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Drug Administration through Hyperbaric Procedure

Lt Cdr Mayank Sharma

B Sc Naval Sciences, Goa University, Certification course from Institute of Naval Medicine, INHS Kalyani, Mumbai, India

Abstract: ***Pharmaceutical drug in gaseous forms can be administered via various mixtures of breathing gases prepared ergonomically to treat a particular disease or condition. During administration, hyperbaric conditions can be maintained in a chamber and once the target area of the drug is affected or treated, the pressure can be reduced to facilitate subsequent off-gassing of the gaseous drug from the body. This methodology would entail zero side effects of any drug because it remains in the body only for the duration of its actual requirement and is eliminated completely leaving no residue or traces post treatment. Manufacture of various breathable mixtures containing gaseous drug is to be researched thoroughly. The dosage of any gaseous drug in therapeutic mixture can be increased or decreased by altering the mixture composition accordingly. Characteristics of gaseous drugs such as solubility quotient in blood, off-gassing and on-gassing rates, suitable mixing procedures of gaseous drugs with breathing gases etc needs to be thoroughly analysed.***

Keywords: Drug administration, side effects, hyperbaric, off-gassing, on-gassing

1. Introduction

Hyperbaric therapy has been used worldwide for treatment of various diseases, neurological conditions, cancer treatments etc. But the use of therapy is constrained to post occurrences of symptoms as related to diseases and conditions mentioned above and utilizes only benefits of hyperbaric oxygen.It is pertinent to mention that various drug administration methods to treat occurrences of any disease or symptoms are either in liquid or solid form of medicines. However, it is submitted that the same can be administered in gaseous form under hyperbaric conditions which would facilitate faster on-gassing and can be subsequently off-gassed post effecting the targeted area in the body. This research paper aims at discovering an adequate methodology to convert conventional drugs into gaseous form which can then be injected into the body under hyperbaric conditions to facilitate swift delivery to affected part of body followed by off-gassing of the same by reduction of pressure.

2. Background

At present, hyperbaric therapy is limited to the use of pure oxygen at higher partial pressures. The underlying principle is the enhanced dissolution of oxygen into the blood (RBC and in plasma). Normally a 100 ml of blood contains about 20 ml oxygen in RBCs and only 0.19 ml is present in plasma. However, when the PPO_2 is increased in a hyperbaric chamber, the plasma content of oxygen increases to about 6ml. This enhanced oxygen in plasma is the cure to the ailing tissue of the body under treatment. Hyperbaric treatment, popularly known as HBOT (Hyperbaric Oxygen Therapy) finds its use in a variety of treatments such as Gas gangrene, cerebral palsy, Decompression sickness, AGE etc in divers etc. The aim of this research is to use a similar concept of enhanced dissolution of gases in blood to deliver drugs in gaseous form under pressure (more than one bar) followed by off-gassing subsequently to carry out various treatment procedures by reduction of pressure.

3. Literature Survey

A pharmaceutical drug, often referred to as medication or medicine, may be defined as a substance that is used to treat cure, prevent or diagnose a disease or to promote well-being. Traditionally drugs were obtained through extraction from medicinal plants, but more recently they are synthesised from organic precursors. Pharmaceutical drugs may be used for a limited duration, or on a regular basis for chronic disorders. The most common form is powder, that is, capsules made from gelatine or a non-animal substitute, tablets, pellets or pills. In addition, drugs can also be administered in the form of liquids as Gels, Emulsions, magmas etc consumed either orally or applied directly on the affected area such as ointments, liniment, lotions, paste etc. However, it is highlighted that after these drugs are utilised in the body to treat the concerned affected area, they remain in traces in the body and cause what is generally termed as side effects. For example - Cancer cells tend to grow fast, and chemo drugs kill fast-growing cells. But because these drugs travel throughout the body, they can affect normal, healthy cells that are fast-growing too. Damage to healthy cells causes side effects. The normal cells most likely to be damaged by chemo are Blood-forming cells in the bone marrow, Hair follicles, Cells in the mouth, digestive tract and reproductive system etc. Moreover, some chemo drugs can damage cells in the heart, kidneys, bladder, lungs and nervous system. Such side effects cannot be neglected. Therefore, there exists a need to determine requisite methodology or procedure by which drugs can be administered with minimum side effects and at the same time, desired effect of the drug can also be achieved at enhanced rates. This has given birth to the formulation of a new concept of drug administration in the gaseous form under hyperbaric conditions to induce rapid on-gassing of drug in gaseous form through circulatory system in the body and subsequent off-gassing after desired effect is achieved by reducing pressure to Nomobaric or Hypobaric conditions.

The hyperbaric conditions lead to increased solubility [Henry's Law] of gas in circulatory system via lungs and lead to delivery of gaseous drug to the affected part of the body instantly. Not only the speed of delivery of drug to the

desired body part but also the gaseous dosage can be adequately increased or decreased with respect to patient specifics by altering the hyperbaric environment.

4. Methods and Approach

1) **Concept 1**. Pharmaceutical drugs can be dissolved in a suitable solvent at high pressures similar to a coke bottle which contains CO_2 gas at higher pressure dissolved in it. These drugs can then be delivered to patients inside a hyperbaric chamber so that they do not off gas from the dissolving solvent and enter patients' body at pressures higher than 1 bar. Once they enter through conventional method of digestion in the body, they will dissolve in blood through site of digestion. Thereafter, once the desired effect of drug is achieved, the chamber pressure can be reduced so that the drug is again converted to gaseous form and expelled via respiration or excretory route similar to removal of CO_2 from the body through lungs via blood.
2) **Concept 2**. Drugs can be converted into gaseous form similar to inhalers and can be administered to patientsunder regulated hyperbaric conditions. This gaseous drug when administered to patient under hyperbaric conditionsdissolves throughrespiration site, that is alveoli. The drug in gaseous form is then transported through blood which circulates with each pump of heart. The gaseous drug then reaches the concerned part of the body immediately where it eradicates the problem. Once this is achieved, at the first sign, the pressure in the chamber is to be reduced so that this gaseous drug is again off-gassed from the body similar to removal of CO_2 through lungs.By doing so, the drug in gaseous form is completely removed from body leaving no trails. In addition, the drug has stayed in the body for a minimum period of time, hence side effects will be minimum and there will be apparently no traces of unwanted drug in the body which would need to be eliminated from the body.
3) **Considerations For Preparation Of Breathable Mixtures**. There are two underlining considerations to be taken for preparing a breathable mixture. These are:-

a) **Oxygen Content:** Should not fall below .195 PPO2. Maximum limits under hyperbaric conditions should not cross 2.8 bars. However, due to associated risks of CNS and POT, the PPO_2 to be maintained at optimum levels so that benefits of oxygen are also accrued while maintaining UPTD limitations.
b) **Nitrogen Content:** Should not be raised beyond 4 bars to avoid nitrogen narcosis.
c) **Gaseous drug content:** Following considerations are vital prior administering drug in gaseous form: -
- Should possess similar characteristics as breathing gases i.e. air.
- Should be soluble in blood under hyperbaric conditions.
- Should off-gas when pressure is reduced.
- Should be insoluble in blood at normal pressures. However, if this is not possible, the chamber pressure can be reduced below one bar whilst maintaining oxygen levels at optimum to facilitate off-gassing of gaseous drugs. Preferential gas displacement technique can be also be utilized for off-gassing in which PPO_2 and PPN_2 can be increased to displace gaseous drug from the system post desired drug effect is achieved.

5. Results and Discussion

Procedure for Administration

When a suitable gaseous drug as discussed above is made, it can be stored in a pressurized bottle similar to a divers' breathing gas separately if it is reactive with oxygen of breathing gas or if it is non-reactive with oxygen at HP, it can be mixed with breathing gas and stored in same HP breathing mix bottle. There might be a condition if it is not feasible to store gas under HP conditions above 8 bars. In such circumstances, these gaseous drugs can be filled in separate LP pressurized/non pressurized bottles and fitted with a regulator assembly. This regulator assembly will maintain dosage of gaseous drug in unit of litres/min. One input from this regulator (containing gaseous drug) is then mixed with input from breathable mixture through BIBS mask and is inhaled by the patient. A sampler can be fitted taken from parallel supply of final mix from BIBS to ascertain percentages of mix which is inhaled by the patient and is monitored by the chamber operating supervisor and doctor.Apparently, there might be a condition wherein it is not possible to do the procedure as mentioned above with respect to administration of drug in gaseous form . In such cases, the most simple form of gaseous drug administration is through IV, IM route by using hyperbaric needles containing solvent with gaseous drug dissolved in it.

6. Conclusion and Future Scope

A detailed research is required to analyse abovementioned procedures and the sphere of applicability of such gaseous drugs. A reference example can be chemotherapy for cancer patients which entails post treatment side effects significantly. In such cases, the poisonous drug aimed at targeting the cancer cells can be administered in gaseous form or can also be administered in dissolved form in solvent under hyperbaric conditions. Once the desired effect is achieved, it can be off-gassed by reducing the pressure of chamber thereby entailing minimum side effects. Effect of gaseous drugs with respect to off-gassing and on-gassing on human physiology and its effects needs to be thoroughly researched before carrying out any such administration of gaseous drugs.