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Nursing Human Factor During COVID-19 Pandemic

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Abstract This paper explores the effects of COVID-19 pandemic on nurses capacity of delivering services to infected patients with minimal risks. The role of nursing during the first four months since the outbreak of the COVID-19 is reviewed. The nursing, both preventive service and response preparedness are evaluated along with their human factor in such a crisis are evaluated. Then the researchers argue about the importance of human factor tools and how they could impact the different challenges and risks that the nurses are going through during the COVID-19 pandemic at various stages, till the time of this paper. A specific framework is exploited, and its implications and limitations are discussed. This research makes two main contributions. From a theoretical perspective, it sheds light on how specific dimensions of human factor could help to raise the capacity of the nurses and their availability, therefore their reliability during a dynamic and complex pandemic as COVID-19. From a practical implication, this study could help prepare nurses for the coming pandemics with better overall productivity effectiveness that would lead to less nurses suffering, beside minimisation of risks and most of all deaths. Future research may extend the present study and test the various propositions made, notably through alternative data collection methods.

Keywords COVID-19, Pandemic, Nursing, Nurses, Human Factor, Overall Productivity Effectiveness

1. Introduction

The number of outbreaks has tripled in the last several decades and the economic impact of the human immunodeficiency virus (HIV), severe acute respiratory syndrome (SARS), Ebola, H1N1, and other diseases, has been staggering. Yet, only a few countries have carried out epidemic or pandemic preparedness exercises. The World Bank (2017) emphasis that a global preparedness for pandemic outbreaks is critical to world security and must be included as part of the strengthening health care delivery systems.

Nursing is the main active partners in any primary and secondary infectious disease prevention efforts. In every country, regardless of their socio-economic development, nursing is considered to be the top first line dedicated profession in the prevention from diseases and alleviation of suffering during and after a treatment of any disease, including the COVID-19. (WHO, 2020a).

Nurses were and still are the pioneers in developing all the best practices in relevant to patient management and clinical safety. Their capacity and effectiveness thrive more during crisis, wars, disaster and even in infectious disease pandemics, as the COVID-19. In this paper, we shall review the nursing roles, responses and challenges before and during pandemics and shed light on what they have managed to do during the first five months of the COVID-19 outbreak, to set the background of this research.

The authors illustrate throughout the review, the core role of nursing in creating inter-disciplinary bridges and effective teamwork, especially during the different stages of mitigation or in response to the surge of the COVID-19 cases. The role of nursing in managing the different infected patients, their personal sacrifice, along with their challenges, are compared to their relevant experience from previous outbreaks, are further explored.

Based on realising the importance of the role of nursing in the COVID-19 pandemic, the authors present the essential implementation of the human factor to support the overall productivity effectiveness of the nurses during an awful contagious disease as the COVID-19. Evidence of nurses needs of human factors during the COVID-19 crisis is exploited and linked to the patient safety and reduction of the vulnerable system syndrome.

To enhance nurses 'overall productivity effectiveness' (OPE) to pandemics, we need to work on raising their capacity to respond to the demand pressure that usually comes with fierce pandemics with minimal errors or malpractice. This means the nurses' psychological stress needs to be managed while enhancing their preparedness to different types of outbreaks scenarios and raise their

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'resilience capacity'.

The paper shows the importance of customising the tools of the human factor to compensate with the nursing COVID-19 challenges and to improve the nurses capacity for capturing errors (incidents) at the right time. A change management model is proposed to minimise the negative impact of nursing errors stigma during the pandemic. The authors show how this is important more than ever today to eliminate nurses needs to reach social media when their essential safety rights are not addressed. Based on the literature review, a nursing human factor framework, suitable to the COVID-19 pandemic is proposed.

2. Literature Review

2.1. Role of Nursing During Pandemics as COVID-19

2.1.1. COVID-19 as a Dangerous Pandemic

In December of 2019, reports emerged about pneumonia clusters, of unknown cause, at the health facilities in Wuhan, China. These cases were linked to a wet animal wholesale market in the region and, after extensive epidemiologic investigation, led to the identification of a novel coronavirus (COVID19). COVID-19 is among a family of viruses — called coronaviruses — that can affect both humans and animals, where the infections of this coronavirus are respiratory in nature and can range from the common cold with mild symptoms to more severe infections, such as Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) (World Health Organization (Zhu et al., 2020; WHO, 2020a). The newly identified COVID-19 infection typically presents as fever, tiredness, fatigue and a dry cough. However, more severe symptoms such as dyspnea, diarrhoea, pneumonia and others have been reported. As of March 9, 2020, cases of COVID19 have been reported in countries across the world, and thus the WHO declared the pandemic alarm. Since then, and till the time of the submission of this paper, the estimated number of reported cases has surpassed 2.0 million with almost 125,000 deaths (WHO, 2020a), (Choi et al., 2020).

2.1.2. Nursing Roles, Responses & Challenges in Pandemics

Florence Nightingale is one of the earliest nurses and the pioneers who dealt with epidemics through the principles of hygiene and sanitation. Nightingale showed the relation between infection control and hand washing (World Economic Forum, 2020). The lessons of Florence Nightingale's nursing practice during the Crimean War are still being applied today during the COVID-19 pandemic — essential handwashing, maintaining standards of cleanliness, learning from the data, and more. (Bonnie et al., 2020).

The World Health Organization, Department of Pandemic and Epidemic Diseases (WHO-PED) develops strategies, initiatives, and mechanisms to address emerging and re-emerging epidemic diseases to reduce the impact on affected populations and limit international spread. Part of the policies and protocols are focused on the role of the healthcare team led by the nurses on how to deal with diseased patients.

Since this a novel virus epidemic, all COVID-19 protocols are expected to be deployed mainly by the nurses and the community health workers. At the same time, nursing leaders must formulate more practical solutions (Corless et al., 2018).

2.1.3. Role of Nursing as a Hook for Inter-Professional Teamwork

The role of nurses goes beyond the care for the patients; they are considered the secured hook that integrates all the interprofessional teams and communities across different professions or sectors to ensure the effective communication for mitigating risk as to the latest coronavirus global pandemic.

Emerging global pandemics pose high risks for individuals and communities. Nurses play a very crucial role in preparing the healthcare services for managing and mitigating infectious diseases, as COVID-19, which are considered to be the third leading cause of death worldwide (WHO, 2020a).

One of the challenges of the COVID-19 is the time delay in the early identification of infections, due to its long incubation period that might extend to about fourteen days on average. This poses a threat to health care staff, especially nurses, who would be the initial point of contact with the infected person. (Corless et al., 2018).

2.1.4. Experiences with Previous Outbreaks

Nurses were always the first line of meeting the patients in all the previous outbreaks. The recent experience for the Ebola outbreak, demonstrates, for example, how the lack of nurses preparation and communication gap during the alert phase when a pathogen has been identified contribute to a delayed response and increased their number of mortality and morbidity (Dzau & Sands, 2016).

2.1.5. Nurses Leading the Core Team for the COVID-19 Prevention and Response Efforts

2.1.5.1. Role in Response to COVID-19

Nurses are central force team for preventing and responding to any pandemic, including the COVID-19. This is due to nursing being the most significant healthcare profession in all the sector in any country. For example, in the United States, the number of nurses reach approximately 4 million nurses, while today, there are more than 20 million nurses worldwide. Nurses were and still are the most important service provider and the front-line care professional that stand near the patients' journey when they face a complex disease that requires hospitalization and even intensive critical care, as the COVID-19.

Similar to many previous and recent infectious outbreaks,

nursing resources are considered the most critical factor that would define the capacity of any hospital for managing any COVID-19 cases or population, EDT (2020). Their role and demand even surge when many of the admitted cases have pre-existing health conditions, and when the patients are vulnerable to mortality, i.e.at greatest risk. (Jiang et al., 2020; Pan et al., 2020).

2.1.5.2. Role in Preventing COVID-19

Nurses also play a key role in providing public education, especially in infectious diseases prevention and in reducing the spread of misinformation around these diseases outbreak (Wen et al., 2020), (Choi K, Jeffers K. S. & Logsdon C., 2020) [5].

The main known role of nurses during a worldwide response to a novel coronavirus like COVID-19 is to assist the sick and address their concerns. However, nurses are expected to play an even more pivotal role in preparation for- and management of- the pandemic. The nurses' role in a pandemic begins even before a disease has an opportunity to cause widespread devastation. In a 2018 policy brief, the ANA said nurse leaders are the key to preventing and containing widespread illnesses. They have the skills and education to develop coordinated global networking and properly identifying infectious diseases (American Nurses Association 2020) [2].

The gap in the incorporation of nursing knowledge and skills related to screening, disease identification, rapid response, community involvement, inter and intra-agency communication, governmental notification, and coordination need not remain challenges to adequate and timely responses (Corless et al., 2018) [7].

2.1.5.3. Role of Nursing in the Psychological Healing of Patients During COVID-19

Nurses play a great role in reassuring the patient during the different phases of the disease. With the fluctuating symptoms of the COVID-19, patients found to be fearful and require consistent support and reassurance.

Besides fear, the COVID-19 patients might develop strong emotions and psychological trauma; the nurses can experience that through their level of grief and anxiety. The COVID-19 patients have plenty of reasons for panic, especially when they are isolated or separated from those who they love, besides being worried about their livelihood. Hence, a nurse has to play a role of calming the patients and easing their uncertainty, misinformation, over-information about the dangers of the disease.

2.1.6. Role of Retired Nurses During COVID-19

The demand for nursing services to combat the outbreak of the COVID-19 is unprecedented. Hence many retired nurses were called to come back for help. (Gilory and Ford, 2020). In the United Kingdom, the government considered recalling the retired nurses, knowing that they are essential for the frontline of the NHS system and will be the first responders as COVID-19 moves through the community. In the USA, many nurses delayed their retirement plan so that they support their colleagues to manage the surge of emergency patients or to deliver support for screening and testing (American Nurses Association, 2020).

2.1.7. Transforming Nurses to Critical Care Units

During the height of the COVID-19 pandemic, the number of patients that required ventilatory support outnumbered the available intensive care unit (ICU) beds. General beds were rapidly converted to ICU beds. Even general hospitals were converted to critical care hospitals. This required a transformation of many nurses to be trained on critical care medicine, and many were transferred to service in different hospitals to fill the gap as it occurs (Hopman et al., 2020).

Till the end of March majority of the studies confirm that about 20% of suspected and confirmed patients with SARS-CoV-2 infection developed severe hypoxemia and required some form of ventilatory support such as a high-flow nasal cannula and non-invasive and invasive mechanical ventilation. And since there is no antiviral agents have been proven to be effective against the coronavirus, therefore, the nursing services for the critically ill COVID-19 patients remains supportive rather than definitive. This created remarkable physical and mental workload for intensive care physicians and nurses. WHO (2020b).

2.2. Enhancing Nurses Expected Responses During Pandemics

2.2.1. Managing Nurses Psychological Stress

Nurses across the world struggled with the impact of COVID-19 on their life, their families and besides the demands for long hours work and concerns about working environment safety. In Italy, for example, many frontline COVID-19 nurses collapsed due to lack of sleeping while having bruised for using a tightened face mask and a relentless 10-hours shift. Some nurses complained that they could not go to the toilet or drink for more than six hours. Many posted on the internet how much they are stressed and being afraid of adequately putting the PPE, or having accidentally touch any dirty surface.

Sabah (2020) reported about a 34-year old Italian nurse who was working on the frontline seeing the suffering of the coronavirus patients at the intensive care unit of a hospital in Lombardy, the worst-affected region of Italy, committed suicide after testing positive for coronavirus. The National Federation of Nurses of Italy said that the known cause is that she killed herself out of fear that she was spreading the virus without knowing to many of her colleagues and patients.

The situation is even worse in the city's nursing homes, with nearly 1,500 health care workers infected out of just over 5,800. Bergamo has been so overwhelmed that the army has stepped in to move bodies to other provinces because the local cemetery was too full (Sky News. UK., 2020).

The consistent news coverage about COVID-19 about different countries in the world starting from China, Italy, Spain, UK, and the USA, for weeks, created a sense of anxiety amongst the nurses because they have seen that regardless what are hospitals preparedness, many experienced the worst-case scenarios. (Baumgaertner and Karlamangla).

The close contact with COVID- 19 patients has affected many nurses, and many could not be sent home because of the shortage of staffing. Many organisations asked their health workers who are treating COVID-19 patients to continue working with them until they show symptoms of the disease, in order to recover the staffing needs (Baumgaertner and Karlamangla, 2020) [3].

2.2.2. Resilience of Nurses During COVID-19 pandemic

Resilient nurses made a difference in many success stories during the war rounds with the COVID-19. Their ability to coop was and still so high and their conviction, despite many challenges and circumstances, as a shortage of staff and resources, made them unique in being able to deliver care with compassion during a very contagious disease (Bonnie et al., 2020).

The repeated surge demand for the critically ill patients required the nurse to work with high resilience with a response team consisted of medical rescue team, infection control specialists, local health authorities representative, and centre for disease control and prevention, whom each have different requirements (WHO, 2020b; Qiu H et al. 2020).

Many nurses had to set up a clean area at the entrance to their homes to change in and out of scrubs, besides change and shower at work as well. Their ultimate challenge was to stay healthy so that they can continue to care for others. Despite the worries of being infected from COVID-19 patients, the commitment to have smiling faces, making jokes, and distributing chocolates continued to be the norm among most of the nurses. The teamwork spirit and seeing each other's for who need help was well demonstrated in many reported cases. (Keshavan, 2020).

Nurses in Wuhan played a great role in winning its battle, despite the conditions and environment of Wuhan were challenging and extreme where there was a severe shortage of PPEs. Many nurses had to avoid eating and drinking for two hours before entering the isolation ward, in order to save energy and the time it takes to put on and take off protective clothing. This increased as they became overwhelmed with emergency patients and severe shortage in staffing, and lack of multiciliary team to control the situations such a respiratory therapist or clinicians.

Nurses are the primary source of organisational resilience since they are the most group that build workload and can adjust the rest of other groups behaviour. The four tenets of resilience are monitoring, anticipating, responding, and learning to suit the perceived most essential needs of the moment. Buheji (2013).

2.3. Importance of Human Factor for COVID-19 Nurses

2.3.1. Defining Human Factor & Its Suitability for COVID-19 Pandemic Nurses

Human factors are needed when there is a demand for studying all the factors that make it easier to do the work in the right way. Through human factors, the interrelationship between humans, the tools and equipment, used in the workplace or work environment are investigated. By applying a human factor principle, many adverse events can be prevented. This is very important for a life and death business like healthcare nursing. Therefore, the human factor is very important for the reduction of accidents and certain incidents. WHO (2008).

Under crisis pressures like the COVID-19 pandemic and when nurses are not properly trained, the human factor would deteriorate. Through human factors, nurses can take safe practices, and they communicate well in teams, and hand over information to other healthcare professionals. These tasks, once thought to be basic, have become quite complicated, as a result of the increasing complexity of health-care services and systems. This is particularly important during a pandemic as the COVID-19.

Through improving the human factor, the nurses could perform at their best while caring for patients, and it compensates for an inexperienced healthcare worker who might be stressed, fatigued and rushing. Human factors experts use evidence-based guidelines and principles to design ways to make it easier to safely and efficiently deliver best services to COVID-19 with minimal risks. These factors can help nurses move and transfer patients and ventilate them without sacrificing self or getting infected.

2.3.2. Role of Nursing in Managing Infected Patients

Millar (2020) shown that nurses, as part of a health service team must be trained and provided all the necessary personal protective equipment (PPE) for applying the infection control measures while working in a safe environment in order to prevent intrahospital spread.

American Nurses Association (ANA) (2020) emphasis for the nurses' rights to be provided and trained what can help them to protect themselves during the management of outbreak in clinical care with clear infection control protocols (standard, contact, airborne) and adequate availability of (PPE), including N-95 respirators, masks, gowns, eye protection, face shields and gloves. WHO (2020b).

To ensure effective implementation of a COVID-19 crisis or similar pandemic contingency plan, the nursing workforce should be flexible and ensure the health and safety of all nurses. This means there should be a stringent observation of infection prevention and control measures and access to personal protective equipment (PPE), once the emergency is declared, WHO (2020b).

It expected that once public health declares emergencies of an international outbreak such as the COVID-19

pandemic, immediate adjustments to nursing staffing is carried out, limiting the ratio of patient-to-nurse. This would eliminate the possibilities for virus transmission and also limit nurse-to-nurse transmission. (Veenema et al., 2020).

Miller (2020) gives details of how should the nurses behave to avoid getting infected, for example, not to enter the patients' room or approach them without full PPE, including the footwear, the goggles and face shield are already in place. During the COVID-19, the nurses are supposed to ensure that the patients are quarantined in suitable, preferably negative-pressure, treatment rooms. During the intra-hospital patient transport, nurses supposed to accompany the patient and where they need to be kept to a minimum in public areas. Even the floors and the lift should be dedicated to COVID-19 patients.

2.3.3. Managing Nurses Personal Sacrifice

There many stories about nurses' courage and dedication to COVID-19 patients. Without their tremendous support and teamwork, many patients won't make it or could not navigate illness and start haling. As fighting the disease needed high care, and very close patient contact, even during this time of social distancing need to help them

Some extreme actions have been taken by some Chinese nurses treating COVID-19 patients. These include head shaving to prevent cross-infection, on the basis that long hair may carry infective material and impedes donning and removal of PPE, and prohibiting the wearing of anybody adornment such as jewellery while on duty, including embedded body decoration. Connley (2020) reports that in China, at least 3,300 health-care workers have gotten the COVID-19 virus, and 13 have died, according to the Chinese healthcare authorities. The virus has already taken a toll of more than 1000 nurses in just the first few weeks in Europe and the USA, due to being into contact with COVID-19 patients.

Robitzski (2020) reports that many nurses suffered pressure ulcers on their ears and forehead from donning multiple layers of protective gear for hours at a time; they continue to be dedicated. However, despite their occupational risk, nurses continued to be at the front line of patient care in hospitals and closely involved with assessment and monitoring in outpatient and community settings. They managed to ensure that all patients receive individualized, high-quality care regardless of their infection status and participate in preparation for increased nursing and health system demand related to COVID-19.

Pictures from Wuhan China in early January 2020 showed the difficulty of wearing many donning multiple layers of protective gear for hours PPE, which lead to pressure ulcers on their body. Some nurses reported having fainted from low blood sugar and lack of oxygen, in addition to the physical exhaustion. Many have suffered psychologically feeling helplessness, with high anxiety and fear. Grasselli et al. (2020). Despite the existence of PPE, many nurses are considered to be at highest-risk for COVID-19 infection, as admitted by China's National Health Commission. More than 3,200 health workers have contracted the coronavirus, 90 per cent of which were working in Hubei province. (Robitzski R, 2020).

2.3.4. Evidence of Nurses Needs of Human Factors during COVID-19

Human factors are an established science that uses many disciplines (such as anatomy, physiology, physics and biomechanics) to understand how people perform under different circumstances. Human factors define the relationship between human beings and the systems with which they interact. By focusing on the human factor, a critical error can be eliminated more efficiently.

Several individual factors are impacting on nurses performance. The most important of these factors and which nurses during the COVID-19 repeatedly reported having suffered are both fatigue and stress. There is strong scientific evidence linking fatigue and performance decrement, making it a known risk factor in patient safety.

Law (2020) reported that many nurses in the USA experienced fatigue during their prolonged care for patients with this deadly virus, which is of no known cure, besides being highly contagious. The psychological pressure is even worse, where many nurses have tested positive for COVID-19, and transmitted the virus to their home or friends. Supporting medical workers' mental health could be a key component in the fight against COVID-19, as per the report of Law (2020).

In order not to avoid the mistakes of the 2003 SARS outbreak, the nursing staff need to be given all the empowerment required to maintain their wellbeing and resilience to fight the COVID-19 disease again. Many nurses showed persistence to leave the profession, be absent, or developed PTSD, due to stress or exacerbated pre-existing mental health conditions.

Ayanian (2020) reported that nurses in the front line shown higher levels of severe mental health symptoms than those in secondary roles. For example, in a study published March 23 in JAMA, done on 1,257 healthcare workers working with COVID-19 patients in China, 50.4% reported symptoms of depression, 44.6% symptoms of anxiety, 34% insomnia, and 71.5% reported distress. Nurses and other frontline workers were among those with the most severe symptoms.

Many nurses found to suffer emotional strain and physical exhaustion when caring for growing numbers of acutely ill COVID-19 patients of all ages who have the potential to deteriorate rapidly. Ayanian (2020) reported that the matter becomes worse when the nurse finds his/her co-worker critically ill and sometimes die from COVID-19 while they are caring for them.

Studies show that prolonged work, similar to what COVID-19 response nurses gone through, can cause deterioration in performance.

All healthcare workers should consider using a series of

personal error reduction strategies to ensure that they perform optimally at work. Applying human factors thinking to the COVID-19 similar situation would help to go beyond the limit of the potential errors caused by nurses and would enhance their resilience at the same time. RCN (2020) sees that the human factor is an essential part of nursing care to prevent avoidable errors and patient harm. With human factors approach, nurses can deliver safer healthcare and co-ordinated interprofessional services.

2.3.5. Nursing Education During Infectious Pandemic

During the global outbreak, active participation of the nursing in clinical care, education and information sharing, and implementation of public health policy is highly trusted and expected. Therefore, clinical nurses are supposed to have time for updated learning and education on specific risks in relevance to their area of practice (e.g., hospital wards, ICUs, paediatrics, maternal-infant health, nursing homes, schools, etc.). This education should extend to nursing students, who might be brought during the pandemic to support their colleagues. (Choi et al., 2020). The program of short continuous learning during a prolonged pandemic similar to the COVID-19 would ensure the best control of any nurses' human factor deterioration.

To ensure effective nursing education during the pandemics, healthcare facilities employing nurses must ensure consistent availability of resources (ANA, 2020), (Choi K. et al., 2020). It is these small shortages, here and there, and lots of pressure, are what made many nurses get either infected or lost their lives; despite being trained on such crisis. For example, statistics from Italy shows that nurses had to suffer a lot, as the number for ICU admissions reached 12% of the total positive cases, which is higher than what was reported from China, where only 5% of patients who tested positive for COVID-19 required ICU admission. The inadequate education or drills with simulated pressure on nurses, since the start of the outbreak, made enormous pressure on the Italian nurses and deteriorated their capacity for caring per patient (Grasselli G. et al. 2020).

2.3.6. Patient Safety and Human Factor

A human factor approach to patient safety starts with an understanding of the things that support or hinder the way people work. Thinking about people, thinking about systems. Changes to the design of physical things can make a big difference in how well people work. The interfaces of devices, control panels packaging, lighting levels can all make a difference. During COVID-19, many new changes had to be brought to many units and especially the critical care units. Also, many field hospitals or wards turned to be used for other purposes. Hence, this created sudden disruption to many nursing services and hence disrupted the human factor.

A nurse, like any other healthcare worker, might suffer a 'moral injury', when they can't provide the care, they perceived they could. The moral injury even increases when they don't reach what is medically necessary for their patients. The matter comes worse when these nurses are part of a team that make painful decisions in the triage or the daily rounds about the patient admission and getting a slot to the ventilator. Law (2020).

Fryer (2012) seen that through human factor, we can include social interactions with the patients and how to operate within their environment. Human Factors is not patient safety, as the first focus on the high profile or high priority issues such as adverse events. The Institute of Medicine defines Patient Safety as the prevention of harm to patients; human factors focus on risk management.

Human factor helps to mitigate any possibility for an accident with the patient or the healthcare delivery environment. Human factor works on eliminating the none reasonably foreseeable through reducing the foreseeable incidents. By eliminating the minor chances of an event or circumstance, such as the possibility of incidental mistake due to administration of specific setup, we can eliminate accidents. Through such a mindset, we can be acknowledging errors and take necessary actions to monitor and learn from 'attribution' error.

Nurses like any other humans are very good at recognizing and responding to situations rapidly and adapting to new situations and new information, however, again as any other humans can also be distracted and thus may not pay attention to the most important aspects of a certain task or an emergency response situation. The relationship between human factors and patient safety is important for all healthcare workers as their situations can increase their likelihood of errors.

2.3.7. Vulnerable System Syndrome

Vulnerable system syndrome (VSS) is a syndrome that is a collection of blame, denial, and single-minded wrong-pursuit. This syndrome happens when blaming among frontline individuals lead to systemic error provoking. Therefore, Reason et al. (2001) suggested that overcome such VSS we need go beyond immediate unsafe actions to the core underpinning assumptions about human fallibility, before beginning to resolve the conditions that provoked such blame culture.

For managing pandemic patients as the COVID-19, VSS would be surely available, since the number of hazardous domains is high with a high possibility for adverse events. Thus, blaming the front-line nurses, denial for systemic error provoking weaknesses, and the blinkered pursuit of productive indicators are highly expected. To eliminate VSS during and after the COVID-19 patients care, the human factor needs to be frequently calibrated, and double-loop learning should be shared. Reason et al. (2001).

2.3.8. Capturing Errors

Human Factors often present in strings or chains of events, circumstances, and phenomena where the dynamic error or violation is the end product. Still, they are equally present at

the conception of latent errors.

Due to the speed and the evolving knowledge about the COVID-19 pandemic disease, the nurse capacity for capturing errors, before happening is limited and complicated. The previous expertise in other pandemics might help, but many things are also learned through doing, and fuzziness along with uncertainty is part of the scene. To optimise a response based on a captured error, during a pandemic like the COVID-19, nurses need to do a 'situational awareness' and then measure the environment of the workplace while operating within it.

Chedru and Geschwind (1972) demonstrated humans generally have a built-in error rate of 0.5-1.0% for every task. Sometimes, it's about the things not done, called the act of omission that raises the errors rate (Reason, 2002). Errors of omission outnumber errors of commission by 2:1 (Weingart et al., 2000). Slips, lapses, forgetting, and not knowing lead to acts of omission, as make the opportunity losses built into the system by designs that focus on the known and targeted elements.

Dealing with acquired highly dangerous, infectious disease like the COVID-19, nurses being humans who at certain cases won't be predictable or unreliable, need to improve *their capacity vs demand*, to reduce errors, through raising their 'working memory'. Applying human factor at high speed, a hostile dynamic environment helps us to distractibility notice when something unusual is happening.

Burses unempowered with enough resources and delegation may be an error of commission, while not having enough nurses may be the error of omission. Just as there are errors of detection, so there are errors of diagnosis. Therefore, there should be incentive programs for detection and recovery of errors. Forward planning approaches and built-in resilience enhances the error-wisdom (Reason 2002).

2.3.9. Communication as part of the Human Factor During the COVID-19

Communication during the pandemic is a set of processes with particular routine courses of prescribed actions that work together to achieve a particular result. For a complicated novel and contagious disease like COVID-19, the nurses need to the breakdown of information shared, captures and synthesised. The processes can be designed with instructions that meet the limitations of human memory, so decreasing the rate of errors and lapses.

Improving the communication model as part of the human factor is considered to be a prospective activity rather than a retrospective activity. The role of nurses here is to develop the knowledge pertinent to create design modification suitable to the COVID-19 demand. We need to anticipate human cognition and to design systems that prevent the likely error with a complicated patient disease.

During an emergency as COVID-19 cases surge, there is a high probability for miscommunications and actions. The communication difficulties increase when the nurses are in critical areas, putting heavy PPEs, working for monitoring more than one patient. WHO (2008).

Knowing that the challenges, the fatigue, the stress accumulate on nurses during the COVID-19 might optimise the possibility of poor communication, the human factor could be introduced to address the likelihood of errors occurring and their impact when they do occur. For tough scenarios as the COVID-19, understanding the human limitations and setting a communication plan that allows for variability in humans and human performance is very important. WHO (2008).

2.4. Tools of Human Factor

2.4.1. Change Management Model

Change management Models are important during times of crisis and also when a gradual crisis exit need to be planned. The model should include the adoption process, the rate of adoption, the category of adoption, and opinion leadership, and must go through the five stages of diffusion: knowledge, persuasion, decision, implementation and confirmation (Harder 2009).

This model can be built by first doing situational analysis and 'needs' assessment. Ultimately the end-user - the nurse at the sharp end, must own the solutions.

2.4.2. De-Stigmatising Error

The other important tool for the human factor, is to de-stigmatise the error during the fight with a hidden enemy where no enough details are available about. The culture of nursing has always been prescriptive and proactive as evidenced by nursing diagnosis, which focused on preventative management and quality of life. A lot needs to be done around de-stigmatising error during a dynamic crisis like COVID-19 pandemic. When things go wrong, it's a symptom of deeper system trouble, not nurses causing trouble. We shouldn't be looking for what a nurse did wrong (an act of commission), but how a mistake could be made. System and process re-design or re0engineering need to be reconsidered to reduce the general human error probability, Shelton (1999).

Once the culture implements an effective productivity improvement program through human factor and focuses on de-stigmatising errors, the outcomes would be more resilience in dealing with errors, not from being error-free. Having a level of fault-tolerance, or non-punitive scheme help to absorb the incidents without serious impact on the nurses during the huge demand of a crisis like the COVID-19.

2.4.3. Importance of Nurses Attention & Non-Interruptions

Interruptions have been studied most recently in nursing, demonstrating via 'cognitive pathway' mapping the shifting of a nurses' attention from patient to patient and of each interruption, while 'Stacking' is the number of tasks a nurse 'balances' concomitantly. Current Studies Nursing workload studies are breaking-down the division of work into four

levels: unit level in terms of nurse-patient ratios, job level as the amount of work routine to the job, including the degree of difficulty and level of attention required, patient-level in terms of acuity, and situation level in terms of performance obstacles and facilitators (Carayon and Gürses 2005).

To create the best environment for attention, the physical working environment, the models of care, the supplies availability, the logistical systems simplicity, the patients and carers, the communication styles; need to be laid out clearly.

2.5. Enhancing Nurses Expected Responses During Pandemics

2.5.1. Nurses in ICU During COVID-19

Normally, ICU nurses take care of two patients at a time, but for COVID-19 patients, one ICU nurse is assigned per patients in the beginning. Then as the number of patients surged, a shift to 2:1 ratio done again. As of March, 2020, many countries or regions where COVID-19 hit most might have gone for a ratio of more than 2:1. This gets difficult when the patients are really in bad condition and getting worse, and the nurse gets stuck in the ICU room. However, there are great success stories about how nurses have been helping each other out, so all the patients have been getting the care that they need. (*Keshavan* M. 2020).

While the shortage of staffing in critical units and workload increased in ICU, nurses became more professionally assertive and autonomous working as teams, helping each other, to make sense of consciousness and take critical decisions to encounter and cope the stressful situations.

2.5.2. Nursing Preparedness Drills for Future Coronavirus Outbreaks

Most hospitals who have done well are those who anticipated a big wave of coronavirus patients and prepared for the possibility of being overwhelming with the number of infected patients flowing to the emergency rooms and intensive care units. This nursing preparedness was clear in Hong Kong, Taiwan, Korea, Singapore; as they learned the lessons well from SARS and H1N1 outbreaks.

A study by Corely et al. (2010) based on the experience of H1N1 in Australia confirmed that preparing the frontline health care workers, specifically nurses, to manage admitted patients in ICU during a future pandemic is invariably difficult due to unpredictable nature of the event and the type of the virus. Nurses who are concerned about their ability to perform duties during such huge surge they were the one that might get prone to risk their own and patients health and safety. Contreras (2020).

Li et al. (2020) illustrated the importance of drilling on how to reduce the risk of exposure of COVID-19 to nurses as they usually stay in wards longer and provide direct nursing practice to patients. Therefore, Li et al. (2020) see that there should be ongoing training of infectious diseases, even during the pandemic. When a new infectious disease, such as COVID19 emerges, professional training regarding the hazard of the disease, route of transmission, prevention and control measures, and personal protection, as well as a psychological intervention should be provided in time.

The staff shortage caused by COVID-19 infecting nurses in many hospitals could have been avoided if well training in dealing with such infectious disease. In the same time, the anxiety and the staff re-distribution to areas they are not trained in should have been included in the drills, to avoid experiencing such situation with real high risks as happened since the pandemic started. Nurses fears and safety concerns when they have to serve high infected patients while that is out of N-95 masks could have also been included as part of the training. (Baumgaertner and Karlamangla, 2020).

2.5.3. Nurses Responding Through Social Media

The level of the striking situation that nurses had to face without enough support made many nurses go to social media. Across the world, many video streams showed how nurses are surrounded by fears of getting infected from COVID-19 patients and worried about transmission to family members and other health care workers. This shows the situation of failure of embedding human factor practices that could have compensated for these incidents and accidents.

Other nurses posted concerns about none availability of proper protective equipment and less access to ventilators and medications needed to support those seriously ill patients. Many nurses posted in Instagram and Facebook describing their physical stress, hunger, dread and emotional distress and frights from also to be contaminated or having to see many patients who don't come back to life once enter the ICU.

The streamed stories emphasis that many nurses expressed that the COVID 19 need special preparedness other than the what was experienced with the Ebola. Additionally, shortage of personnel protective equipment such as protective gear and N-95 masks, was creating a hysterical situation among the nurses, while nursing and caring of vulnerable patients ((Baumgaertner E. & Karlamangla S. 2020).

2.5.4. Overall Productivity Effectiveness (OPE)

Buheji and Ahmed (2017) introduced the concept of 'Overall Productivity Effectiveness' (OPE) which is based on 'pull thinking', i.e. it is not about how much you do, but it is about the way you do it.

OPE = Availability x Efficiency x Effectiveness.

In relevant to nursing services during a challenging crisis like COVID-19, the OPE is a very practical gauge that would help them to focus on parameters as availability, efficiency, effectiveness while also enhancing the variables of the human factor. This would encourage nurses to adopt 'learning by doing' and accepting a level of humility while exploring what is right and what is wrong while dealing with the deadly virus and later adopting it in drill preparedness scenarios.

The OPE would raise the nurses' ability to explore with deep focus 'What' needs to be done to eliminate risks of the nurses in the front line with the COVID-19 or similar pandemics, and not the 'How' need to be done as usually available in the guidelines of the international, regional nursing associations or updated by the WHO.

3. Methodology

Based on the synthesis of the literature, the role of the nurse during the COVID-19 pandemic is explored. Then, another more in-depth exploration is taken about enhancing nurses expected responses during the pandemics. The importance of specific human factor that addresses the uprising needs to COVID-19 nurses is proposed. The human factors extracted based on the incidents and the challenges reviewed in the various literature and publications of nursing stories from different countries. Then, the review shed light on the possible tools of a human factor during such a crisis, and what is needed more for enhancing the nurses expected responses during pandemics.

Taking all the above into consideration, a nurse specific COVID-19 human factor framework is proposed, followed by a discussion on the validity and importance of such a framework.

4. Proposed Human Factor Framework

The framework represents the main variables that need to be available to raise the nurses' reliability during pandemics as the COVID-19, based on the formula:

Reliability = P (Availability).

This means that the more the main variables of human factors are available in the right time and place, the more reliable would be the nurses' services for the COVID-19 patients and similar pandemic infectious disease patients. The main variables that are needed for the human factor that were extracted from the literature and which could play an essential role in helping the nurses to combat the COVID-19 pandemic are: patients' safety, problem orientation, technology interface, emergency interventions and design of the working environment, besides last but not least the human sciences.

As shown in Figure (1), to raise the capacity of nurses in relevant to COVID-19 patient safety variable, they need to be supported by resources that help to track accident investigation, improve scenarios planning, mitigate complex situations, improve safety assessment and selective training. For problem-solving orientation, the nurses need to be trained on decision analysis, distraction elimination, effective awareness about the problem, and accuracy once a solution is deployed.

Since a COVID-19 patient would go through lots of technology interfacing, the nurses need to be more supported by all the resources that ease emergency interventions with emergency equipment as the ventilators and life-monitoring, or life-support equipment. The methodology used for this interface needs to be accounted for also, as part of the nurses' human factor overall productivity improvement.

The last two variables proposed for the COVID-19 nurses' human factors are the work environment design and the human sciences. For the human sciences, the COVID-19 nurses would need to support for leadership, teamwork, besides the development of an effective communication model, along with management of both stress and fatigue. The proposed framework is called for short NHFC-COVID-19.

Figure (1). Framework Proposed for Nurses Human Factor to Combat COVID-19 Pandemic (NHFC-COVID-19)

5. Discussion

5.1. Synthesising Nursing Challenges of COVID-19 in Relevance to NHFC-COVID-19 Proposed Framework

Nurses today facing the biggest challenges and concerns in their nursing profession towards the unprecedently outbreak of coronavirus worldwide. They have put their life in vain to combat the COVID-19. Numerous epidemics of viral infection have been studied in the last decades, such as influenza, H1N1, SARS, etc. However, the COVID-19 epidemic has placed a huge burden on the health care system and specifically nurses in significant ways. Establishing a nurse pandemic specific human factor could help in having more effective preparedness should the coronavirus come in another wave, or to be ready and available for future epidemics.

Applying the proposed framework NHFC-COVID19 to the outbreak of the pandemic in China could have dramatically reduced affected the lack of appropriate nursing critical care management and would have controlled the escalation in the number of infections among them and thus reduced their mortality rate.

In order to have nurses that are always prepared for problem-solving during novel virus disease outbreaks, they should be involved in comprehensive planning, training, and education, with a focus on more on intensive care services, as recommended by Makamure et al. (2013). This can be achieved when NHFC-COVID19 has applied effectively.

5.2. Tools of Human Factor Suitable for COVID-19 Challenge

NHFC-COVID19 brings in tools for human factor that could reduce complexity, increase information processing capacity, use constraints, mitigate side effects, task analysis, assess the likelihood, attach a reminder, use the five C's (conspicuity, contiguity, context, count, and content), use heuristic evaluations, cognitive walkthroughs, protocol analysis, and reduce the number of competing tasks. The effect of these tools would ensure that nurses overpass the trap of vulnerable system syndrome and have the time during the crisis to capture errors at the right time.

James Reason (1995), a leading author in error management, believed people generally do not act in isolation, but that our behaviour is shaped by circumstance. The likelihood of an unsafe act being committed is heavily influenced by the nature of the task and by the local workplace conditions. NHFC-COVID19 reduce the possibility of unsafe acts to the minimum.

Humans reason in 'causal series' and this linear thinking reduces our ability to think in terms of networks. Thus, NHFC-COVID19 would help the nursing staff to focus on safety-critical tasks. The framework helps to control the incident and reduce any vulnerable circumstances. Another advantage of HFC-COVID19 is that it makes nurses become more 'on-the-spot problem solvers', and better reporters of near-miss.

6. Conclusions and Recommendations

6.1. Implications of This Research

Overall, COVID-19 epidemics has placed a huge burden on the health care system, and mainly on nurses who have faced the biggest challenges and concerns in their nursing profession towards the unprecedently outbreak of coronavirus worldwide. This crisis has dramatically affected the nurses capacity sustained critical nursing care due to the lack of maintaining effective communication channels in times of unpredicted circumstances which the guidelines couldn't help to fill. The human factor framework NHFC-COVID19 come to fill this gap and help develop the necessary tools, protocols and guidelines for a similar pandemic in the future. The NHFC-COVID19 shows that despite the lack of resources, and the lack of psychological and mental health support, still nurses can deliver best critical care and manage most of all to combat a dangerous contagious disease like COVID-19 with minimal morbidity and mortality.

6.2. Recommended Pandemic Preparedness

Nurses should be involved in the details of the national plan for high preparedness. Integrating NHFC-COVID19 framework into nurses training. The framework would enhance their critical thinking and their capacity for complex problem-solving. The NHFC-COVID19 need to be also tested in scenarios of uncertainties in the future, especially if the outbreak carries sudden rising emergencies attacks as the COVID-19 pandemic.

6.3. Role of Nursing in COVID-19 Evidence-based Research

It is crucial that nurse staff is trained to employ protocols extracted from experience with NHFC-COVID19 for management of the COVID -19, SARS-CoV-2. This would help to develop protocols that are beyond WHO COVID-19 evidence-based guidelines, for services as ventilation and general ICU care and especially in the cases where there is an overwhelming workload (WHO, 2020a; Xie et al., 2020).

By testing the proposed framework NHFC-COVID19, or similar, nurses could be involved in developing more selective preparedness drills, along with compiling of resource inventories that should be kept for pandemics similar to COVID-19. This experience would help to develop the type of disaster drills that need to be formulated and simulated annually. Surely, nurses who experienced and survived this global disaster want to reflect their experience on relevant to disaster communication methods; again, the NHFC-COVID19 framework could be a good point of reference for this. More research is needed for re-prioritising specific capacity - building training for all the front - line nurses as well as to develop and implement disaster

management plans to better prepare nurses for future disasters (Li et al. 2016).

6.4. Role of NHFC-COVID19 in Supporting the Wellness of Nurses Mental Health During Pandemics

With the rapid increase in the number of patients, doctors and nurses have to face enormous workload and high-risk infection, during any pandemic similar to NHFC-COVID19. With this surge, we might also have more physical and psychological pressure on nurses. NHFC-COVID19 can bring in tools that can help in managing the problems that lead to anxiety or depression.

NHFC-COVID19 encourage effective autonomous mental counselling during and after the pandemics to avoid cases where nurses have more anxious or depressive symptoms.

6.5. More Innovation Efforts in Infection Control During Emergency

The proposed NHFC-COVID19 emphasis that nurses and their related nursing leading organisations have more efforts in relevance to exploring and researching infectious control approaches to the new novel contagious diseases. If nurses manage to register the lesson learned from implementing a human factor framework as the NHFC-COVID19, hazards and infection preventions can be easily specified based on the experience with pandemic similar to COVID-19. This exploration should include about the development of the best way to have PPE that can be dressed in a simple way, that would maintain the quality of life of the nurse and in the same would ensure transmission prevention.

More consideration should be given for practical PCR tests, on a weekly basis, to be done to all the exposed nurses to infectious, contagious diseased COVID-19 patients. This suggestion is based on the known minimum incubation period of about seven days, and the capacity for viral spread before symptoms appear. (Millar R. C., 2020).

6.6. Nurse Human-Factor International Framework

It is highly recommended that global nursing leading organisations as the International Council of Nursing (ICN), besides the WHO Pandemic and Epidemic Diseases Department (WHO-PEDD) work on drafting effective and proactive nurses human-factor guidelines and network that embeds human factor as a dynamic shock absorber. This guideline should help identified the nurse psychological and physical stress and ensure that nurses would be replaced or grand access to relax before continuing to treat or monitor patients unique during emergency situations as the COVID-19 pandemic. The NHFC-COVID19 might a basis for future better empirically tested framework.

Gauging the human-factor should go into the curriculum for nurses continuous education. A nursing human factor framework, as NHFC-COVID19, would allow nurses to study the ‘properties’ of the nurses' capability and limitations in the right time and place and thus reduce unnecessary incidents or accidents that lead to consequences of death or psychological guilt. For COVID-19 pandemic crisis, diversity and resilience are needed for a dynamic and rapidly changing environment. Therefore, the more NHFC-COVID19 become internationally tested, the more human soft issues as communication can be generalised and more interactions can be shared.

Working in areas where small errors can define the sequence of life and death, must governments, public health and healthcare organisations make use of the human factor and integrate it in the self-assessment rounds and overall productivity plans for facing a disaster similar to COVID-19 in the future. Recognising the level of sacrifice the nurses all over the world who survive and served us in COVID-19 pandemic should not be appreciated only by clapping, but by more research dedicated to their productivity, focus and livelihood. This is the minimum token of appreciation we can give them to assure them that they are not alone.

6.7. Implications and Limitations of This Paper

This research brings in different implications and contribution to the healthcare services and the body of knowledge, amongst which it integrates between the different variables of the human factor and the nurses required capacity during a dynamic and complex pandemic as COVID-19. The other implication the study shows what to focus on to raise the nurses' reliability of services, through raising the nurses' availability during a pandemic, with minimal risks or errors. Despite there are some regional guidelines about the human factor and nursing, they do not cover what requirements needed specifically during the life-threatening emergency as in the pandemics. Practically, this research helps prepare nurses for the coming pandemics with better overall productivity effectiveness. This should reduce or hopefully eliminate the nurses suffering, beside minimise the risks of physical and psychological injury and most of all, deaths. Future research is recommended to empirically test the various propositions made, and maybe through alternative data collection methods.

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