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A STUDY ON THE STRATEGIES TO OVERCOME THE BAD IMPACT OF RADIATION

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ABSTRACT

In some instances, the use of ionizing radiation by medical equipment is required for the purpose of clinical diagnosis. The catheterization laboratory is a hazardous place to work because to the concealed risk of ionizing radiation exposure to both patients and personnel. This risk is present in the laboratory. One of the most important things to focus on is lowering radiation levels, particularly scattered radiation. The use of radiation dose feedback is one of the possible strategies that might be utilized to reduce exposure levels. The ability to accurately forecast the possibility of unfavorable biological outcomes and the dangers that are associated with them is an essential component of medical practice. As a result of the near closeness of the operator to the radiation source, the implantation of cardiac resynchronization devices is often associated with one of the greatest doses of radiation exposure for the operator. It is imperative that all medical professionals adhere to the principle of doing as little as is reasonably feasible. It is of the utmost importance that the catheterization laboratory implements certain precautions in order to reduce the potential for radiation exposure. The purpose of this article is to offer a complete summary of the approaches that are currently being used to lower the radiation dose that operators are subjected to during electrophysiological, diagnostic, and interventional cardiac procedures. In addition to electrophysiology and interventional cardiology, occupational dangers include radiation exposure, ionizing radiation, cardiovascular resynchronization devices, and radiation exposure.

Keywords: electrophysiological, radiations, laboratory.

INTRODUCTION

The breakdown of atoms results in the emission of ionizing radiation, which may take the form of particles (beta or alpha), electromagnetic waves (gamma or X-ray), or both. Radioactivity is the process by which atoms disintegrate of their own accord, and the ionizing radiation that is produced as a consequence of this process is referred to as radioactivity. Unstable elements that decay and emit ionizing radiation are referred to as radionuclides respectively. Because exposure to radiation raises the chance of developing cancer and has other negative effects, it is imperative that radioactive materials be handled with the utmost prudence before being handled. Within the nuclear medicine and radiology department, radiation may be found in a variety of sources, including radiopharmaceuticals, patient X-rays, calibration sources, radioactive waste, and other sources. Employees must not be exposed to radiation at levels that exceed the limits that have been established by law. Additionally, it is recommended that workers be subjected to levels that are "As Low as Reasonably Achievable" (ALARA).a. 1. In essence, this is the ALARA concept. A department that is well-managed and conforms to the ALARA principle will make certain that workers are exposed to a level of exposure that is far lower than the legal limit.

Exposure to radioactive material that is within the body is referred to as internal radiation exposure, while exposure to radioactive material that is outside the body is referred to as external radiation exposure. Employees have a responsibility to be aware of the possible sources of radiation exposure, as well as the ways in which they may protect themselves and their clothing from radiation. Additionally, they must be aware of the ways in which they can maintain their work spaces free of radiation, including counting equipment and benches.

Biological Effects of Radiation:

It does not matter if the radiation exposure comes from natural or artificial sources; there will be biological effects regardless of the dose quantity. The term "biological effect" refers to the manner in which radiation interacts with cells that are still living after exposure to radiation. It is the first step in the chain reaction that leads to any form of biological injury that radioactive decay of the building blocks of cells takes place. In order for radiation to enter cells, it must first go via two separate paths. Direct effects and indirect impacts are the two categories of affects that might occur. An example of a direct influence would be the interaction of radiation with DNA atoms or another component of a cell that is vital to its functioning. When a cell is exposed to radiation, the possibility of radiation interacting with DNA and other key components is minimal. This is due to the fact that DNA and other vital components are so small. As a result of the interaction between radiation and water molecules, the water molecules

may be broken up into smaller molecules such as hydrogen (H) and hydroxyls (OH). These fragments would not cause any damage to the cell if they were to recombine or interact with one another or with ions in order to produce compounds such as water. When combined, however, they have the potential to generate toxic byproducts such as hydrogen peroxide (H2O2), which may contribute to the death of cells. Each living cell is of its own kind.

OBJECTIVES

1. Researching the Risks, Safety, Control, and Protection of Radiation
2. Researching Novel Approaches to Radiation Injury Prevention

MATERIALS AND METHODS

Animals

Both male C3H/HEN mice and CD2F1 mice were obtained from the National Cancer Institute in Frederick, Maryland. The Jackson Laboratory in Bar Harbor, Maine was the source of the CD2F1 animals. The Institutional Animal Care and Use Committee gave its approval to all of the operations that involve animals that are described in this article, and they were carried out in accordance with the standards that were outlined in the Guide for the Care and Use of Laboratory Animals section 4.

Irradiation

The mice were subjected to radiation doses ranging from 0.25 to 16 Gy, with dose rates of either 0.4 or 0.6 Gy per minute. The 60Co gamma rays were delivered bilaterally to the animals. There is a possibility that further information on the exposure and dosimetry techniques may be found in other studies.

Drug administrations

Between 25 to 745 milligrams per kilogram of amifostine (Ami) Subcutaneous injections of WR-2721 were given in very small volumes (0.1-0.2 ml) about thirty minutes before to the irradiation or sham irradiation7. PBS, which stands for sterile buffered saline, was used to administer the injections. The origin of WR-2721 may be traced back to the Drug Synthesis and Chemistry Branch of the National Cancer Institute, which is located in Bethesda, Maryland. 30 minutes to four hours before to the administration of acute, lethal irradiation (8-16 Gy),7 mice were implanted with slow-release, biodegradable pellets containing 6.25 mg of amifostine (Ami-sr) in their hind legs. Approximately one day before to the potentially lethal acute

irradiation therapy, a subcutaneous injection of 0.1 milliliters of 5-androstenediol (5-AED) that was dissolved in polyethylene glycol 400 was given to the nape of the neck. The automated external defibrillator (AED) was provided by Sigma, located in St. Louis, Missouri, while the vehicle, the PEG-400, was provided by Steraloids, located in Wilton, New Hampshire. The oral prophylaxis was given by the use of gastric tube feeding in conjunction with high doses of 5-AED (ranging from 1000 to 3000 mg/kg). Vitamin E and vitamin E analogs were given subcutaneously into the nape of the neck at a dose ranging from 100 to 400 international units per kilogram on the day before the lethal irradiation. An injection of the cytokine IL-1β analog, which is a radioprotective nanopeptide domain (IL-1β-rd) with a palmitoyl ester linkage, was administered subcutaneously (nape of neck) using a PBS vehicle at a concentration of 80 ug/kg.

Survival assays

In order to determine a dose-response factor (DRF), two different versions of a conventional 30-day survival-based test were used to examine the efficacy of certain pharmacologics in enhancing whole-body radio resistance to whole-body irradiation (TBI). These tests were an extended 5-dose test and a basic 2-3 dosage test. Both of these tests were conducted in order to determine the effectiveness of the treatments. On the subject of these survival tests, there are more sources that provide extensive details.

Clinical assays

For the purpose of calculating complete blood counts (CBCs) and blood differentials, Bayer used an automated hematology device known as Advia. Mouse blood sera were utilized to produce comprehensive clinical chemistry panels, which contained 19 different analytes. This was accomplished with the use of the Vitros 250 apparatus.

Experimental hematology assays

In bone marrow, cellularity and cytomorphology are both examined [1]. Extraction of bone marrow from the femurs of deceased mice was performed after the animals had been subjected to surgical procedures and having been cleaned. To determine the cellularity of the femoral marrow, a Coulter Z2 cell and particle counter (12) was used to count the number of nucleated cells obtained from the sample. It was determined via the use of light microscopy that impression smears of the extruded marrow that had been stained with Wrights-Giemsa were suitable for cytological examination. Progenitor testing is being done. Quantification of the number of multipotential cKit+ lin-progenitors in blood and marrow materials was accomplished by the use of a flow cytometry technique that was first reported by Orlic et al. thirteen years ago and then refined fourteen years later. The Multipotential Granulocyte

Erythroid-Macrophage-Megakaryocyte (GEMM-CFU) experiment was carried out by making use of a colony test that was described by Cortdy15. In order to examine Bipotential Granulocyte-Macrophage Colony Forming Cells (GM-CFC), a conventional investigation using a single layer of agar was carried out. This was done in accordance with past descriptions.

Statistical analysis

For the purpose of comparing the data obtained from the survival-based tests, the generalized Savage (Mantel-Cox) approach was used. Calculations of DRFs were carried out on the basis of the probit analysis that was performed on the mortality data that was collected. A statistical program called SigmaStat 5.0, which is available to the general public, was used in order to compare and evaluate the hematological data obtained from animals that were administered medications and those who were given vehicles. We utilized the Student's T test to determine whether or not there was a statistically significant difference between the test group and the control group. In order to determine whether or not there were statistically significant differences between the groups, P values that were lower than 0.05 were evaluated.

RESULTS

Radioprotectants may be broken down into four distinct categories, each of which has been shown to be safe, effective, and field-tested. The agents that are currently being tested include: (1) 5-AED, which is an androstane steroid; (2) vitamin E and its structural analogs; (3) interleukin-1β and its radioprotective nanopeptide domain (IL1β-rd)11; and (4) Ami (WR-2721), which is an aminothiol that can be administered in low doses or through sustained release formulations (Ami-sr) in order to control harmful side effects. 7. A summary of the primary properties of these protectants may be found in Table 1. As shown by either a significant enhancement in survival at single radiation dosage levels (for example, IL-1β- rd) or by the estimated "dose-reduction-factors" (DRFs) of around 1.2 to 1.3 (for example, 5-AED, Vit E, Ami-sr), the medications in issue seem to possess moderate radioprotective qualities. Some medications, such as vitamin E, have been shown to significantly improve the 30-day survival rate of mice that have been given prophylactic treatment. This occurs before the mice are given increasingly greater doses of traumatic brain injury (TBI), which may be fatal. The three pharmaceuticals that are at the top of the list (Table 1), which are 5-AED, IL-1β-rd, and vitamin E, do not seem to cause any damage by administering doses that are greater than the radioprotective values. Additionally, these drugs have positive side effects. On the other hand, rats seem to be able to tolerate and show little toxicity to low doses of Ami (100 mg/kg or less) when it is delivered as a bolus. However, when the dosage is increased, the drug's toxicity becomes plainly evident, which results in behavioral and locomotor dysfunctions7). Regarding

this subject, implanted biodegradable pellets that contain a sustained-release form of Ami (Ami-sr) have the potential to delay and, to a limited degree, minimize the toxicity of the drug; nevertheless, they are unable to completely eliminate the toxicity.

When the following additional features of these protectants are taken into consideration, there are discernible similarities and differences: First and foremost, when it comes to the time windows for effective prophylaxis, Ami has a very small window, around 15 to 45 minutes, but Ami-sr has a considerably longer window, approximately 2 hours. On the other hand, there is a temporal window of around twenty-four hours for 5-AED, vitamin E, and IL-1β-rd substances. To continue, the two most popular methods of administering 5-AED are by oral administration and through injection. On the other hand, it seems that Ami, Ami-sr, Vitamin E, and IL-1β-rd are the only ones that are effective.

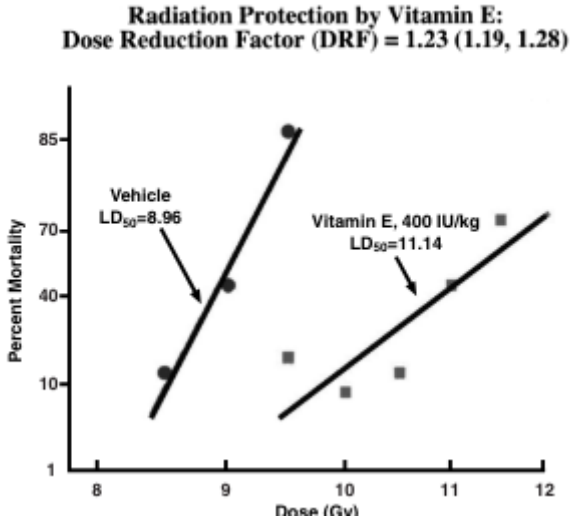

Fig. 1. A single subcutaneous vitamin E injection 24 hours before lethal gamma irradiation protects CD2F1 male mice. Vitamin E-prophylaxed mice had significantly lower mortality (fractional survival at 30 days post-irradiation) under supralethal ionizing radiation.

The computed DRF was 1.23, with 1.19–1.28 95% confidence as was the case with Ami-sr, regardless of whether it was given intravenously or by implantation. It is important to keep in mind that there are vitamin E analogues that are more hydrophilic, have the ability to be taken orally, and provide a moderate level of radioprotection (results that have not yet been published)16,17. In the third place, subsequent blood plasma peaks are seen one day or several days after the administration of the medication 5-AED and vitamin E, respectively. This is in contrast to the pharmacokinetic profiles of Ami and Ami-sr. The data presented here is drawn from pharmacokinetic data obtained from canine trials with 5-AED.

DISCUSSION

The peculiar radiation environment that exists in space presents a health risk to astronauts due to the fact that they will be exposed to high doses of ionizing radiation for extended periods of time and for extended periods of time (1-3). The majority of people would agree with this assumption. Despite this, there is a certain amount of controversy over the level of risk and the most efficient ways to mitigate it.

Table 1. Characteristics of radioprotective prophylactic agents currently under test

Agent [1]	Route[2]	Dosage [3]	Efficacy [4]	Window[5]	P-Kinetics[6]	Toxicity[7]	References [8]
5-AED	Inject-sc Oral gavage	10-360 mg/kg 1.6 gm/kg	DRF = 1.26 60% Survival - 11 Gy	24 h preexposure 2 h postexposure	nd nd	Local inject site nd (no apparent toxicity)	8,9
Vit E	Inject-sc	100-400 U/kg	75% Survival - 10.5 Gy DRF = 1.23	20–24 hr pre-exposure	4 & 24 h peaks; w. rad 24 h peak	nd (no apparent toxicity)	10
IL-1β-rd	Inject -sc	80 µg/kg	40% Survival - 8.5 Gy DRF = nd	24 hr pre-exposure	nd	nd (no apparent toxicity) non-pyrogenic, non-inflammatory	11
Ami-sr	Inject-sc Implant -sc	100 mg/kg 100 mg/kg/h	DRF = ~1.3 DRF = ~2.0	0.5 h pre-exposure ~ 2 h	15–30 min peak broad ~ 1h peak	nd (no apparent toxicity) Delayed locomotor effects	7

The second obvious truth is that the most effective method for lowering the danger of radiological damage is to lessen the amount of radiation exposure. The notion that reducing the amount of biological damage that an exposure may produce is an effective strategy to decrease radiological risk is a natural extension of this concept. Could you perhaps explain the process

by which these radiological controls are created and implemented? There is little question that this will be difficult to do because to the considerable and perceived relative hazards that are linked with the anticipated cumulative doses that astronauts would get over the course of extended missions (for example, a journey to Mars that lasts for a thousand days). For the purpose of attempting to lessen the amount of biological damage, it is required to implement medical countermeasures that are both safe and effective. This attempt is slipping behind other efforts that are being made to ensure the astronaut's health, and additional efforts are being made. Here is the question: why is that? Would it be possible that our medical kit does not include anything that may be helpful in this circumstance? Despite the fact that there are many who are skeptical, we are of the opinion that radioprotective drugs are either currently available or will be possible in the not-too-distant future. The following article provides a list of radioprotective agents as well as a discussion of each option.

There are a few different ways that these drugs may be administered, their potencies are not very high, and there are a lot of unknowns about their toxicity, range of effects, and specificity of protection. Their safety and effectiveness profiles are strong enough to merit serious study as medical countermeasures for radiation dangers in space, despite the fact that they have these limitations. As mentioned in Table 1, the following precautionary actions should be taken into consideration: The term "nutraceuticals" refers to a variety of these substances, which are used on a daily basis by millions of individuals all over the world without causing any discernible adverse effects on their health. In light of the fact that astronauts would need to replace their nutritional supplies and maintain a certain degree of radioprotection while they are in space, it is reasonable to suggest that they take an agent such as a hydrophilic formulation of vitamin E on a regular basis. On the other two protectants, 5-AED and Ami-sr, it is possible to carry out further studies to determine their safety and toxicity.

CONCLUSIONS:

At the present time, the discipline of nuclear medicine and diagnostic radiology is facing a significant challenge in terms of radiation safety. Radiation protection measures are something that should be implemented in every radiology or nuclear medicine department that is worth its salt. Providing adequate protection against excessive radiation exposure to those who are directly or indirectly linked with radiation without unduly decreasing the benefits of radiation exposure is one of the most important topics in the field of radiation protection. It is necessary to take into consideration all aspects of radiation protection, including the necessity of the radiation-exposing procedure, the appropriateness of the radiation-exposing procedure in relation to the diagnostic information it provides, the requirement to shield personnel and patients from radiation that they do not want, and the monitoring of radiation exposure among

occupational workers and the working environment. Regularly monitoring the radiation levels in the appropriate department, keeping an eye on the radiation protection programs, and hosting educational events on a regular basis are all responsibilities that fall within the purview of the RCO and other administrative authorities of the department or hospital.

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