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GREENING THE OPERATING ROOM

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Abstract

Health Care Sector represents approximately 4.4% of the net global emissions which is equivalent of 2 gigatons of carbon dioxide and the operating room contributes to the total amount of the emissions with nearly 40%. Anesthetic gas emissions are one of the three main components of the carbon dioxide footprint as the remaining two are waste production and energy demand. The operating room and the procedural suits are the biggest source of garbage contributing in around 30-70% of total health care related waste. Separating the waste in a proper manner in a daily practice has been reported as a problem and a resource of significant amount of nRMW which in fear of possible infection potential is lost in the RMW which is non-recyclable, nor reusable. Inhalational anesthetic usage is related to significant environmental hazards therefore, total Intravenous Anesthesia (TIVA) is a preferred technique when Going Green. Reducing waste from the operating rooms is a must in order to minimize the harmful emissions and environmental hazards. Securing a sustainable and better future is possible with taking actions for minimizing the OR waste with implementing the 5Rs rule. Five Rs rule includes: Reduce, Reuse, Recycle, Rethink and Research.

Key Words: Go Green; Greening the Operating room, Medical waste.

Globally, the climate footprint of the Health Care Sector represents approximately 4.4% of the net global emissions which is equivalent of 2 gigatons of carbon dioxide [1]. It is estimated that the operating room contributes to the total amount of the emissions with nearly 40%. Anesthetic gas emissions are one of the three main components of the carbon dioxide footprint as the remaining two are waste production and energy demand [2]. Anesthetic gases including Nitrous oxide and carbon dioxide, as a metabolic byproduct because of their capability to absorb the infrared radiation in the atmosphere and to contribute to a global warming effect as well as because their long lifetime and concentration in the atmosphere, could be considered as greenhouse gasses [3,4]. Those physicochemical properties of the halogenated and even fluorinated anesthetic gases makes them harmful for the ozone layer. The Global Warming Potential (GWP) as an index, was developed to compare and show us how big the effect on the global warming of different types of gasses is. GWP is a measure of how much energy emissions from one ton of a gas is absorbed over a period of time, compared to emissions from one ton of Carbon Dioxide (CO_2) [2,3,4]. GWP of a halogenated fluorocarbon contribution to global warming is equal to 1. Compared to CO_2, which is the reference greenhouse gas with a GWP100 of 1, volatile anesthetics have significantly higher GWP100: sevoflurane 144, N_2O 298, isoflurane 510, and desflurane 2,540. For example, a single anesthesiologist administering N_2O or desflurane can cause the CO_2 equivalent of more than 1,000km of driving in an average workday [5]. The environmental impact of our work demands core changes which will lead to less CO_2 use and production, less gas emission and less waste production. It means that crucial changes in global health care must be made in order to achieve more sustainable environment and future. Hospitalizations could be minimized by improving primary care and expanding outpatient procedures which is expected to contribute to less significant gas emissions as pollution, as well as reducing the use of medications and devices. For example, it is considered that the operating room and the procedural suits are the biggest source of garbage contributing to around 30-70% of total health care related waste. According to one Australian study during the neuroradiological procedures the mean amount of garbage was 8kg per case and the endoscopic rooms were identified as a second hot zone in producing a significant amount of waste [6]. This study's results led to a recommendation that the focus should be put on the use of a multiple use devices, while all single-use devices should be recycled as well [6]. Gill AS et al. have reported that in one hospital in UK yearly were made around 1,000 tonsillectomies which resulted in 1,984kg of waste or approximately 2kg per procedure. This implies that more than 100,000kg of waste will be created in whole UK due to average number of tonsillectomies [7]. The study of Skowno J. et al. has reported that 25% of the total amount of garbage is produced into the operating room while one quarter of that is related to anesthesia practice [8]. Another study has confirmed that using a "Power Down" initiative in a hospital with turning off all the anesthesia and OR machines, equipment and lights when they are not in use led to a saving of 33,000$ and 243 metric tons of CO_2 emissions per year [9].

Many centers in USA have implemented a standard for using reusable scrubs and gowns instead of disposable ones which resulted in saving of 100,000$ per year [10]. When talking about usage of perioperative textiles, it has been confirmed that reusable and disposable ones are similar in cost, comfort and safety, but using a reusable versus disposable textiles has offered substantial reduction of the environmental footprints [11]. It is well known that ORs could contribute to up to 2,000 tons of medical waste per year made up mostly of disposable materials which end up as a medical waste. Medical waste is divided in two categories regarding the fact if it has contact with biological fluids and consequent infectious potential or not. Actually, if medical waste has been in contact with any biological potential, already possesses an infectious potential which automatically means that could not be recycled and reused and is categorized as a Regulated Medical Waste (RMW). The other category which could undergo recycling and reuse is considered as non-infectious and could be a source of new products if recycled and could save significant amount of money because does not undergo special destruction procedures and is categorized as a Non-Regulated Medical Waste (nRMW). Separating the waste in a proper manner in a daily practice has been reported as a problem and a resource of significant amount of nRMW which in fear of possible infection potential is lost in the RMW which is non-recyclable, nor reusable [12]. That fact raises the need for another system of waste separation due to proper categorization.

Depending on the anesthetic technique used in a daily practice, anesthesia teams could or could not contribute to Going Green. It has been confirmed that reusable blades for laryngoscopy produce a significant amount of waste and are sources of carbon emissions when undergo RMW related destruction. Even though they are superior in risk for cross linked infection transmissions, reusable metal blades are better in terms of cost and avoidance of environmental carbon footprint due to their manufacturing and destruction [12]. Reusable LMAs were entitled as the one of the steps that contribute when Going Green in comparison with single use LMAs which demand energy and resources for manufacture as well as for destruction. In the study of McGain et al. it was found that even Central Venous Line Kits when sterilized and reused were described as Go Green friendly because of being less expensive and avoid manufacturing and destruction as well [13]. As it is already established that inhalational anesthetic usage is related to significant environmental hazards, Total Intravenous Anesthesia (TIVA) is a preferred technique when Going Green, but it must be taken in consideration all the waste that will be generated in the process of providing TIVA including the loss of unused medications and the need of destroying of the plastic syringes and systems needed for the continuous delivery of the medication, as well as the energy needed for pump delivery of TIVA [12].

According to Essaki et al., only one single surgical intervention is a source of a waste even bigger than the one that could be made weekly in a family of 4 persons [14]. Therefore, reducing waste from the operating rooms is a must in order to minimize the harmful emissions and environmental hazards. Securing a sustainable and better future is possible with taking actions for minimizing the OR waste with implementing the 5Rs rule. Five Rs rule includes: Reduce, Reuse, Recycle, Rethink and Research.

Reduce: Reducing production of a OR waste could be possible with using reusable devices and materials, for example, using metal reusable laryngoscopy blades, reusable suction canisters, LMAs, facemasks, surgical kit wrappings, hospital made regional anesthesia and central venous placement kits and many more. One of the most important actions that could make a huge difference is careful and proper waste segregation because it has been reported that approximately 85% of the OR waste is solid and nonhazardous which exhibits treatment as a nRMW, but unfortunately around 50-85% of the nRMW is wrongly sorted as a hazardous and potentially infective demanding treatment of an RMW [15]. It really matters how the waste will be treated because hazardous and potentially infective waste demands special procedures of destruction which cost even 8 times more in comparison to the nonhazardous solid OR waste (963$ vs. 121$ per ton) [16]. LED lighting in the OR instead of classical halogen lighting has shown few advantages including better lighting and color, decreased radiant energy and 49% lesser energy load [17]. Polypropylene plastic is main component of the blue sterile wraps which are used for coverage of surgical instruments and some kits, but it is not reusable which means that is one of the major components of the OR generated waste, or more specifically 19% of the total amount of waste is believed to be generated by polypropylene made blue sterile wraps which demand expensive disposal treatment [18]. In terms of cost-effectiveness polypropylene blue sterile wraps could be exchanged with simple green textilewrappings which are reusable and could undergo process of sterilization safely.

Reuse: It has been found that in the hospitals where reusing medical devices is a practice costs are lowered for about 50% [19]. Reuse could be implemented at many points in OR life, including scrubs, surgical gowns and coverings, wrapping materials, canisters, LMAs, laryngoscope blades, airways, facemasks, regional anesthesia sets and even needles.

Recycle: Many surgical and anesthesia sets and devices, as well as their packings are made out of plastic, and in reality, generate significant amount of solid waste which ideally could and should be recycled. Operating room paper should be properly stored and recycled. All together could made to 40% of savings in terms of recycling instead of destroying.

Rethink: Around 5-20% of the anesthetic gases are metabolized by the patient leaving the remaining part to be vented out into the atmosphere creating a contribution to the global warming since inhaled anesthetics have 2,000 stronger global warming potential than carbon dioxide [20]. This fact should lead to preference of TIVA over inhalational anesthesia, or if inhalational anesthesia is used, the fresh gas flow should be as lower as possible or even lower than 1.0 l/min. In order to Go Green if inhalational anesthesia is a must, Sevoflurane is preferred over Desflurane and Isoflurane. Nitrous oxide should not be used at all.

Research: Protocols and propositions should be made based on scientifically proven data in this field which implies the need for structured trials and careful analysis of the data.

Despite raising voices about medical practice, healthcare related procedures and their impact over environmental sustainability, lack of knowledge, poor guidance by the management, institutions and government, and acceptance were found as a limitation that reduce implementation of the measures that will enhance Going Greener Strategy, it was concluded in

the WSES STAR investigation [21]. The lack of the environmental sustainability team in most of the hospitals could be a limitation of implementing measures that could turn operating room into a greener area despite that individual efforts could be met in daily practice [22]. When speaking of the environmental impact of practicing Anesthesia and Operation Room related tasks the French Society of Anesthesiology and Intensive Care Medicine has published strict recommendations about how we could minimize the negative environmental impact of our work which are based on all the facts that were already discussed above. Actually, they recommend choosing sevoflurane over desflurane and isoflurane when inhalational anesthesia is chosen as suitable for the patient, but they recommend that Nitrous oxide should not be used at all and the fresh gas flow should be kept as lower as possible with maximal flow of 1l/min. Routine usage of an anesthesia depth monitoring when practicing inhalational anesthesia, considering the depth and the exhaled fraction of the volatile anesthetic together to prevent inhalational anesthetic overuse, is strongly recommended. Advantages of TIVA over inhalational anesthesia from the environmental toxicity point of view were minimized when emphasized that propofol derived metabolites could be found in the hospital related disposal liquids. Choosing a reusable over single use devices related to practicing anesthesia was strongly recommended as well as using the reusable devices as much as possible. Special attention was dedicated to the need for proper waste segregation and separation, evaluation of the waste and its type, as well as the way it should be destroyed, the need of bins and their positions, as well as the significance of the management of waste disposal.

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