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REVIEW

Mustard lung anesthesia: general anesthesia in patients with chronic obstructive pulmonary disease due to sulphur mustard exposure

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ABSTRACT

Sulphur mustard is a powerful blistering and alkylating chemical weapon which has been used in many wars. Pulmonary complications have the highest prevalence and result in a wide range of chronic side effects. A particular kind of chronic obstructive pulmonary disease (COPD) is defined for these patients and it is known as mustard lung. Another important issue that has become essentially important over the years is interference of this disease with other invasive and non-invasive treatment procedures. An anesthesiologist and a surgeon must have a thorough understanding of local and systemic comorbidities and a general understanding of extra pulmonary side effects. This article studies important diseases and clinical manifestations affecting the process of anesthesia in these patients. This review article attempted to summarize the contents, to offer practical notes, to express necessary indications and to review preoperative evaluation and proper intraoperative and postoperative management. To reach this aims we search on valuable academic data base such as Google Scholar, PubMed, Scopus, and Web of Knowledge, and use our experience from management of this patients. In addition to X-ray and spirometry, these patients may require high-resolution CT of lungs. Since systemic inflammation is possible in these patients like other COPD cases, checking inflammatory blood tests (such as the C-reactive protein test) is also necessary. Venipuncture site for IV is vital in skin lesions and for the health of blood vessels. In order to prevent acidosis-alkalosis changes, ABG test must be performed. Respiratory monitoring and O₂ saturation monitoring are also very important. Using protective eye goggle is crucially important in these patients — who have eye problems and, specifically, corneal problems — during anesthesia and then in the ICU. It should be noted that medications and blood products should be administered for these patients by considering extra pulmonary complications and above mentioned diseases. In addition, blood tests and pulmonary tests should be conducted after the surgery and before patient's discharge to control possible complications.

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Key words: Mustard gas - Anesthesia - Chronic obstructive pulmonary disease - Respiratory tract diseases.

Sulphur mustard or mustard gas (*i.e.*, bis (2-chloroethyl)sulfide) is a powerful blistering and alkylating chemical weapon which has been used in many wars, including the war of Iraq against Iran.^{1,2} Mustard gas has numerous acute and chronic side effects, including:

dermal complications, ocular complications, pulmonary complications as well as systemic changes, such as hematological changes, changes in the immune system and hormonal changes.³ Among different complications, pulmonary complications have the highest preva-

lence and result in a wide range of chronic side effects. In Iran, about 100 thousand patients exposed to mustard gas are suffering from pulmonary complications and these complications are demonstrated in a various forms, from bronchitis to chronic obstructive pulmonary disease (COPD). A particular kind of COPD is defined for these patients and it is called mustard lung. This name is chosen because of pulmonary exposure to mustard gas.⁴ These patients are suffering for almost three decades; however, they are still deprived of effective treatment. The mechanisms of action behind mustard gas have not been perfectly identified and medical teams have failed to successfully treat these patients and only try to perform symptomatic treatments and to control symptoms.⁵ The continuation of undesirable conditions of this chronic disease can result in other side effects and researchers are looking for ways to reduce or prevent these side effects. Another important issue that has become essentially important over the years is interference of this disease with other invasive and non-invasive treatment procedures. In fact, these patients' physiological changes have changed the behavior of medicines in their bodies and this interferes with medications they take for other diseases. Also, today worsening chronic pulmonary complications and lack of adequate control over their clinical manifestations have made it very difficult to examine these patients for various surgical procedures; so that, an anesthesiologist and a surgeon must have a thorough understanding of local and systemic comorbidities and a general understanding of extra pulmonary side effects. This article studies important diseases and clinical manifestations affecting the process of anesthesia in these patients. Therefore, we will study pulmonary patients exposed to mustard gas in two parts: preoperative evaluation, intraoperative management and postoperative care.

Preoperative evaluation of mustard lung patients

In order to achieve better results from anesthesia, patients must be aware of the coex-

isting disease.⁶⁻⁸ This paper aims to provide general recommendations and guidelines resulting from experiences obtained from general surgical operations on mustard lung patients and they are not offered only to be applied in a specific type of surgery or medical field; but, they should be used by anesthesiologists in all surgical procedures requiring general anesthesia. In fact, this paper tries to familiarize specialists with a specific type of lung disease and the knowledge required for anesthesia in these patients. Preoperative evaluation in these patients requires conducting more diagnostic tests compared with pulmonary patients. In fact, a simple X-ray lungs chest graph cannot manifest pulmonary function in these patients and a spirometry pulmonary function test should be conducted before any general anesthesia; because previous studies have reported reduction in lung capacity of these patients and their forced expiratory volume in one second (FEV₁) in particular is much lower than other patients. Also, in addition to X-ray and spirometry, these patients may require high-resolution CT (HRCT) of the lungs, as well. It is also essential to mention that chronic cough is the most common complaint of these patients. Phlegm and dyspnea have been observed in more than 80% of mustard lung patients since the early years of poisoning.⁹ Bloody sputum, chest tightness and shortness of breath at night are common symptoms. Also, the main respiratory symptoms include: generalized wheezing, crackles, reduced breath sounds and cyanosis.¹⁰

Also, since systemic inflammation is possible in these patients like other COPD cases,¹¹ checking inflammatory blood tests (such as the C-reactive protein test) is also necessary; because in the case of inflammation, medication should be used in these patients before surgery. Also, in order to prevent acidosis-alkalosis changes, ABG test must be performed in these patients. In addition, drug interactions should be considered in these patients; because many extra pulmonary complications like cardiovascular diseases,¹² osteoporosis¹³ and systemic inflammation¹⁴ are possible in these patients and they should be examined in terms of tak-

ing other medications. The importance of cardiovascular disorders, kidney disorders, skin and ocular disorders in these patients is not less than pulmonary disorders and by obtaining a thorough report of patient's history and his ongoing treatments, prognosis of these disorders should be provided during anesthesia. Such care will be explained further in the next section.

Intraoperative management and postoperative care in mustard lung patients

Intraoperative recommendations in Mustard Lung patients begin from their entry into the operating room and even before inserting an IV into patient's hand; because most patients suffer from skin¹⁵ and cardiovascular problems¹⁶ and familiarity of nurses with the venipuncture site for IV is very important and vital in terms of skin lesions and the health of blood vessels; therefore, an additional IV must be always inserted for the patient and special attention should be paid to the health of blood vessels and skin lesions when choosing the right site to insert the IV. Here, it should be noted that in the case of using electrocautery device in the surgery, it should be adjusted very carefully, because, possible burns can exacerbate older skin lesions and on the other hand, their inhibition is very difficult in patients with systemic inflammation and pulmonary disorder. As mentioned, these patients are likely to develop ocular complications of mustard gas poisoning and the least possible complication in these patients is dry eye syndrome. Therefore, in the case of performing a long-term surgery (like neurological surgeries) or in cases where patient is placed in prone position, moisturizing eye gels or eye protection goggles should be used for patients during anesthesia; because using this protective goggle moisturizes the eyes during anesthesia and prevents progression of corneal lesions. In fact, during anesthesia tear secretion is stopped due to anesthetic drugs and corneal surface will become dry. This process can dry the cornea even in normal patients. Therefore, using protective eye goggle is crucially important in these patients —

who have eye problems and particularly corneal problems — during anesthesia and then in the ICU (in the case of low Glasgow Coma Scale values or prone position).

Following the cardiovascular complications, continuous monitoring of arterial blood pressure is vital in these patients and invasive blood pressure monitoring should be used to obtain more reliable values. Moreover, continuous monitoring of urine volume to control the health of kidneys as well as re-testing arterial blood gases in order to avoid possible acidosis-alkalosis changes are both vital in these patients.

Pulmonary ventilation is the golden key of anesthetic management of mustard lung patients and it requires familiarity with the capacities and volumes of patient's lungs and mastery of spirometry, before setting the ventilator is very important. Spirometry results in these patients have shown that forced vital capacity (FVC), FEV₁, and FEV₁/FVC (FEV₁%) may be lower than non-exposed healthy individuals as well as chemical devotees who have used gas masks.¹⁷ Apparently FEV₁ decreases by 50 mL/year.¹⁸ Residual volume (RV) is significantly increased; while, the diffusing capacity of the lung for carbon monoxide remains normal.¹⁹ More than half of exposed patients did not show any pulmonary function defect. Other individuals with pulmonary function disorder often demonstrate more obstructive patterns.¹⁷ Therefore, during the surgery and in the recovery room or in the ICU, the ventilator mode should be set on the basis of these prognoses and spirometry test results. Also, analgesic drugs should be administered for these patients at the end of surgery and in the ICU by considering their pulmonary complications. Additionally, respiratory monitoring and O₂ saturation monitoring are very important in these patients after the surgery and in the recovery room or in the ICU.

Conclusions

As stated before, this study aims to provide a general description of issues associated with mustard lung patients to anesthetists in order to

enable them to offer better anesthesia services to these patients. Hence, this paper attempted to summarize the contents, to offer practical notes, to express necessary indications and to review preoperative evaluation and proper intraoperative and postoperative management. At the end, it should be noted that medications and blood products should be administered for these patients by considering extrapulmonary complications and above-mentioned diseases. In addition, blood tests and pulmonary tests should be conducted after the surgery and before patient's discharge to control possible complications.

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Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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