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Inside this Issue:

Dedicated to the Indomitable Spirit and Sacrifices of the SOF Medic

A Peer-Reviewed Journal That Brings Together the Global Interests of Special Operations' First Responders

Sea State Green

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CONCEPTS AND OBJECTIVES

The series objective is to review various clinical conditions/presentations, including the latest evidence on management, and to dispel common myths. In the process, core knowledge and management principles are enhanced. A clinical case will be presented. Cases will be drawn from real life but phrased in a context that is applicable to the Special Operations Forces (SOF) or tactical emergency medical support (TEMS) environment. Details will be presented in such a way that the reader can follow along and identify how they would manage the case clinically depending on their experience and environment situation. Commentary will be provided by currently serving military medical technicians. The medics and author will draw on their SOF experience to communicate relevant clinical concepts pertinent to different operational environments including SOF and TEMS. Commentary and input from active special operations medical technicians will be part of the feature.

KEYWORDS: *motion sickness; medication, antimotion sickness*

Scenario

Your commander approaches you with the following directions. The team is planning for a maritime assault that will involve an opposed ship boarding in possibly severe sea states. Your team will loiter in rigid-hulled inflatable boats and make an opposed boarding of a vessel of interest while it is under way. He wants to make sure he does not lose any of his guys to seasickness and that whatever preventive drugs you use do not affect their ability to conduct the assault. You take stock of the situation. You realize that the clinical question at hand is: what is the most effective antimotion sickness medication with the least effect on clinical performance?

Motion Sickness

Motion sickness is a syndrome that occurs when there is a disagreement between visually perceived motion and the vestibular system's sense of movement.[1] It is characterized by pallor, nausea, and vomiting. It can be brought about by exposure to real, or apparent, or unfamiliar motion to which the individual is not adapted.[1] It can occur in a variety of environments: air, sea, space, motor vehicles, and even virtual reality. There are significant differences in individual susceptibility to motion sickness but, given enough stimulus, most people will experience some degree of symptoms. The spectrum of symptoms can vary based on the individual and the degree of motion. These symptoms can range from simple nausea, sweating, and occasional vomiting, to almost complete incapacitation. The symptoms usually improve over 72 hours but can recur. In fact, some individuals will experience a level of motion sickness after they return to land.

Pathophysiology

The prevailing theory explaining motion sickness is the neural mismatch theory. It hypothesizes that motion sickness arises when there is a conflict in signals the brain is receiving regarding motion. The brain receives a variety of sensory signals to determine the position of the body and head in space. These include visual cues, somatosensory cues, and vestibular input from the inner ear. In the inner ear, the labyrinth encodes angular motion, which is sensed by the semicircular canals and linear acceleration, and gravitational force (sensed by the otolith organs).[2] Disparity in these sensory inputs can cause conflict that can lead to motion sickness. For example, if a person is inside a boat that is being tossed around by waves, the conflict between limited visual cues and the input from the vestibular system leads to motion sickness. Experimental support for this hypothesis is demonstrated in test animals that have their labyrinth system disrupted, they do not develop motion sickness.[1]

Motion sickness can be induced in almost all people if the stimulus is sufficient; however, certain people are more susceptible. Susceptibility is not existent until the age of 2 years, peaks at about 12 years of age, then typically declines with advancing age. Women tend to be more susceptible than men, and pregnant women are particularly susceptible. People who suffer from migraines are more susceptible, as are those with disease or illness that alters vestibular or visual sensory cues that may make the person more sensitive to head motion and visual stimulation. It has been reported that a person's expectations and prior experiences may affect risk of motion sickness; in some cases, people can develop an almost anticipatory sense of motion sickness.

Environmental factors play a major role in motion sickness. The type of motion can be a factor, with low-frequency lateral and vertical motion being particularly stimulating.[1] Body position also plays a role: lying down decreases susceptibility and onset of motion sickness. Many people feel food is a protection against motion sickness, but the research regarding this is conflicted.

Incidence

The incidence of motion sickness depends entirely on the intensity, duration, and type of motion that people are exposed to. Very few people are not susceptible. For instance, in a study of 466 Royal Navy personnel, 4% were occasionally sick in calm seas, whereas in rough sea states, 6% were always sick, 16% were often sick, and 44% were occasionally sick.[3]

Prophylactic Treatment

Because of the common nature of motion sickness, a variety of treatments have been historically used to treat it. It is clear that medication is more effective preventively rather than waiting for symptoms to occur.

Labyrinthine Cues

One proven treatment is to try to reduce the conflict between the visual system and the labyrinth organs. This can be accomplished by viewing the horizon. In many military operational settings, this may not be possible. Additionally, lying flat has been shown to reduce the incidence and severity of symptoms.[4] The physiology of this effect may be due to the reduction in head movement while lying supine.

Adaptation is the most potent prophylactic option.[2,3] Protective adaption is best accomplished by gradual and incremental exposure to provocative motion. Once adaption is achieved, it can be maintained by regular and repeated exposure to the stimulus.[2] This technique has been used frequently in the training of pilots and aircrew. Those prone to motion sickness are frequently subjected to progressive desensitization training. Much of this work was pioneered by Dowd and Dobie in the 1960s and an element of cognitive behavioral therapy was incorporated. Unfortunately, these desensitization treatments are not as effective in a maritime environment. This is felt to be due to the largely unpredictable motion that can be experienced in this setting.

Nonpharmacological Treatment

Various nonpharmacological options have been explored for the treatment and prevention of motion sickness. Ginger is a popular alternative medicine used for motion sickness. One Naval study found that 1–2g of ginger had some benefit in preventing motion sickness.[5]

Acupressure has been purported to be useful in preventing motion sickness. According to the theory, pressure at the P6 point on the flexor surface of the wrist can reduce symptoms. Some research seems to demonstrate a benefit, whereas other data do not.[6] The role of acupressure in an operational setting is likely limited.

Medication

A variety of medications have been used to treat and prevent motion sickness. The majority of these drugs are hypothesized to reduce the conflicting sensory information by suppressing activity with the labyrinthine system. Despite the common nature of motion sickness, the research and trials tend to involve small numbers of patients. There are also very few head-to-head trials of medications.

Drugs classified as antihistamines probably are effective because of their anticholinergic effects. Several medications in this category have been used, but the two most common are dimenhydrinate and meclizine. The side effects of these drugs are related to their anticholinergic effects, which include sedation, blurred vision, and dry mouth; in higher doses, they can cause urinary retention and confusion. Dimenhydrinate is available as a liquid, tablet, or injectable formulation. It is readily available over the counter. Meclizine is also commonly used; typical oral dosing is 25–50mg every 8 hours. Operationally, these drugs are limited primarily by the side effect of drowsiness. Unfortunately, studies evaluating the nonsedating antihistamines fail to show a benefit in preventing motion sickness.[7]

Anticholinergics

Scopolamine is perhaps the most commonly used drug for the treatment of motion sickness. It has been shown to prevent motion sickness.[1,2,8] In one trial, it was found to be superior to promethazine, meclizine, and lorazepam.[9] The drug is limited by its short half-life, however; it peaks within an hour of ingestion but lasts only about 4 hours. It is for this reason that a transdermal patch that steadily releases 20µg/h for 72 hours has been developed. The patch must be put on 8–12 hours before exposure to allow a steady state of drug to be reached. This may limit its operational effectiveness because the user or medical provider has to predict the need for prophylaxis. Alternatively, an oral or intramuscular loading dose can be used in conjunction with the patch to reach a quicker steady state.[1] Significant research has been directed toward the intranasal administration of an aqueous form of scopolamine, referred to as INSCOP. Much of this research has been conducted by NASA and the Naval Medical Research Unit. Although the reports are very promising, to the author's knowledge, no publically published trial results are available.[10]

Side effects of scopolamine include sedation, blurred vision, and dry mouth. It can also precipitate acute-angle closure glaucoma in those susceptible. In higher doses, it may also cause some confusion.[1,2] From an operational perspective, the sedation and blurred vision may be a significant issue. Special care must be made not to touch the eyes after applying the transdermal patch, because significant blurred vision can occur.

Antidopaminergics

This class of drugs has been frequently used in the medical setting for the treatment of nausea. Promethazine and metoclopramide have been used and studied for motion sickness.[1,2]

Antiemetics such as prochlorperazine and ondansetron are both very effective antinausea medications and can help alleviate vomiting in motion sickness. However, in very small studies, they have not demonstrated a benefit in preventing motion sickness.[11]

Benzodiazepines have demonstrated some benefit in preventing motion sickness but are limited by the sedating effects.[1,2] One theory is that this type of medication is most effective for those who suffer anticipatory motion sickness.

Adjunct Medication

The most frequently cited side effect of medication used to prevent motion sickness is sedation. A variety of medications have been used to combat these sedating effects, including ephedrine, amphetamines, and caffeine. Amphetamines are controlled substances, with addictive properties and concerning side effects that may not be suitable for operations. It should be noted that they have been used and studied, and form the basis of many Air Force airsickness regimens.[12] Co-administration of 5mg of dextroamphetamine does appear to counteract the side effect of sleepiness and drowsiness associated with scopolamine. Whether this is an option for the Special Operations Soldier is disputed and is probably left up to individual unit or military regulations.

Ephedrine is readily available and commonly used with decongestants. It is stimulating and can increase heart rate and blood pressure, and cause tremors. Ephedrine has been studied in combination with promethazine at a dose of 25mg of ephedrine and was found to decrease side effects of sleepiness and drowsiness.[1,13]

Caffeine may be a useful adjunct in the Special Operations setting. In one study, when 200mg of caffeine was combined with promethazine, it significantly decreased symptoms and improved reaction times.[14] The benefit of caffeine is that it is readily available and socially acceptable. Most individuals have been exposed to it and, in pill form at a 200mg dose, it is not a significant diuretic.

Performance

The key issue from an operational perspective is what works and what is going to allow the operator to do their job. There is very little research comparing the various medications in an appropriate head-to-head fashion. In one small study of 67 patients, meclizine had the least impact on cognitive effects. It was followed in order by scopolamine, promethazine, and lorazepam.[15]

Table 1 *Drug Doses and Typical Onset of Action (based on Benson[1])*

Drug	Route	Dose	Time of Onset	Duration of Action, hours
Scopolamine	Oral	0.6mg	30 minutes	4
Scopolamine	Transdermal	20µg/h	8–12 hours	72
Meclizine	Oral	25–50mg	2 hours	8
Dimenhydrinate	Oral	50–100mg	2 hours	8
Dimenhydrinate	IV/IM	50mg	15 minutes	8
Promethazine	Oral	25–50mg	2 hours	15

IM, intramuscular; IV, intravenous.

In other trials, administering amphetamine with promethazine prevented drowsiness and impaired psychomotor performance compared with promethazine alone. The same effect was not seen when pseudoephedrine was paired with promethazine.[16] Another trial found that ephedrine decreased sleepiness and improved performance when administered with the antihistamine chlorpheniramine.[14]

Summary and Recommendation

You inform your commander that you can provide a variety of medications for the team. You caution that even with prophylactic medication, some of his force will likely suffer from motion sickness. The proportion of individuals affected will be directly related to the time spent in the boats and the severity of the sea states. You recommend a trial of either scopolamine transdermal or oral meclizine. The medication will have some impact on performance, but some of the sedative effect may be counteracted by caffeine or ephedrine. You recommend prophylactic use of medication in workup training so you and the operators can individually assess a regimen's impact on alleviating their symptoms and the impact on their performance.

Disclaimers

The views and medical opinion herein represent those of the authors. They do not reflect the operation practice or views of the Canadian Forces or other organizations. The cases are provided to be educational and thought provoking; at no time does the author suggest that the tactical clinicians exceed the scope of their practice or act against the direction of their medical protocols or recommendations of their medical leadership.

Disclosures

The authors have nothing to disclose.

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