

Effective Medical Creation (EMC)

—A New Approach to Improvement of Patient Management in the Standpoint of Hospital Room Environment

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Abstract

Effective Medical Creation (EMC) is a kind of campaign to implement a team healthcare that can provide the most efficient and effective intensive care units (ICUs) by improving hospital room environment for not only patients and their family but also healthcare providers. This campaign was based on the concept of the “Art of Medicine”, which provides everyone a comfortable ICU environment of meditation and feeling with the five senses of sight, hearing, touch, smell, and taste. EMC can provide a healthcare environment that is not restricted by existing and traditional verse rules or style and aims to always provide better healthcare by working on the five senses. Provision of facilities for aromatherapy massage at an ornamental hospital room and landscape through a false window has been the ongoing activity of the EMC at Nara Medical University. These seemed effective in reducing a patient’s stress response in the ICU. However, the effect of EMC on the outcomes of critically ill patients has not been determined. EMC might be one of the promising measures to create environments that positively affect both patients and healthcare providers. In this review article, the concept of EMC and practice of EMC at Nara Medical University Hospital are presented.

Keywords

Effective Medical Creation, Five Sense, False Window, Intensive Care Unit

1. Introduction

Effective Medical Creation (EMC) is a kind of campaign to implement a team healthcare that can provide the most efficient and effective intensive care units (ICUs) by improving hospital room environment for not only patients and their family but also healthcare providers. This campaign was based on the concept of

the “Art of Medicine,” which provides everyone a comfortable ICU environment of meditation and feeling with the five senses of sight, hearing, touch, smell, and taste [1]. EMC originated from the experiences of Professor Nobuhide Shigemitsu, who was previously from the Division of Intensive Care, University of Nevada and is present from the Division of Intensive Care, Tokyo Medical and Dental University, and Ms. Eriko Takezawa, who is a designer. They sought ways to utilize the five senses in order to implement the best care and to cure by deepening the bonds among the multidisciplinary team healthcare, patients, and the patient’s family. EMC can provide a healthcare environment that is not restricted by existing and traditional verse rules or style and aims to always provide better healthcare by working on the five senses. Since 2016, we have incorporated EMC in daily practice at the Division of Intensive Care, Nara Medical University.

2. Five Senses

The definition of the five senses originated from the Aristotelian classification of sense, which meant sight, hearing, touch, smell, and taste. Aristotle thought these five senses comprised the human cognitive process of sensation and perception. Therefore, the term five senses have been traditionally used to express all human senses, although other senses, in addition to the classical five senses, comprise all human senses. These five senses are based on the sensory systems that recognize the external environment. Each of the five senses can perceive pleasure and displeasure, the degrees of both depend on the individual.

3. Pleasure and Unpleasure

Pleasure and displeasure were thought as two of the basic psychological attributes that can explain behavior. Animals instinctively choose pleasure and avoid displeasure. Each behavior, such as approach, avoidance, and escape, is a fundamental principle of the animal to improve survival probability by adapting to the external environment. These fundamental behaviors are modified by individual experience, which is known as operant conditioning.

In the ICU environment, there may be pleasant or unpleasant perceptions. In particular, patients are usually restricted by life support devices and suffer from a lot of unpleasant stimuli under the pretext of therapy. Obviously, patients cannot escape from these unpleasant environments by themselves. From the point of view of the pleasant-unpleasant principle, patients may instinctively judge that they cannot escape from the situation of worsening survival probability, and this may cause them to give up. To avoid the inevitable perceptions of displeasure, providing patients with pleasures may be an option to improve survival probability.

4. ICU Environment Blunts the Five Senses

It would be reasonable to think that ICU is one of the situations that blunt the

five senses. Most ICU patients are on sedatives, which may decrease sensory functions. Although the five senses are blunted by sedatives, patients in the ICU may continue to receive noxious stimuli, which are expected to influence them negatively. Some examples for each of the five senses are as follows: 1) for sight, the brightness of light during night time may deplete sleep; 2) for hearing, the unceasing alarm sounds and noise from life support devices; 3) for touch, untimely and intermittent uncomfortable care and treatment; 4) for smell, offensive odors from filth and blood; and 5) lack of taste because of eating disorders and thirst.

To offset these unpleasant stimuli in ICU environment, strategies to make the five senses comfortable may be provided. For example, we may provide beautiful views for sight; natural sounds and favorite music for hearing; caress and massage for touch; aromas for smell; and some flavors, even in cases of eating disorder, for taste. It may be possible to generalize the stimuli that would have a positive influence on the five senses, but the pleasure or displeasure perception of the five senses can be modified by individual differences and experiences. We need to pay attention when providing these stimuli.

5. Effects of Stimulation of the Five Senses on Mental and Physical Aspects: What Works Favorably or Unfavorably?

5.1. Sight

Humans can sense light by sight. Light is strongly related with the secretion of melatonin, which plays an important role in the regulation of sleep-wake cycles and is produced in the pineal gland generally during night time, when light cannot be sensed. Nocturnal light levels in the ICU may interrupt sleep pattern. In fact, the light levels in the ICU have been documented to be over 1000 lux [2]. Nocturnal light levels as low as 100 to 500 lux can affect melatonin secretion, and those between 300 to 500 lux may disrupt the circadian cycles [3]. Although nocturnal light levels have been associated with sleep disorder, getting enough bright light in the morning and in the daytime is important to maintain the circadian rhythm [4].

The visual field of patients in the ICU is occasionally obstructed or limited because of immobilization. Interruption of sight was suggested to cause a loss of approximately 80% of information input [5]. We empirically noticed that color vision has psychological effects. Based on general opinion, such as that in pseudoscience, red gets people excited and increases body temperature and inflammation; blue leads to calm and relaxation and reduces inflammation; and green inhibits extreme excitation and balances emotional harmony. In the scientific aspect, perception of red color was likewise suggested to be associated with higher testosterone concentration. In fact, high intensity exercise while wearing red-colored lenses was reported to increase testosterone secretion [6]. In the 2004 Olympic Games, the contestants in all four combat sports of boxing, Taekwondo, Greco-Roman wrestling, and freestyle wrestling were observed to

have consistent and significant patterns of winning more fights when wearing red. Even in cases of similar effects among the weight classes in each sport, 60% had more red winners and only 40% had more blue winners [7].

5.2. Hearing

Noise has several negative effects on health. It is an unwanted sound that is judged to be unpleasant, loud, or disruptive to hearing, although these perceptions may be subjective. For example, rock and roll music may be perceived as unpleasure by some but not by others. Therefore, qualitative assessment of noise is difficult. Most researches on noise have been conducted based on the degree of loudness. Noise is recognized as one of the sensory nuisances and has been suggested to be associated with cardiovascular risks, such as hypertension and ischemic heart disease [8].

For the ICU, the World Health Organization recommended that sound levels should not exceed 35 dB on the average and 40 dB all throughout the night; however, one study reported that sound levels in the ICU exceeded 45 dB on the average and 85 dB at a moment [9]. Moreover, such large noise was said to have occurred and persisted for about 10 minutes every hour. Around 80 dB is equivalent to the noise from heavy city traffic [9] [10]. Most of the ICU noise that is more than 80 dB are likely from alarm activities and electronic sounds, which are more arousing, compared with human voices; therefore, these likely caused the continuous disruption of the patients' sleep [9]. Noise exposure impairs sleep quality and is associated with negative physical changes on the cardiovascular, respiratory, immune, and neurocirculatory systems [11].

On the other hand, some sounds can reduce the stress response, and these include music that is comfortable based on individual preference. However, as mentioned before, a kind of music can be a noise for someone. Another option is provision of sounds with 1/f fluctuation characteristics; examples of these are the various natural phenomena, such as breeze, streams, candle flames, and the luminous patterns of fireflies [12]. In general, listening to 1/f sounds has been previously demonstrated to effectively reduce stress response, although this remains a matter of debate [13].

5.3. Smell

Bad smell is one of things that can have negative effects on people. Although the definition of bad smell strongly depends on individual preferences, perception of a bad or nasty smell becomes a kind of pollution for the individual and can induce a stress response. Instinctively, humans perceive an uncomfortable smell as unpleasure, which may decrease the probability of survival and cause an individual to avoid or escape from such smell. Animals were reported to show stress response and escape behavior against the odors of predators and putrefaction odors [14]. A previous research suggested that overall, olfactory-evoked memory were more intense and vivid, compared with the memories evoked by the primary sensory systems of sight and hearing [15].

In the ICU, an uncomfortable memory evoked by a nasty odor is a concern. On the other hand, in aromatherapy, smell has a healing effect. In fact, aromatherapy using lavender essential oil has been reported to significantly contribute to improve mood, perceived levels of anxiety, and sleep quality [16] [17]. Although the influence of smell variations on the healing effects of aromatherapy remains conclusive, some have reported different healing effects of various aromas other than lavender.

5.4. Touch

Different kinds of tactile sensations, such as those from frequent painful interventions or treatment, may affect patients in the ICU physically and mentally. After ICU discharge, more than half of patients were reported to recall an experience of discomfort during ICU stay. The presence of an endotracheal tube was the most frequently reported source of discomfort [18]. Moreover, one study showed that care interactions were provided at a mean number of 42.6 per night and were most frequent at midnight; moreover, only 6% had uninterrupted sleep periods of 2 to 3 hours during the study period [19]. Indeed, the previously reported sleep disturbance in 68% of patients in the ICU is very convincing [20].

On the other hand, stimulating tactile sensation can sometimes alleviate hard symptoms. Touch therapy is popular in the field of palliative care. A systematic review showed that touch therapy may have a modest effect on pain relief [21]. In addition, alleviation of pain by rubbing the sore site is a common observation. The gate control theory, which describes how non-painful sensations can override and reduce painful sensations, may explain this phenomenon [22]. Aromatherapy massage, which is often shortened to aroma massage, is a combined therapy of touch and smell. Aroma massage with plant-derived oil substances may be beneficial as a complementary therapy or relaxing technique for the symptomatic management of various conditions, mainly psychological and pain-related disturbances, and palliative care conditions [23].

5.5. Taste

Taste can affect patients in the ICU physically or mentally. Patients in the ICU seem to rarely have an opportunity to taste something, because they are rarely on oral intake. Although there is insufficient evidence on the topic, sweet tasting was suggested to alleviate pain [24] and had been found to reduce needle-related pain in infants during immunization. If this treatment can be substantially promising for adult patients, sweet tasting may possibly alleviate the physical and mental burden in the ICU. However, the perception of pleasurable or unpleasurable taste depends on individual preferences. This kind of treatment might be difficult to apply universally, because taste preference differs from person to person. Aside from sweet tasting, quenching of thirst is important, especially for patients in the ICU. In fact, thirst was reported to be the second most prevalent symptom among patients in the ICU [25]. Effective interventions to

relieve this distressing sensation are important, because thirst is closely related with the activation of the rennin-angiotensin aldosterone system [26].

6. Ongoing Activities and Researches on EMC at Nara Medical University

6.1. Aromatherapy Massage at an Ornamental Hospital Room

After institutional review board approval and obtaining a written informed consent from each patient, we investigated the effects of aromatherapy massage at an ornamental hospital room in the ICU on the stress response of patients during ICU stay. Stress response was objectively evaluated by measurement of salivary amylase and heart rate variability before and after the aromatherapy massage. In addition, the degree of burden or distress was subjectively evaluated using a visual analog scale (VAS) before and after aromatherapy massage. The patients received the same specialized aromatherapy massage on the arms, hands, and upper legs for 20 - 30 minutes by skilled therapists. Lavender, rose, or eucalyptus essential oil was used, according to the patient's preference.

Salivary amylase, which has been widely used as a noninvasive biomarker of the sympathetic nervous system in response to stress [27], was supposed to reflect the degree of comfort or discomfort of the patients in the ICU. We used a salivary amylase biosensor (Nipro Corporation Cocoro Meter, Osaka, Japan), which is commercially available, was easy to operate, and produced results fast.

By far, a total of 40 patients have experienced aromatherapy massage, and the results of the interim analysis of these patients (**Table 1** and **Table 2**) have been reported in a local Japanese journal [28]. After the intervention, the mean arterial pressure, heart rate, and respiratory rate; VAS; and level of salivary amylase significantly decreased. Based on these results, we supposed that both the objective and subjective stress responses were reduced by the aromatherapy massage.

In addition, we notice some effects of the aromatherapy massage on heart rate variability. The time interval between heartbeats is not consistent and varies from 10% to 30%, even at a constant heart rate; this physiologic phenomenon is called heart rate variability [29]. In general, after frequency domain analysis, heart rate variability can be divided into the high frequency band (HF), which represents 0.15 - 0.4 Hz, and the low frequency band (LF), which represents 0.04 - 0.15 Hz. However, the study designs for heart rate variability have been complicated because of the different HF and LF standards adopted by several researchers [29]. HF is recognized as an index of parasympathetic activity, whereas LF is considered as an index of both sympathetic and parasympathetic activities. Therefore, LF or HF may be used as an index of sympathetic activity; however, these definitions remain controversial [29]. Previously, we found that LF/HF showed insignificant changes before, during, and after aromatherapy massage (**Figure 1**). This finding suggested that a pleasant feeling may not always suppress sympathetic activity or that aromatherapy massage may not always give a pleasant feeling.

Table 1. Subjects for aroma massage (n = 40).

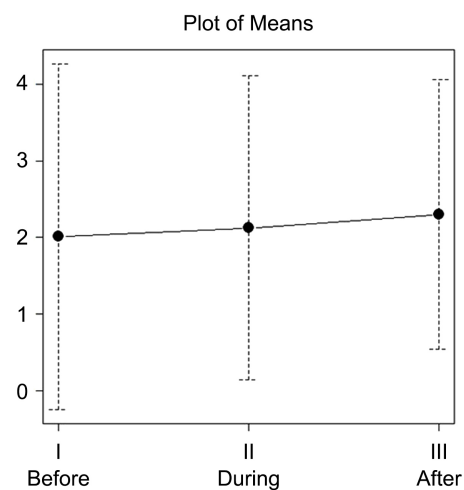
Age (year)	67 (14)
Height (cm)	157 (7)
Weight (kg)	53 (11)
Male/Female	18/22
APACHE.II	17.5 (13 - 26)
GCS	15 (15 - 15)
Emergency admission Yes/No	35/5
The reason of admission	
Respiratory	15
Gastrointestinal	7
Neurological	10
Others	8
Mechanical ventilation Yes/No	16/24

APACHE II: acute physiology and chronic health evaluation II score; GCS: Glasgow coma scale.

Table 2. Changes in parameters by the intervention (n = 40).

	Before aroma massage	After aroma massage	P value
Respiratory rate (bpm)	23 (10)	20 (6)	0.0348
Mean arterial pressure (mmHg)	92 (19)	87 (18)	0.023
Heart rate (bpm)	89 (18)	85 (22)	0.056
VAS (mm)	6.5 (1.6)	4.4 (2.0)	<0.00001
Activity of α -amylase in the saliva (kIU/L)	49 (11.8 - 93.8)	15.5 (3 - 71.3)	0.00972

VAS; Visual analog scale for stress; Shaded cells show parameters, which significantly changed by the intervention.

**Figure 1.** Changes in LF/HF before, during and after intervention. LF/HF shows insignificant changes before, during, and after aromatherapy massage; LF: low-frequency power, 0.04 - 0.15 Hz; HF: high-frequency power, 0.15 - 0.4 Hz.

6.2. A False Window

A false window is an artificial frame that can display a range of different outdoor scenes, such as a specific landscape from the hospital, superb views from all over the world, and world heritage sites. At our hospital, the false window usually displayed a real-time landscape view from a web camera that was set on the roof of the hospital and was connected to the display through the intranet (**Figure 2**). This was introduced with the cooperation of Professor Mitsunori Miki, the Faculty of Science and Engineering, Doshisha University. False windows using a liquid crystal display were reported to be effective in providing psychological effects that were equivalent with those provided by real windows in the working space without windows [30]. Interestingly, one study reported that patients who had a window view of nature had relatively short postoperative hospital stay, received few negative comments from nurses, took moderate and strong analgesic doses less frequently, and had slightly low scores on minor postsurgical complications [31]. In the ICU environment, a false window view may be given similar promising and positive effects on patients. However, our prototype false window is not available commercially and lacks versatility, because its real-time landscape view is provided only through the intranet. On the other hand, there is a commercially available false window (Atmoph Window, Atmoph Inc., Kyoto), which can display real-time landscape views from 1000 web cameras set at all over the world and can be connected to the display through the internet (**Figure 3**).

6.3. Ornamental Hospital Room

A room in the ICU was remodeled with fantastic emblems to break through the commonly held image of ICUs or hospitals (**Figure 4**). In addition, the room is

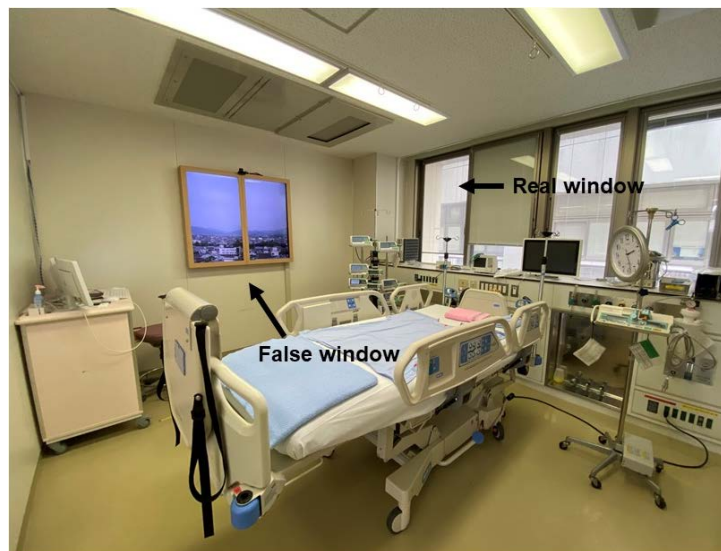


Figure 2. False window. The false window usually displays a real-time landscape view from a web camera that is set on the roof of the hospital and is connected to the display through the intranet. The left arrow shows the false window. The right arrow shows the real window.

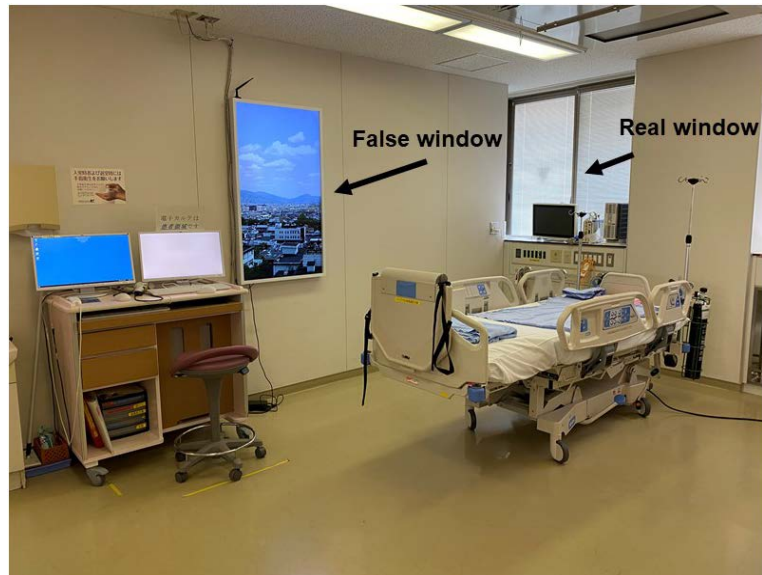


Figure 3. Commercial type false window. The commercial type false window can display real-time landscape views from 1000 web cameras set at all over the world and can be connected to the display through the internet. The left arrow shows the false window. The right arrow shows the real window.



Figure 4. Ornamental hospital room. A room in the ICU was remodeled with fantastic emblems to break through the commonly held image of ICUs or hospitals.

colored with a lot of vitamin colors. It should be noted that the term “vitamin color” is an English word coined in Japan, and the nearest word for vitamin color is vivid color or bright color but different. It is believed that vitamin colors affect us positively and bravely as well as vividly and brightly. To facilitate this concept, the ICU staff started to wear fantastic emblems on their sleeves and scrub suit tops after the room was created (**Figure 5**). Although acceptance of this design by all patients was a concern, we thought that the ornamental hospi-

al room concept gave an opportunity to start a conversation and helped improve the communication among the healthcare providers, patients, and the patients' families. We previously conducted the survey that asked patients and their family about the false window and ornamental hospital room in an intensive care unit [32]. Majority of answers positively supported these innovations; however, there was still room for improvement in the remodeled room. The remodeled room at that time was as shown in **Figure 6**. Based on the results of the survey, the current ornamental hospital room was remodeled.

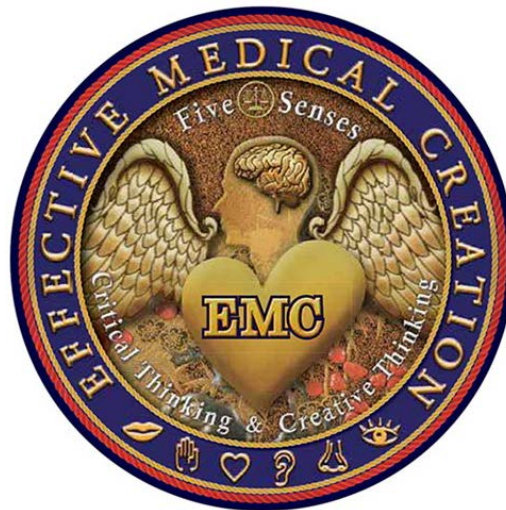


Figure 5. A representative fantastic emblem for EMC. An emblem for EMC expresses critical and creative thinking based on the five senses, which meant sight, hearing, touch, smell, and taste. This emblem is used as a symbol mark for EMC.



Figure 6. The former ornamental hospital room. This is a picture of the former ornamental hospital room, which was pointed out to have still room for improvement. Based on the comments from patients and their family, the current ornamental hospital room was remodeled.

7. Future Perspectives and Conclusion

In the future, we plan to provide patients with the experience of seeing a variety of images created with projection mapping techniques, in addition to the fantastic emblems. We continuously attempt to find ways for hospitalized and bedridden patients to feel as if they were out of the hospital. In addition, proper arrangement of the WEB environments may improve and allow the false windows to provide landscapes not only from the hospital but from the patients' homes or their favorite scenes. For research, we would like to establish an EMC in the ICU and investigate its effects on the outcomes of critically ill patients. For EMC to propagate worldwide, it may need to be developed commercially and as service packages, such as a combination of a false window and an ornamental hospital room or a projection mapping technique.

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Presentation

A part of this review was presented at the 46th annual meeting of the Japanese Society of Intensive Care Medicine, Kyoto March 7th 2019. A part of the material submitted has already been published in a domestic journal (*Rinsho Masui*) in Japanese. However, most parts have been rewritten and submitted for the new publication.

Approval

The manuscript has been read and approved by all the authors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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