hm/14af

19-21
WCID 2020 - World Congress on Infectious Diseases -
Rome, Italy
https://iii.hm/14ag

28-30
Euroanaesthesia 2020
Virtual conference
https://iii.hm/14ah

DECEMBER

1-4
10th World Congress of the World Federation of Pediatric Intensive
& Critical Care Societies
Virtual conference
https://iii.hm/14ai

2
4th World Day of the Critical Lung
Virtual conference
https://iii.hm/14aj

5-9
ESICM LIVES 2020 - 33rd Annual Congress
Madrid, Spain
https://iii.hm/14ak

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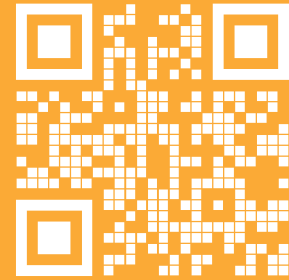
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