THE SEAFARER
EXPOSURES, ENVIRONMENTAL HAZARDS, AND CANCERS

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ABSTRACT

Seafarers are exceptional in their profession, having to spend a large part of their lives at sea. They are exposed to occupational risk factors, as well as environmental risk factors, as part of their normal, everyday activities. Most seafarers live and work under extremely hazardous conditions that can cause serious short-term and long-term damage to their health. In some cases, they are exposed to conditions that can even be fatal.

There has been a gradual rise in the number of cases of various types of cancers among seafarers. Cases of lung, renal, pancreatic cancers, as well as leukaemia, mesothelioma and lymphoma are being identified on personnel employed on various types of vessels, as well as on the docks. These vessels include dry cargo ships, oil tankers, gas tankers, passenger vessels, and icebreakers. Increasing in number is the incidence of lung cancers among both engine crew, as well as deck officers.

Maritime activities are found to be major contributors to toxic pollutants in the air, with focus on diesel exhaust, formaldehyde, benzene, as well as smoke, soot, dirt and dust, which, due to their microscopic particles, find easy access to the respiratory tract and lungs, leading to respiratory disease, asthma attacks, heart attacks, various types of cancers, birth defects, lung damage, immune system damage and nerve damage.

Occupational hazards such as asbestos, benzene, benzidines, etc are been removed and/or substituted; however, new potential carcinogens are continuously being introduced into the workplace. Moreover, there is the risk of cancer originating from sources other than exposures to chemicals, e.g. stress, radiation, virus, bacteria, night work and late-night shifts, physical inactivity.

Keywords: Risk Factors, Exposures, Cancer

1. INTRODUCTION

Cancer is rated among the top five causes of death the world over. The World health Organisation (WHO) states that cancer is a leading cause of death worldwide, having accounted for 7.9 million deaths in 2007. The infinitely growing Maritime industry, poses many risks to the seafarer, exposing the deck officer, the engine crew, as well as the shipyard worker, to a wide variety of carcinogens. The length of the seafarer’s career and the type of vessel on which he/she is employed, whether tanker, cargo vessel, icebreaker, passenger vessel or product carrier are also important factors to be considered.

The aim of this presentation is merely to look at what a seafarer is faced with during his career, the risks he is exposed to, and to show how easily one may contract cancers and other major life-threatening diseases, and other minor diseases as he goes about his regular duties at sea.

To fully grasp an understanding of what we are dealing with, it is necessary to first understand what a cancer is.
2. WHAT IS CANCER
Cancer is the rapid growth of abnormal malignant cells in the body. Very often, a lump or mass called a tumour is formed, caused by uncontrolled cell division. Cells from the tumour eventually metastasize or spread to other areas of the body via the bloodstream or the lymphatic system.

2.1. TYPES OF CANCERS
There are four major types of cancer:

- **Carcinomas**, the most common types of cancer, arise from epithelial cells that cover external and internal body surfaces. Lung, breast, and colon are the most frequent cancers of this type.
- **Sarcomas** are cancers arising from cells found in the connective or supporting tissues of the body such as bone, cartilage, fat, connective tissue, and muscle.
- **Lymphomas** are cancers that arise in the lymph nodes and tissues of the body's immune system.
- **Leukemias** are cancers of the immature blood cells that grow in the bone marrow and tend to accumulate in large numbers in the bloodstream.

3. THE ENVIRONMENT
When we think of the environment, we usually cast our minds to the outdoors, the beauty of Mother Nature. We think of forests, oceans, mountains, etc. However, in cancer research, environment is defined as everything outside the body that enters and interacts with it. This interaction is called an exposure. So, environmental exposures can include such factors as sunshine, radiation in our homes and workplaces, hormones, viruses, bacteria, and chemicals in the air, water, food, and workplace, as well as lifestyle choices like cigarette smoking, excessive alcohol consumption, an unhealthy diet, lack of exercise, infectious diseases, unnatural or excessive sexual behaviour, and stress.

We must remember as well, that a person adapts to the environment in which they exist over a period of time, causing random changes in their genes.

4. EXPOSURE
The environment influences cancer rates and risks. Certain types of exposures are linked to specific cancers. For example, exposure to asbestos is linked to lung cancer, and exposure to benzidine (a chemical found in some dyes) is linked to bladder cancer. Exposure to carcinogens from tobacco use is linked to several types of cancer, including cancers of the lung, bladder, mouth, lip, throat, voice box, and oesophagus.

The individual chance that someone will develop cancer as a result of coming into contact with a particular, single environmental exposure depends on how long and how often that person was exposed. It also depends on the person's genetic makeup, age, gender, and their exposure to other environmental factors including their diet, and lifestyle habits.

Listed are some of the popular exposures to which seafarers and shore men are exposed at some point in their career.

4.1. Arsenic
Arsenic is known to cause cancer, as well as many other serious health problems. Arsenic is a naturally occurring element in the environment. It has no taste or smell. Although sometimes found in its pure form as a metal, arsenic is usually a part of chemical compounds. The first evidence linking arsenic with cancer came from case reports of skin cancer after exposure to inorganic arsenic in medical treatments, drinking water, or pesticides.

Arsenic-contaminated inorganic compounds are found in industry, in building products (arsenic-treated wood), and in arsenic-contaminated water. This is the form of arsenic that tends to be more toxic and has been linked to cancer.

4.2. Asbestos
Asbestos is the name given to a group of minerals that occur naturally in the environment as bundles of fibres and can be separated into thin, durable threads. These fibres are resistant to heat, fire, and chemicals and do not conduct electricity. For these reasons, asbestos has been widely used in many industries. The shipbuilding industry has used asbestos to insulate boilers, steam pipes, and hot water pipes. Asbestos has also been used in ceiling and floor tile; paints, coatings, and adhesives; and plastics.
People may be exposed to asbestos in their workplace, their communities, or their homes. If products containing asbestos are disturbed, tiny asbestos fibres are released into the air. When asbestos fibres are breathed in, they may get trapped in the lungs and remain there for a long time. Over time, these fibres can accumulate and cause scarring and inflammation, which can affect breathing and lead to serious health problems.

Exposure to asbestos may increase the risk of lung cancer and mesothelioma (a relatively rare cancer of the thin membranes that line the chest and abdomen). Although rare, mesothelioma is the most common form of cancer associated with asbestos exposure. In addition to lung cancer and mesothelioma, some studies have suggested an association between asbestos exposure and gastrointestinal and colorectal cancers, as well as an elevated risk for cancers of the throat, kidney, oesophagus, and gallbladder.

4.3. Benzene
Benzene is a colourless, flammable liquid with a sweet odour. It is a volatile chemical that evaporates quickly. Benzene is formed from natural processes, such as volcanoes and forest fires, as well as from human activities. Benzene is even a component of cigarette smoke. Benzene is widely used and ranks among the top 20 chemicals produced. Benzene is primarily used as a solvent, as a starting material for the synthesis of other chemicals and as a gasoline additive.

Workers in industries that make or use benzene may be exposed to high levels of this chemical. These industries include the rubber industry, oil refineries, chemical plants, shoe manufacturers, and gasoline related industries.

Sources of benzene in the environment include gasoline, automobile exhaust fumes, cigarette smoke, emissions from coke ovens and other industrial processes, and waste water from certain industries. Benzene has also been identified in contaminated water and food. Some consumer household products, such as glues, cleaning products, detergents, art supplies, and paint strippers, contain benzene.

The evidence linking benzene and cancer predominantly comes from studies of workers, and relates to leukaemia, particularly with 2 types called acute myeloid leukaemia (AML) and to a lesser degree, chronic lymphocytic leukaemia (CLL). Leukaemia is a cancer of blood-forming cells in the bone marrow.

4.4. Beryllium
People working or living near beryllium industries have the greatest potential for exposure to beryllium. Lung damage has been observed in people exposed to high levels of beryllium in the air. About 1-15% of all people occupationally exposed to beryllium in air become sensitive to beryllium and may develop chronic beryllium disease (CBD), an irreversible and sometimes fatal scarring of the lungs. CBD may be completely asymptomatic or begin with coughing, chest pain, shortness of breath, weakness, and/or fatigue.

Seafarers doing ship maintenance use Jason’s De-rusting and de-scaling guns (also known as J-gun or Jason’s pistol) and are at risk for exposure to beryllium. Unlike other metals, beryllium does not spark and was therefore used on tanker ships containing fuel.
Long term exposure to beryllium can increase the risk of developing lung cancer in people. Communities become contaminated with beryllium from nearby factories, mines, shipyards or by uncontrolled burning of fossil fuels.

4.5. Cadmium
Cadmium is an extremely toxic metal commonly found in industrial workplaces, particularly where any ore is being processed or smelted. Due to its low permissible exposure limit (PEL), overexposures may occur even in situations where trace quantities of cadmium are found in the parent ore or smelter dust. Several deaths from acute exposure have occurred among welders who have unsuspectingly welded on cadmium-containing alloys or worked with silver solders. Cadmium is also found in some industrial paints and may represent a hazard when sprayed. Operations involving removal of cadmium paints by scraping or blasting may similarly pose a significant hazard. Cadmium is also present in the manufacture of some types of batteries. Cadmium emits a characteristic brown fume (CdO) upon heating, which is relatively non-irritating, and thus does not alarm the exposed individual.

Cadmium is a naturally occurring metal, found in soil, rocks, and water. It has well known carcinogenic effects, with documented links between cadmium exposure and lung cancer, lung disease, and kidney damage. Additional studies have suggested a link to prostate cancer. People are exposed to cadmium by eating food grown in contaminated soil or fish from tainted water, but more extreme exposure comes from smoking or interaction with smelting, welding or shipbuilding. Smoking doubles the average daily intake of cadmium.

4.6. Chromium
Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases. Chromium (III) occurs naturally in the environment and is an essential nutrient. Chromium (VI) and chromium (0) are generally produced by industrial processes. The metal chromium, which is the chromium (0) form, is used for making steel. Chromium (VI) and chromium (III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving.

Maritime uses include welding and thermal cutting, spray application of corrosion-resistant protective coatings, and metal cleaning. Breathing high levels of chromium (VI) can cause irritation to the nose, such as runny nose, nosebleeds, and ulcers and holes in the nasal septum. It is a severe irritant of the nasopharynx, larynx, nasal epithelia, and lungs, and causes lung cancer. Ingesting large amounts of chromium (VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact with certain chromium (VI) compounds can cause skin ulcers. Some people are extremely sensitive to chromium (VI) or chromium (III). Allergic reactions consisting of severe redness and swelling of the skin have been noted.

The World Health Organization (WHO) has determined that chromium (VI) is a human carcinogen. The United States Department of Health and Human Services (DHHS) has determined that certain chromium (VI) compounds are known to cause cancer in humans.

The EPA has determined that chromium (VI) in air is a human carcinogen.

4.7. Lead
Lead is a naturally occurring bluish-gray metal found in small amounts in the earth’s crust. Lead can also be found in plants, animals, air, water, dust, and soil. As an element, lead is indestructible. But lead compounds can be changed by air, sunlight, and water. Once lead is released into the air, it lasts, and can move from one medium to another. For example, lead in dust can be carried long distances, dissolved in water, and find its way into soil where it can remain for years.

There is some evidence showing that lead may cause cancer, but this evidence is weak. Still, lead has been loosely linked with cancers of the lung and stomach, and more weakly linked to brain and kidney cancers.

Like most metals, it is difficult to evaluate lead's ability to cause cancer because it is found in so many forms. Most of the evidence linking lead exposure and cancer comes from studies of workers with high levels of occupational (work-related) exposure to inorganic lead. In 2000, Steenland and Boffetta summarized results from 8 studies of workers exposed to lead, using standard methods to compute combined relative risk estimates for the cancer sites of concern. The results of their study are reviewed here.
4.7.1. Lung cancer
All 8 studies of highly exposed workers reported results for lung cancer, with 2 showing an increased risk of lung cancer (at least 50% higher than people not exposed). In all studies combined, the risk was about 30% higher than in people not exposed. But, the results depended heavily on one study where a very high (3-fold) excess risk of lung cancer was found.

Workers in the highest risk study may have been exposed to arsenic as well as lead in the early years of plant operation. Because arsenic is known to cause lung cancer, it is not clear whether the increase in lung cancer was due to lead, arsenic, or the combination of the two.

More studies are being done to find out if lead or arsenic is responsible for the increase. Without the one highest risk study, all studies combined estimate the risk of workers exposed to lead at about 14% higher than unexposed persons. And, these studies could not determine whether this increase was because of lead exposure or if it happened because the lead-exposed workers tended to smoke more than the comparison groups.

4.7.2. Stomach Cancer
The combined analysis of 8 groups of lead-exposed workers showed a 34% increase in their risk of developing stomach cancer. A case-control study in one of the groups found that workers with the highest exposure levels were no more likely to develop stomach cancer than were workers with lower exposure levels. But many case-control studies in the general population found higher rates of stomach cancer among people who worked in jobs likely to have exposed them to high levels of lead. The evidence from studies does not agree, and stomach cancer among people exposed to lead is still a concern.

4.7.3. Brain Cancer
A case-control study of lead-exposed workers in Finland compared 26 patients who had brain cancer to 200 control subjects who did not, and found that the brain cancer patients had higher blood lead levels. In a death-certificate based study in the United States, researchers looked at the occupations of more than 27,000 people who died of brain cancer and more than 108,000 who died of other causes. The brain cancer cases were about twice as likely to have worked in an occupation that exposed them to lead. When combined data from all 7 studies of brain cancer among lead-exposed workers was reanalyzed, it did not show evidence of increased risk. But this finding was limited by the small number of brain cancer cases available to study. More recently, a 2006 study found that brain cancer risk was highest among people with the highest likelihood and intensity of lead exposure, which gives further support to the link between lead exposure and brain cancer. And so, research continues and the link between lead exposure and brain cancer is still a concern.

4.7.4. Kidney Cancer
In animal studies, kidney cancer is the most common cancer linked to lead exposure. Still, the combined results from all 7 studies of lead-exposed workers showed no evidence of an increased risk. Two of the studies did show about a 2-fold excess of kidney cancer, so kidney cancer remains a concern.

4.7.5. Colon and Rectal Cancer
A 1991 study found that workers in tetraethyl lead manufacturing industries were nearly 4 times as likely as unexposed people to develop rectal cancer, and workers with higher estimated exposure had higher risk. Less tetraethyl lead is produced today because it is no longer used as a gasoline additive.

4.8. Nickel
Nickel is a naturally occurring element. Pure nickel is a hard, silvery-white metal used to make stainless steel and other metal alloys. Skin effects are the most common effects in people who are sensitive to nickel. Workers who breathed very large amounts of nickel compounds developed chronic bronchitis and lung and nasal sinus cancers. Nickel has been found in at least 882 of the 1,662 National Priority List sites identified by the Environmental Protection Agency (EPA).

Nickel is a very abundant natural element. Pure nickel is a hard, silvery-white metal. Nickel can be combined with other metals, such as iron, copper, chromium, and zinc, to form alloys. These alloys are used to make coins, jewellery, and items such as valves and heat exchangers. Most nickel is used to make stainless steel.

Nickel can combine with other elements such as chlorine, sulphur, and oxygen to form nickel compounds. Many nickel compounds dissolve fairly easy in water and have a green colour. Nickel compounds are used
for nickel plating, to colour ceramics, to make some batteries, and as substances known as catalysts that increase the rate of chemical reactions.

5. RISK FACTORS
5.1. Ultra-violet and other radiation
For personnel carrying out external duties on deck, for example, the cancer most likely to afflict you is non-melanoma skin cancer, often caused by the sun’s harmful ultraviolet rays. This is usually treated and cured. Melanoma, a deadlier skin cancer, is less common but is increasing. Ultraviolet radiation, which comes from natural sunlight, sunlamps, or tanning beds, can lead to melanoma and other forms of skin cancer. Though UV light is the cause of many skin cancers, there is some evidence that small amounts may also help prevent other cancers.

Disruption of the earth’s ozone layer by pollution may cause rising levels of UV radiation. If possible, avoid sun exposure during the day, especially when the sun is hot and in full glow. Wear protective clothing and use sunscreen. Do not use tanning beds or other types of artificial UV exposure. Radon exposures can increase risk of lung cancer. Cigarette smoking greatly increases the effect of radon exposure in lung cancer risk.

Other forms of radiation can help to cause cancer. We are all exposed to radiation each day. There is natural radiation from the earth and space, radiation from the nuclear power and weapons industries, and radiation from medical tests (X-rays). Radiation helps to cause cancer by damaging the genes in body cells and causing gene mutations. These may or may not lead to cancer, but the more radiation we are exposed to, the greater the chance that a mutation will occur that will.

5.2. Tobacco Use
Smoking remains the biggest single risk factor, with tobacco linked to approximately one third of all cancers. Cigarette, cigar, and pipe smoking have been linked to more than a dozen types of cancer, including lung, mouth, bladder, colon, and kidney cancers. Chewing tobacco and snuff increase the risk of oral cancer, and second-hand smoke increases the risk of lung cancer.

For men, lung cancer mortality has been falling since 1990, mirroring a peak in popularity of smoking during the 1960s. For women, who commonly took up smoking later, lung cancer mortality is still rising. Tobacco is also rapidly becoming the leading cause of cancer in Asia.

5.3. Chemical exposure
Personnel travelling on tankers, especially very large crude carriers, chemical tankers and even product carriers are at risk for being exposed to carcinogens. Normally, persons with tanker experience are retained for their skill specific to that particular vessel, causing them to have to be exposed to the high risk factors over a long period of time. As opposed to personnel who may move on from ship to ship only being retained on a short-term basis on chemical carriers during their seafaring career.

Painting, welding, and cleaning of ship holds, improper venting and de-gassing of compartments on carriers all present possibilities of exposure to crew members.

Risk factors for developing breast cancer include: being childless or delaying childbearing until aged over 30, starting periods early, using hormone replacement therapy, being exposed to oestrogen-like chemicals, and drinking one or more units of alcohol daily. More than one risk factor is usually needed before cancer cells develop.

5.4. Alcohol
Alcohol consumption is a leading contributor to chronic disease and for several types of cancer. It is an influential risk factor for cancers of the mouth, pharynx, larynx, oesophagus, colorectum (in men), and breast. Evidence supports alcoholic drinks as probable causes of liver cancer, as well as colorectal cancer in women. Although there are potential benefits of alcohol consumption as in the case coronary heart disease, or the helpful effects of alcohol on the digestive system, it is important to note that it is not the type of alcohol consumed; however the risk lies more with the quantity consumed.

5.5. Viruses
Some viruses are risk factors for cancer. In the developing world the most common cancers are linked to infectious agents, such as cervical cancer or liver cancer, caused by hepatitis B.
**Human Papilloma virus**

Certain strains of human papillomavirus (HPV), which are sexually transmitted, are the primary causes of cervical and anal cancer. Women who begin having sexual intercourse before age 17, or who have multiple sexual partners, are at greatest risk of HPV infection.

The virus is found in and around the genitals and is most often passed between two people through sexual activity, but this can also happen through other close skin to skin contact. While most women with HPV do not develop cervical cancer, some persistent infections lead to cancer. HPV may also be responsible for some cancers of the head and neck.

Some seafarers tend to engage in excessive sexual behaviour, the old quip of a ‘sailor having a mate in every port’ in which he/she docks, readily comes to mind.

**Hepatitis B and C**

The hepatitis B and hepatitis C viruses are major causes of liver cancer worldwide. The viruses are transmitted through blood transfusions, injectable drug use, and unprotected sex. Vaccinations can protect against hepatitis B, but there is not yet a vaccine for hepatitis C.

Epstein-Barr virus causes mononucleosis. In people with weakened immune systems, it can also lead to some types of lymphoma. People with weakened immune systems may also be at risk for a cancer called Kaposi’s sarcoma if they are infected with human herpes virus 8 (also known as Kaposi’s sarcoma-associated herpes virus, or KSHV). In the United States, KSHV infection is most common in homosexual men.

**5.6. Night shift, lack of sleep, and the circadian rhythm**

Seafarers are often called upon to work for extensive hours per day, also extending to night time hours, and frequent night shifts. This can result in shortened sleep time, and the body’s inability to recuperate and repair during this shortened sleep period. The disruption of the normal circadian rhythm, may also lead to the body’s overproduction of hormones, a heightened stress level, unusual behaviour which may lead to tobacco use and alcohol consumption, all which can eventually lead to exposure to cancer.

**6. PREVENTATIVE MEASURES**

Seafarers risk being exposed to carcinogens because of the work that they do. There should be strict regulations covering exposure to know carcinogens at work. If possible, once a substance is known to be a cancer risk, it should no longer be used. If a potentially carcinogenic substance has to be used, there should be regulations covering how it is handled and how workers are protected from it. Seafarers must be educated in proper health and safety practices to be implemented on the workplace. Simple guidelines that may be followed are:

- a. Reduction or cessation of tobacco use.
- b. Reduction or cessation of alcohol use.
- c. Increase of non-smoking areas on board (protection of the passive smoker)
- d. Protective clothing should be worn when outdoors in the sun, as well as sunscreen or sun-block no less than SPF 25.
- e. More attention to be paid to proper diet. Limiting fat consumption, high calorie intake, large amounts of meat, and increasing the intake of fruits and vegetables, foods rich in antioxidants, and beneficial fatty acids such as Omega-3 and olive oils.
- f. Implementing an exercise programme on board.
- g. Mandatory vaccinations and preventive testing and screening.
- h. Education, awareness, of the seafarer on the risk he/she faces, and the necessary action he/she may take.

**7. CONCLUSION**

Since exposure to carcinogens (cancer-causing agents) is responsible for triggering most human cancers, people can reduce their cancer risk by taking steps to avoid such agents. Hence the first step in cancer prevention is to identify the behaviours or exposures to particular kinds of carcinogens and viruses that represent the greatest cancer hazards.

The seafarer must take first responsibility to prevent exposure to carcinogens; for it is ultimately he/she who will have to suffer the effects and either live with, or die from this deadly disease. He/she must take the time to source information about the various types of chemical to which he/she may be exposed. Also, the employer must conform to Safety and Health practices, outlined for the protection of his workers.
Outreach programmes and support groups also create an encouraging atmosphere, where the seafarer can feel comfortable to discuss his fears, receive rehabilitation, or merely to seek advice and information in a less structured or formal setting.

Though cancer is considered to be a very serious and deadly disease, the preventive measures that one can take are relatively simple, provided they are implemented in a suitable time frame. Personal health and hygiene, diet, exercise and lifestyle habits, awareness of risk factors and knowledge and education of the environment in which they exist.

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