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Impact of Environment Pollution on Cancer Mortality in India and possible Preventive Measures to Reduce the Risk

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Abstract

Environmental pollution in India has increased from uncontrolled emission of chemical pollutants from the Industries, automobiles and non-point sources where modern agricultural practices are used. These chemicals have contaminated the air, water, soil and their residues have been detected in drinking water, food and consumer products. Some of these are very persistent in the environment and have bioaccumulated in the biota and human tissues including human breast milk. Industrial development raised the affluence of the people of the country causing changes in lifestyle habits resulting in exposure to chemicals not common before. Contaminated women can release these pollutants under stress during pregnancy and expose the

fetus through the transplacental pathway. Infants can be exposed during nursing by the exposed mothers. Many of these chemicals are highly toxic and have carcinogenic and/or endocrine disrupting activities. In addition, some of the products imported to the country have carcinogenic activity. In the past generations Kangri cancer in Kashmir, Khaini cancer in Bihar and UP, Betel-chewing oral cancer, Chutta cancer in Andhra Pradesh, cancer of the base of the tongue and tonsils in Gujarat, lung cancer among bidi and cigarette smokers, Dhoti (Lenguti) cancer in Bihar and UP, cancer of the cervix in females were prevalent. Currently, the cancer sites of Indians include primarily the oral cavity, throat, esophagus, lungs, cervix, breast, skin, stomach, rectum, blood, prostate, liver, thyroid and bladder in addition to the cancers observed in 1960s in India. Yearly an estimated 600,000 -700,000 deaths due to cancer occur in the country today. The state of Punjab, where farmers implemented modern agricultural practices including use of pesticides earlier than other states, seems to have the country's highest cancer mortality rate. This translation research has tried to examine association of exposure to environmental carcinogens and increased mortality of certain cancers, and implementation of primary and secondary preventive measures to reduce the cancer incidence rate in India.

Introduction

Rapid industrial development in India has resulted in increase in environmental pollution at an alarming rate from uncontrolled emission of chemical pollutants from industries, vehicle and non-point sources where modern agricultural practices are used. These have added additional burden on the atmospheric pollution caused by emission from long time traditional practice of fuelwood and cow dung cake biomass burning used for cooking purposes in rural areas. Acute and chronic respiratory diseases associated with air pollution are common in India. [1] Uncontrolled discharge of effluents from the industries, towns and cities are contaminating the rivers. In addition, India is importing many materials containing hazardous agents, some of which have carcinogenic activity. The industrial development has raised the economic condition of the people of the country. Lifestyle habits of the affluent people have changed resulting in exposure to chemicals which were not common before in the country. In this translation research

an attempt has been made to examine the association of exposure to environmental carcinogens and increased cancer mortality rate, and preventive measures have been suggested to reduce the risk of cancer in India..

Environmental Pollution in India

Rapid Industrial development in India has resulted in an increase in environmental pollution at an alarming rate from uncontrolled emission of chemical pollutants from the industries, automobiles and non-point sources where modern agricultural practices are used. World Health Organization study shows that cities in India are among the most polluted in the world (*http://www.who.net/phe/health_topics/outdoorair/database/cities*). Virtually no regulatory standards are implemented in the country's 111 coal powered plants. (http://www.inhabitat.com/coal_plants. Dated 03/11/2013). Industrial development has raised the affluence of the people and one report shows that 4.7% and 21% of 250 million middle class Indians own automobile and scooter/motorcycle/moped respectively (http://www.dailymail.co.uk. 19 May 2013). Exhaust from these modes of transportation including the three wheelers, trucks, taxis, omnibuses contributes significantly to air pollution. Diesel engines of the Indian railway system also emit considerable quantity of pollutants. Use of coke or charcoal and biomass cow dung burning for cooking purposes by the people, a big source of atmospheric pollution during the pre-independence times, is still common in the slums and villages today. Frequently, the PM 2.5µ (particulate matter 2.5 micrometers in diameter) levels in Indian cities exceed the levels observed in Beijing, China, which is another polluted city of the world. India is the world's leading carbon polluter behind China today (http://nyti.ms/1j0w4PZ). The thermal power plants of the country are the primary source of PM emission to the air compartment of the environment.

Since independence agricultural practices in India have changed considerably resulting in green revolution. Use of pesticides and herbicides by the farmers has gone up drastically to produce food in the country. (http://www.indiaforsafefood.in/farmingindia.html). Oftentimes farmers

apply the pesticides without any adequate protection for the applicator resulting in excessive exposures. In addition many toxic pesticides used indiscriminately to control the household pests [2] are exposing the families.

These chemicals have contaminated the air, water, soil and their residues have been detected in drinking water, food and consumer products. It is not only vegetables and grains, but fish and farm animals and poultry also get contaminated. The pesticides used on the field by the farmers often leach and contaminate surface water of the rivers and ponds during the rainy season. Some of these chemicals can even percolate through the soil strata and contaminate ground water which is an important source of drinking water in the rural and semirural areas of the country.

Some of the pesticide chemicals are very persistent in the environment and have bio-accumulated in the biota and human tissues and have even been detected in human breast milk. Pesticide chemicals used in the farms have been detected in the grains, fish, farm animals and dairy products. Poultry and dairy animals get exposed to these chemicals from contaminated feed.

Uncontrolled industrial discharges of waste and raw sewage from the municipalities are the primary sources of river water contamination in India. In addition to infectious microorganisms municipal discharges may contain non-metabolized pharmaceuticals taken by the people. Traces of pharmaceuticals including prescription medicines, over-the-counter medications and veterinary drugs added in feed additives have also been detected in drinking water (http://*www.who.int/water_sanitation_health/publication*).

Residues of the persistent chemical pollutants or their byproducts can bioaccumulate in human tissues and have also been detected in breast milk samples. Women exposed to environmental chemical contaminants can release these residues under stress during pregnancy and expose the fetus through the trans-placental pathway.[3] DDT and its metabolite DDE have been detected in newborn infants.[4] Presence of DDT residues have also been found in blood, amniotic fluid and

vernix caseosa of pregnant women.[5] Infants can also be exposed to these pollutants during nursing by the exposed mothers.[6] Many of these chemicals are highly toxic and have carcinogenic and/or endocrine disrupting activities.[7] It is essential to mention here that out of the 30 human carcinogens classified by the WHO's International Agency for Cancer Research (IARC) all but one have been demonstrated to be carcinogenic in animals in 2 ½ year exposure bioassays at high doses in small number of animals. Consequently, an animal carcinogen with weak or without any carcinogenic evidence in human is considered to be a probable human carcinogen. In addition, it is important to remember that cancer is a multifactorial, multistage process and in general the latent period of cancer is long.

Changes in Lifestyle of Indians

Rise in affluence of the people has resulted in changes in lifestyle habits. People of India are using some products currently discontinued in the developed countries of the world. In addition, some of the products imported to the country have carcinogenic activity. This has resulted in exposure to chemicals not common before in India.

Following is an abbreviated list on a few chemicals which Indians are using in the contemporary years:

■ Use of bisphenol A (BPA), an endocrine disrupting chemical present in certain plastic containers, by the general public of the country has increased drastically in India. BPA was found to cause benign prostatic hypoplasia (BPH) and prostate cancer in animals.[8] An expert panel concluded that BPA is an animal carcinogen and recent trends of cancer of the prostate and breast cancer observed in human population relate to animal carcinogenic data.[8] There are no conclusive data which show that BPA causes BPH or prostate cancer in human. But it is well known that the rates of BPH and prostate cancer rates are on the rise today.

■ Sale of cosmetic products has gone up in India. Phthalates, a group of endocrine disrupting chemicals which increases the risk of breast cancer, are present in materials made of plastics.

Plastics are present even in cosmetics like nail polish, lipsticks and synthetic fragrance. Trace amount of ethylene oxide, a probable human and proven animal carcinogen, is found in shampoos and body washes as a contaminant.

■ Lanolin is an important component of anhydrous-lanolin-based absorbent ointment used by mothers to treat cracked nipples. Lanolin is obtained from sheep's wool and pesticides are frequently detected in lanolin. Contamination of lanolin occurs as a result of common practice of sheep dipped in pesticide-containing wash to control mites, fleas, and other pest infestation of wool.

■ India is currently one of the largest importers of asbestos, a proven human carcinogen, is used extensively for corrugated sheets and pipes in India. It is mixed with cement and often used in a wide range of building materials and roofing structures. Asbestos exposure causes mesothelioma, an aggressive cancer of the membrane lining of the lungs and abdomen, and in smokers it increases the risk of lung cancer several fold more than regular cigarette smokers. Asbestos also causes asbestosis, a benign disease of the lung. Workers who are retrieving asbestos from the shipbreaking yards in Alang, Gujarat are getting heavily exposed to this human carcinogen. The latent period of asbestos related cancer is long. Exposure to asbestos which is occurring now may eventually lead to a high incidence of asbestos related cancers in the exposed population of the country.

It is impossible to discuss in this short paper all the carcinogenic materials that India is producing or importing for commercial use today.

Cancer mortality in India

In the past generations Kangri cancer in Kashmir, Khaini cancer associated with chewing tobacco usage in Bihar and UP, Betel-chewing oral cancer, Chutta cancer in Andhra Pradesh, lung cancer among bidi and cigarette smokers, cancer of the larynx in hukka smokers, cancer of the base of the tongue and tonsils of those who scrape the tongue daily in Gujarat, Dhoti

(Lenguti) cancer in Bihar and UP, and cancer of the cervix in females were prevalent in India.[9, 10] Yearly cancer mortality rate in India in 1960 was approximately 600,000 [11] compared to around 1 million today.[12] These figures may not reflect the correct figures of the cancer mortality data of the country. The reason being that there are only around two dozens of cancer registries which may not represent the correct cancer mortality figures for 1.25 billion of population of India. It is not possible for a limited number of 'hospital-based' and 'population-based' cancer registries to represent the correct cancer mortality rate of urban and rural population of the country as 75% of the population live in rural areas. It is highly possible that the existing cancer registries are missing data from a good number of cancer patients from the villages. Consequently, strength of cancer mortality data base is not very strong. However, it is worth mentioning here that the hospital based cancer registry at the Tata Memorial Hospital in Mumbai, India is world renowned and highly recognized by the WHO's International Agency for Research on Cancer (IARC) at Lyons, France. It is encouraging to note that in the state of Sikkim a population based cancer registry has recently been set up where the state's ethnic differences in cancer incidence is being studied .[13]

In addition to exposure to environmental carcinogens, the increase in cancer mortality rate in India is also partially due to increase in population from 450 million in 1960 to 1.25 billion today *(Population Pyramids).* Furthermore, today in India cancer detection facilities are easily available primarily in the metropolitan areas resulting in detecting higher number of cancer patients. The cancer sites in the Indian population include primarily the oral cavity, throat, esophagus, lungs, cervix, breast, skin, stomach, rectum, blood, prostate, liver, thyroid and bladder in addition to the cancers observed in 1960s. Currently, the yearly 600,000 - 700,000 deaths in India are due to cancer[12] and the leading cancer sites are *cervix uteri* in females and the lung and lower air ways in males. [12]

Childhood cancers including leukemia, lymphoma and brain cancer are common in the Indian

pediatric population and its rate is increasing.[14] Between 1983 and 2012 leukemia incidence in Bangaluru, Karnataka increased by 7% in boys and 73% in girls. [15] Punjab, where farmers implemented modern agricultural practices including use of pesticides earlier than other states, seems to have the country's highest rate of cancer today .[16] In West Bengal with the onset of green revolution and excessive use of underground water for irrigation has resulted in release of natural trivalent arsenic, a proven human carcinogen, from geological soil strata.[17] Thus there is an increased incidence of arsenical cancers observed in the population of the affected areas [18]

Preventive Measures to Reduce the Risk of Cancer in India

Implementation of primary and secondary preventive measures can reduce the cancer incidence in India.

Primary Preventive Measures

Primary prevention includes decreasing the exposure to carcinogenic agents. This can only be done by the federal, state and local regulatory authorities by setting regulatory emission standards of pollutants from the industries to the air and water compartments of the environment. India does have regulatory emission and occupational exposure limits of several pollutants but unfortunately those regulatory measures are not always implemented.

The US Environmental Protection Agency (EPA) in 1980 established the water quality criteria for 129 priority pollutants detected in ambient water of rivers in USA. Based on these criteria water quality standards were developed and implemented by the states. Today the rivers in USA are much cleaner than what they used to be in the 1970s. Till 1970s news on fish kill in different water bodies were common. Since the implementation of the water quality standards in 1980s there is practically no news on fish kill in rivers, channels and fresh water lakes in USA. Since the implementation of the air quality standards by EPA the air pollution has also decreased. For the last around 30 years automobiles are fitted with catalytic converters which trap many

pollutants including lead. In late1950s and 1960s the air pollution was very heavy in Pittsburgh, PA. Today it is one of the clean cities of USA.

For the last almost 20 years the use of propane as fuel in India has aided in reducing the PM emission from automobiles. Similarly the air and water quality of India can improve if air and water quality standards are strictly implemented by the Pollution Control Board of the Ministry of Environment and Forestry.

2,3,7,8-dibenzo-*p*-dioxin (Dioxin) is present as a contaminate in the manufacture of 2,4,5-Trichlrophenoxy herbicide (2,4,5-T) and related chlorophenol pesticides. 2,4,5-T herbicides are extensively used by the farmers to eradicate broad leaf weeds in corn, wheat, rice fields. Exposures to dioxins are associated with Non-Hodgkin Lymphoma (NHL) in farmers. Agent Orange (which is a mixture of 2,4,5-T and 2,4-D) was used in Viet Nam war. Exposure to 2,4,5-T and 2,4-D was also found to be associated with high incidence of NHL in the farmers in US and Long Island railroad workers. Uncontrolled accidental emission of dioxins in late 1976 from a 2,4,5-T manufacturing plant in Seveso, Italy exposed the neighborhood inhabitants. In all these populations increased incidence of NHL, soft tissue sarcoma and other tumors were found. 2,4-D, one of the chemicals of Agent Orange, is extensively used to kill broad leaf weeds on the lawns of USA. An increased incidence of canine malignant lymphoma in dogs whose owners had theirs lawns treated with 2,4-D has also been observed .[19] Anatomically canine lymphoma is very similar to human NHL Incidence rate of NHL in the USA is on the rise. No report has yet appeared on its association with 2,4,-D exposure . Soft tissue sarcoma incidence rate was increased in Viet Nam veterans who were exposed to Agent Orange.

Dioxins are present in chlorine bleached paper because the paper and pulp industries use chlorine to produce white bleached paper. Paper and pulp industry is a major contributor of dioxins to the water body which collect in the sediments of river beds. Bottom feeding fish bioaccumulate these persistent carcinogens. In the 1980s Swedish Paper Institute contacted EPA to seek advice on the risk of dioxins which is produced during the chlorine bleaching process in the paper and

pulp industries. Based on the advice of the EPA, Sweden applied non-chlorine bleaching process to produce white paper. Today in Sweden the paper industries are not polluting the water bodies with dioxins resulting in practically dioxins free fish and oysters. From pre-independence time many paper and pulp industries in India are using chlorine in the bleaching process to produce white paper. Presence of dioxins has been detected in effluents, sludge, pulp and paper produce by pulp and paper industries of India.[20] Effluents from these industries are contaminating the water bodies and fish. It is a sincere hope of the author that the paper and pulp industries of India will follow Sweden in using the non-chlorine bleaching method for the production of dioxin free white paper and thus eventually improve water bodies.

Dioxins also get formed during incineration of lignin containing material in presence of chlorine. Consequently, municipal waste incinerators are a big source of dioxins in the environment.[21]

Public health measures to stop smoking programs have decreased the male lung cancer rates in the United States of America. Bladder cancer in dye workers has decreased considerably with the elimination of aromatic amines use. Discontinuation of the use of benzene as a solvent of the adhesives has virtually eliminated leukemia incidence in Turkish cobblers.

These are just a few examples to show how primary preventive measures can decrease the mortality rate of cancer in a country.

Secondary Preventive Measures

Secondary preventive measures include implementation of improved surveillance programs at an initial stage of the disease. Utilization by the public of most modern medical surveillance programs by genuinely well-trained experienced medical practitioners in accredited medical facilities at a reasonable cost will aid in detecting the precancerous sites or cancer at an early stage which will reduce the mortality rate of cancer in India. Cancer is a curative disease if it is

detected before it metastasizes to other sites.

India is one of the countries of the world where cervical cancer rate is very high. As a matter ofact more women of India die of cervical cancer than anywhere else in the world. Cervical cancer consists primarily of slow growing cells. Pap smear of the cervix can detect mostly inflammation or disordered growth cells. Often these cells are at a precancerous stage of cervical dysplasia which may take time to develop into frank cancer. Today many women have been saved world-wide whose cells were found to be at precancerous stage in Pap smear test. Bottom line for cervical cancer prevention is to get Pap smear taken at least once a year. Medical measures can be implemented if abnormal cells are detected in this exfoliate cytological analysis. The patients are saved before the cells become frank cancer or at an initial cancer stage before metastasis. The cost for pap should be affordable by most women of India or the test should be free for the poor women. As women are the backbone of the society, the society has the responsibility of helping them in their need. Cervical cancer incidence rate is low in women whose husbands are circumcised. Cancer of the cervix is more common in women belonging to low socio-economic group, who have had early sexual relation, multiple sexual partners; and whose husband, irrespectively of whether circumcised or not, has had multiple partners. The second wife tends to be on high risk of cervical cancer if her husband's first wife had cervical cancer. Infection of HPVs (human papilloma viruses) has now been associated with many gynecologic ailments including cervical cancer (http://www.cancer.gov/cancertopics/factsheet/Risk/HPV). HPV can cause cervical dysplasia. The husband should be checked for HPV if a woman is diagnosed to have cervical dysplasia. Daily washing of the male genitalia especially the gland penis may help. Unfortunately, a very high number of people of India do not have private bathing facilities to clean the private organs thoroughly. HPV vaccines are now available and in the western countries public health organizations are encouraging females between 14 to 26 ages to get vaccinated. However, it is appalling to find that the public health organizations of who have had India are in a dilemma whether to implement the HPV vaccination in the country where cervical. cancer rate is so high.[22]

People from south Asia seem to be more susceptible to develop cancer of the oral cavity, throat and esophagus. People should be educated to stop any type of smoking, chewing tobacco and betel. Cessation of smoking habit will eventually decrease the incidence of lung cancer in the population. Young people should be encouraged not to start the habit of chewing tobacco , betel leaf with betel nut with or without tobacco. Furthermore, the habitual betel and tobacco chewer should be guided on how to decrease the chewing habit. Although smoking habit is on decline worldwide which has resulted in decrease in lung cancer incidence in the male, it is a point of considerable public health concern that like western women there is a significant rise in smoking habit among the Indian women today.[23] With the increase in smoking habit in US Women since the middle of 1960s a steep increase in lung cancer rate has been observed. As a matter of fact the mortality rate of lung cancer in US females has exceeded the breast cancer rate from the middle of 1980s.[24]

Alcohol drinking has increased considerably among Indians of both sexes. Formerly, alcohol drinking was prevalent among the laborer group. Today drinking alcohol has become common among educated and young people. Smoking and drinking seems to increase the risk of esophagus, pancreas and stomach drastically. Both of these two habits are on the rise in young Indians. It is known that habitual drinking of alcohol is associated with cancer of the esophagus. Irrespective of whether they are heavy alcohol drinkers or not, Indians are more prone to develop cancer of the esophagus. Alcohol seems to leach vitamin A from the epithelial cells resulting in the initiated cells to get promoted and eventually progress to form frank tumor. Since Indians are prone to develop cancer of the esophagus, it is prudent for them to stop or decrease alcohol drinking to not more than two drinks of red wine once a week.

Drinking alcohol one drink a day increases the risk of breast cancer in women by 50 percent compared to nondrinkers, and even three drinks a week can make a woman more prone to develop breast cancer. Several years ago arsenical compound, a proven human carcinogen, was

used as pesticide in vineyards. Occupational exposure to arsenical pesticides of vineyard workers was associated with increased risk of various types of cancer among the pesticide applicators. Instead of arsenical pesticide other organic pesticides, many of which are lipid soluble, are now- a-days used in the vineyard. It may be possible that persistent pesticide chemicals may be present in the alcohol made from contaminated grapes. Lipid soluble persistent chemicals have a tendency to accumulate in lipid rich organs like human breast. In addition, intake of pesticide contaminated fish, meat, chicken and other lipid rich food may also be responsible for high mortality rate of breast cancer in women. Women who have late pregnancy or do not nurse babies can also be prone to develop breast cancer. Since the breast cancer rate is on the rise, it is essential that all Indian women should be taught by well experienced medical practitioners, preferably female doctors, how to self-examine the breast correctly to detect suspected hard lump of the breast at an initial stage. Any physical change of the breast detected during self-examination period should be examined by experienced breast cancer specialists.

Conclusion

Although India is better off because of many synthetic chemicals being used today, the same chemicals can do harm if used excessively and handled carelessly. It will require a conscientious joint effort of the government, industries and the public to have a safe environment in India. With the current administration in New Delhi under the leadership of a very competent and honest person, it is a sincere hope of the author that regulatory standards developed by independent genuinely experienced environmental scientists (without any conflict of interest) and implemented by the Government of India, state and local governments will decrease the industrial emissions of the pollutants to the atmosphere. Many non-carcinogenic natural pesticides are available today. People should be educated to use those non-toxic agents including biological means to control the pests. Several countries are currently encouraging Environmentally green industries and agricultural practices. Green industry has become a multibillion dollar business. India can adopt green industry very easily. Concerted joint effort of

the government with the public sector to clean the environment and educating the public on the environment and public health measures can reduce the cancer mortality rate of the country. People do not want to get cancer. Detecting cancer at precancerous or early stage before its dissemination to other organs is the road to conquer this dreadful disease. Workshops should be held in educational institutions including schools and colleges, workplaces, clubs and societies to educate the people on cancer in India. Educating all sectors of the society using the media is the key to promote healthy behavior and foster safe environment to reduce the risk of cancer in the country.

It is not possible to discuss every aspect of the environment and cancer in one single paper. It is necessary to discuss in detail to do justice on this vast subject. The author has tried to provide a short glimpse of this very important and vast subject to create an interest of the reader for more detailed study. This might be a small step for a healthy and more prosperous India.

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References

1. Central Pollution Control Board, Ministry of Environment & ForestsGovernment of India. Epidemiological study on effect of air pollution on human health (adults) in Delhi. *Environmental Health Management Series: EHMS/01/2012.*
2. Chittra, GA, Kaur P, Bhatnagar T et al. High prevalence of household pesticides and their unsafe use in rural south India. *Int'l. J. Occup. Med. Environ. Health* 2013; 26: 275-282.
3. Mukerjee, D. Assessment of risk from multimedia exposures of children to environmental chemicals. *J Air & Waste Manage. Assoc.*1998a; 48; 483-501.
4. Zavon MR, Tye R, Latorre L. Chlorinated hydrocarbon insecticide content of the neonate. *Ann. NY Acad. Sc.* 1969; 160; 196-200.

5. O'Leary JA, Davis JE, Feldman M. Spontaneous abortion and human pesticide residues of DDT and DDE. *Am. J Obstet. Gynocol*. 1970; 108; 1291-1292.
6. Mukerjee, D. Health risk of endocrine-disrupting ortho-substituted PCBs emitted from incinerators. *Environ. Eng. Sc.* 1998 b; 15; 157–169.
7. Mukerjee, D. Introduction (editorial). *Environ. Res.*2006;100; 1; l.
8. Vom Saal et al. Chapel Hill bisphenol A expert panel consensus statement: Intefration of mechanisms, effects in animal and potential to impact human health at current level of exposure. *Reprod. Toxico*. 2007; 24; 131-138.
9. Khanolkar, VR. Susceptibility of Indians to cancer. *Indian J. Medical Research* 1945; 33; 299-314.
10. Paymaster, J.C. Cancer and its distribution in India. *Cancer* 1964; 17; 1026-1034.
11. Mitra S, Das Gupta A. An estimate of the prevalence of cancer in India. *Bull. World Health Org.* 1960; 22; 485-492.
12. Mallath MK, Taylor DG, Badwe RA et al. The growing burden of cancer in India: epidemiology and social context. 2014; *Lancet Oncology* 15; e205-e212.
13. Verma, Y, Pradhan PK, Gurung N et al. Population based cancer incidence in Sikkim, India: report on ethnic variation. 2012; *Br. J. Cancer* 106; 962-965.
14. Arora RS, Eden TOB, Kapoor G. 2009; Epidemiology of childhood cancer in India. *Indian J. Cancer* 46, 264-273.
15. Satyanarayana L, Asthana, S, Labani P. Childhood cancer incidence in India: a review of population-based cancer registries. 2014; *Indian Pediatrics* 51; 218-220.
16. Rao and Bhandari. GlobalPost. July 17, 2014.
17. Chakraborti D. Rahman MM, Chowdhury UK et al. Present groundwater contamination in West Begal, India. 2003; *Environ. Health Persp*. 111; 5th Int'l Conference on Arsenic Exposure and Health Effects. 1194.
18. Chatterjee, A. Das D, Mandal BK et al. Arsenic in ground water in six districts of West Bengal, India. *Analyst 1995;* 120, 643-650.
19. Hayes HM, Tharone RE, Cantor KP et al. Case-control study of canina malignant lymphoma: positive association with dog owner's use of 2,4,dichlorophenoxyacetic acid herbicides. *J. Nat'l. Cancer Inst.* 1991; 83; 1226-1231.

20. Thacker NP, Nitnaware VC, Das SK, Dovotta S. Dioxin formation in pulp and paper mills of India. *Environ. Sci. Pollut. Res. Int.* 2007; 14; 225-226.
21. Mukerjee, D and Cleverly, D. Risk from exposure to polychlorinated dibenzo-p-dioxins and dibenzofurans emitted from municipal incinarators. Waste Management and Res. 5, 269, 1987.
22. Nigam A, Saxena, P, Acharya AS et al. HPV vaccination in India: critical appraisal. *ISRN Obstet. Gynocol.* 2014; Article ID 394595.
23. Goel, S, Tripathy JP, Singh RJ, Lal P. Smoking trends among women in India: Analysis of nationally representative surveys (193302009). *South Asian J. Cancer* 2014; 3; 200-202.
24. Amer. Cancer Soc, Cancer Facts & Figures 2014.

Authors Column

Prof. Debdas Mukerjee was born and brought up in Darjeeling, India. His maternal grandfather moved to Darjeeling around late 1850s. He was one of the Government of Bengal Presidency officers in Darjeeling. Debdas Mukerjee got his B.Sc. degree with Honors from Calcutta University at Darjeeling Government College, and M.Sc. degree with thesis in Cytogenetics under the guidance of Prof. A.K. Sharma, a world renowned cytogeneticist, from the Calcutta University, Kolkata. After getting his M.Sc. degree he was at Bose Research Institute, Calcutta as the Sir J.C. Bose Research Scholar. In 1959 he got a National Science Foundation fellowship to complete his Ph.D. degeree at the University of Kentucky, Lexington, KY, USA. under the guidance of Prof Herbert Parkes Riley, a world cytogeneticist. He did his post doctorate fellowship with another world renowned cancer scientist Prof. Walter J. Burdette at the University of Utah, Salt Lake City, Utah. USA. Prof. Mukerjee was in the faculty of The University of Texas M.D. Anderson Cancer Center at Houston, Texas; and the Jefferson Medical College, Philadelphia, PA. After 16 years of academic career, he joined the US Environmental Protection Agency, Cincinnati, OH, USA as the Senior Science Advisor/Senior Environmental Health Scientist in 1980. During his tenure at the US Environmental Protection Agency he was offered an honorary position of Adjunct

Professorship at the Chritian-Albrechts Universität zu Kiel, Kiel, Germany. He is an environmental health scientist with interest in cancer researcher and has published extensively in high impact peer reviewed journal namely Nature, Cancer Research, Journal of the Human Genetics, Lancet, Cytologia, Genetics, Chemosphere, Journal of Environmental Health Perspectives, Toxicology, Environmental Research, Toxicology and Industrial Health, Proceedings of Medicine, Journal of Air and Waste Management and many other peer reviewed journals. In addition he has authored many peer reviewed documents for the US Environmental Protection Agency and chapters in many books. The most recent one was in 2011 edition of Patty's Toxicology, one of the most referenced Occupational Toxicological Encyclopedia. Two lead scientific journals, namely, Nature and Biocycle had editorial commentaries on his work in 1970 and 1987 respectively. Current Content Citation Index shows that Prof. Mukerjee was cited in more than 1500 scientific papers. Prof. Mukerjee was the guest editor of Environmental Research in 2001 and Toxicology & Industrial Health in 1998. He is a member of the Editorial Board of Toxicology and Industrial Health. Over the years many pre-doctorate, post doctorate and visiting scientists conducted research under his guidance and collaborated with him. He was the external advisor of thesis submitted by students for Ph.D .degree at several universities. Over the years Prof. Mukerjee has delivered keynote addresses and invited talks on his work in USA, Germany, Sweden, Denmark, France, Italy, Austria, Canada, South Africa, Argentina, Japan, China and his native country India. He has delivered around two dozen invited talks in India. He was invited to provide scientific advice on Dioxins by the Swedish Royal Society, Stockholm, Sweden in 1987; on Water Quality Criteria by Prof. TN Khoshoo, Secretary to the Ministry of the Environment and Forestry, Government of India in 1985 and was invited to become a part of a Global Advisory Network on Environmental Sciences by Honorable Jairam Ramesh, Minister of Environment & Forests, Government of India in 2010. Prof. Mukerjee got many awards and commendations from the US federal government. News on Prof. Mukerjee appeared in Stern Magazine (Germany), The Christian Science Monitor, The Hindustan Times, Galveston Times, Texas Times and a few others newspapers. He was interviewed by anchors of TV news in USA and South Africa. His biographic sketch is listed in Who's Who in America. He took voluntary retirement from the US Environmental Protection Agency in 2011. Currently he is involved in Translation Research on Environmental Toxicology, Cancer and Nutrition; and publishes scientific papers and delivers invited scientific and public talks. His extracurricular activities include studying Bhagavad Gita, Upanishads, Vedanta philosophy and comparative religion.

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