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Assessment of Complete Blood Count in the Breast Cancer Patients of Arsenic Exposed Population of Bihar

Yerravarapu Vamsi Krishna[1], Chandrajeet Kumar[1] and Arun Kumar[2*]

Abstract

Arsenic contamination of groundwater has recently been recognized as a major threat to human health. They developed cancer after being exposed to arsenic for a long time. Among women, breast cancer is a rapidly expanding health problem in the modern era. Arsenic exposure leads to hormonal imbalance and breast cancer in the exposed population.

Blood samples from n=203 breast cancer study participants and n=100 control female individuals were taken for analysis of complete blood count in this present research. The study reveals that there is significant elevation in the WBC counts and decrease in the RBC counts, platelets counts and haemoglobin percentage in the breast cancer patients. Out of n=203, female breast cancer patients, n=174 subject's blood had significant changes in the haematological parameters in comparison to the control patient's blood samples. Women who have been exposed to arsenic for an extended period of time in the state of Bihar have hormonal imbalances in their bodies as a result of the poisoning. In the present study, there was significant decrease ($p<0.05$) in the RBC counts in 92% of breast cancer patients in comparison to the control patients. Moreover, RBC indices were significantly fluctuated ($p<0.05$) in PCV%, MCV, MCH and MCHC levels in breast cancer patients in comparison to the control patients. The haemoglobin percentage in 94% in breast cancer patients had significant less levels ($p<0.05$) in comparison to the control patients. Finally, there was significant increase ($p<0.05$) in the WBC counts in 85% of the breast cancer patients in comparison to the control patients. This denotes that there haemotological parameters are highly affected. Moreover, these breast cancer patients were from the arsenic hotspot areas, where in the recent times the breast cancer disease burden has increased many folds. Hence, there is need to make strategies to control the disease burden in these arsenic hotspot regions.

Keywords: Breast Cancer; Complete Blood Counts; Gangetic plains.

Introduction

It is estimated that about 300 million people throughout the globe are at risk of arsenic poisoning. As a result, approximately 70 million people in India are at risk. Around ten million people in the state of Bihar are now at risk of getting arsenic poisoning as a result of drinking water that has been tainted with the element. Arsenic has generated major health concerns for the people of Bihar that live in the Gangetic plains, and these dangers have been induced by arsenic. In addition to this, arsenic is often referred to as the "king of poison" or "the poison of kings." Because of the potentially lethal characteristics of the trivalent form of arsenic, it has been given a particular

Affiliation:

[1]Department of Biochemistry, YBN University, Ranchi, Jharkhand, India

[2]Mahavir Cancer Sansthan and Research Centre, Patna, Bihar, India

***Corresponding author:**
Arun Kumar, Mahavir Cancer Sansthan & Research Centre, Patna, Bihar- 801505 India.

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point of emphasis. The World Health Organization (WHO) has determined that an exposure to 10 ppb of inorganic arsenic in drinking water is the absolute highest level that can be considered safe (WHO) [1]. The United States Environmental Protection Agency (EPA) established a limit for the amount of total inorganic arsenic that may be present in drinking water at 10 ug/L (US EPA) [2]. Due to the widespread use of arsenic-tainted groundwater for agricultural irrigation, not only is drinking water becoming a significant source of arsenic exposure, but so are the crops that are used to produce food. Arsenic comes through geological processes and may be found in the alluvial silt of the Delta [3, 4]. The source of arsenic is geological. People in the tens of millions are being affected by the arsenic pollution of the groundwater in southern Asia. According to [5], in the lowlands of southern Asia, where there is a large human density, there are also hazardous levels of arsenic in the groundwater. According to the most recent estimates from 2014 by the Council for Scientific and Industrial Research (CSIR), more than 7 crore people in India are at risk of being exposed to arsenic in their drinking water. The majority of these people live in the Ganga Basin. The countries with the highest risk include Argentina, Bangladesh, Bolivia, Brazil, Chile, China, Cambodia, Ghana, Greece, Hungary, India, Japan, Korea, Mexico, Mongolia, Nepal, New Zealand, Poland, Taiwan, Vietnam, and the United States of America [6-12]. More than 10 million people in the state of Bihar are now at risk due to arsenic pollution in the groundwater [13, 14]. This contamination has been documented from 22 districts throughout the state. In 2002, the poisoning of the groundwater in Bihar caused by arsenic was first observed in the the village of Semaria Ojha Patti, which is located in the Shahpur block of the Bhojpur district [15, 16]. According to the findings of [17], groundwater arsenic pollution was found in 50 blocks across 11 districts in the state of Bihar. Recently, [18] assessed that there is an extremely significant danger to one's health in the regions of the Maner block of the Patna district that have been poisoned by arsenic. Additionally, the districts of Bhojpur, Patna, Samastipur, and Bhagalpur are the parts of Bihar that have been impacted by arsenic contamination and have levels of arsenic in their drinking water that are higher than 1000 g/L. More than fifty micrograms per liter of arsenic was found in the water in the districts of Vaishali, Saran, Begusarai, Khagaria, Munger, and Katihar [12, 19, 20-30]. In recent years, the incidence of breast cancer among women in our nation has risen to unprecedented heights. Hereditary causes, reproductive variables, hormone imbalances, women who discontinue nursing, and other lifestyle choices are all potential contributors to the development of the condition. In addition, in more recent times, it has come to be believed that environmental factors may potentially be the causal agent underlying the development of breast cancer. It's possible that the contaminants in the environment include things like pesticides, heavy metals, and metalloids like arsenic [31-35]. The Gangetic plains of Bihar have seen an exponential rise in the number of women diagnosed with breast cancer over the last few decades. Unfortuitously, reports of serious arsenic poisoning in the groundwater have also been received in this region. As a result, the purpose of the current research is to compare the patients who have breast cancer to those who do not have the disease in order to look for differences in the haematological parameters.

Methods and Materials

Ethical Approval:

The research project received approval from the Ethics Committee (IEC) of the Mahavir Cancer Sansthan and Research Centre on January 8, 2019, as shown by the authorized IEC No. MCS/Research/2019-2020/11. Both the breast cancer patients who were the focus of the study and the control individuals gave their permission after receiving appropriate information.

Location

The research was conducted at our own institution, the Mahavir Cancer Sansthan and Research Centre in Patna, which is located in the state of Bihar in India. The research began in January 2019 and continued until April 2023, when it was finally finished.

Selection of the Subjects for the study

For the purpose of the investigation, a total of n=100 control normal people were chosen for participation, and for the purpose of the investigation's cross-sectional design, n=203 patients with breast disease that had been pathologically proven were chosen to participate as the arsenic exposed group.

Collection of blood samples for the study

After collecting about 5 milliliters of blood by volume from the peripheral vein in the patient's arm using disposable syringes, the blood was then transferred to a heparinized vacutainer in accordance with the instructions provided by IUPAC [36]. These procedures were carried out in accordance with the IUPAC. In preparation for further analysis, the blood samples were frozen at a temperature of -80 degrees centigrade.

Haematological study

The acquired blood samples were analyzed using the standard protocols in order to determine haematological parameters such as the count of red blood cells, RBC indices level (PCV%, MCV, MCH and MCHC), haemoglobin percentage and White Blood Cells (WBC) counts.

Statistical Analysis

All the data were analysed using the software GraphPad Prism 5.0 and the values were generated as Mean ± SEM. The

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data variables were also analysed statistically through one-way analysis of variance (ANOVA) by using the Dunnett's test [37].

Results

Haemotological Study:

Red Blood Cell Counts (RBC): The RBC counts in control n=100 patients in less than normal levels i.e <4.5 millions/Cu.mm were in n=11 patients but the patients having RBC counts observed >4.5 millions/Cu.mm were in n=89. The RBC counts in breast cancer n=203 patients in less than normal levels i.e <4.5 millions/Cu.mm were in n=186 patients, but the patients having RBC counts observed >4.5 millions/Cu.mm were in n=17 (Figure 1).

Red Blood Cell Indices: The RBC in control n=100 patients were in normal levels in PCV%, MCV, MCH and MCHC levels. But, in breast cancer n=203 patients were in n=186 patients, had fluctuated levels (Figure 2).

Haemoglobin percentage (Hb%): The haemoglobin percentage in control n=100 patients had major patients with haemoglobin in normal range. In breast cancer n=203 patients in more than 94% had their haemoglobin percentage less than normal range of 12-14 g/dL. (Figure 3).

White Blood Cell Counts (WBC): The WBC counts in control n=100 patients in less than normal levels i.e <11000/Cu.mm were in n=96 patients but the patients having RBC counts observed >11000/Cu.mm were in n=4. The WBC counts in breast cancer n=203 patients in less than normal levels i.e <11000/Cu.mm were in n=29 patients, but the patients having WBC counts observed <11000/Cu.mm were in n=174 (Figure 4).

Discussion

In recent years, exposure to arsenic has been linked to a number of major health problems among the general population. Because arsenic mimics the estrogen hormone,

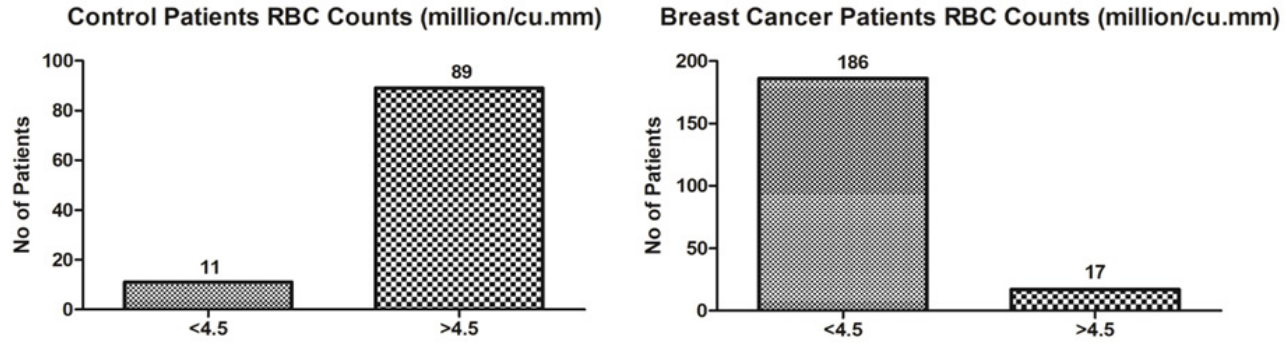

Figure 1: RBC counts of control patients versus breast cancer patients (ANOVA- Dunnett's Test, P<0.05)

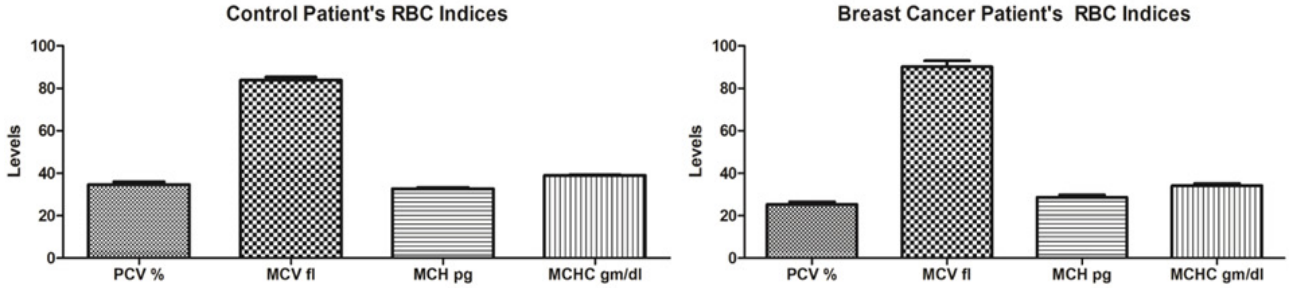

Figure 2: RBC indices levels of control patients versus breast cancer patients (ANOVA- Dunnett's Test, P<0.05)

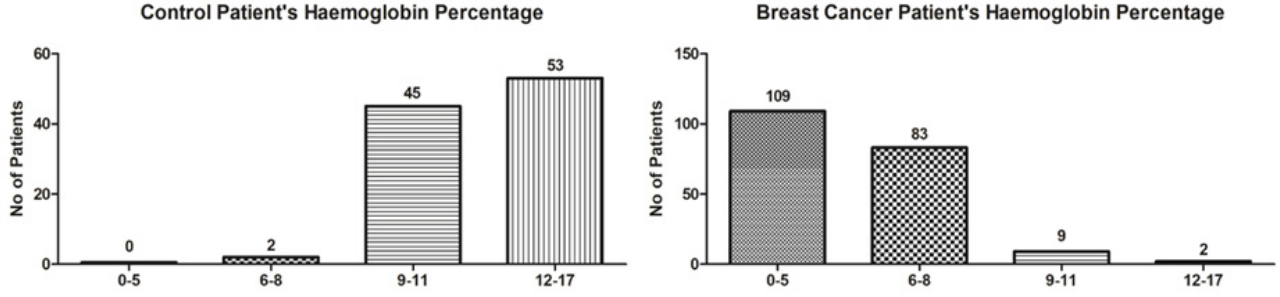

Figure 3: Haemoglobin percentage levels of control patients versus breast cancer patients (ANOVA- Dunnett's Test, P<0.05).

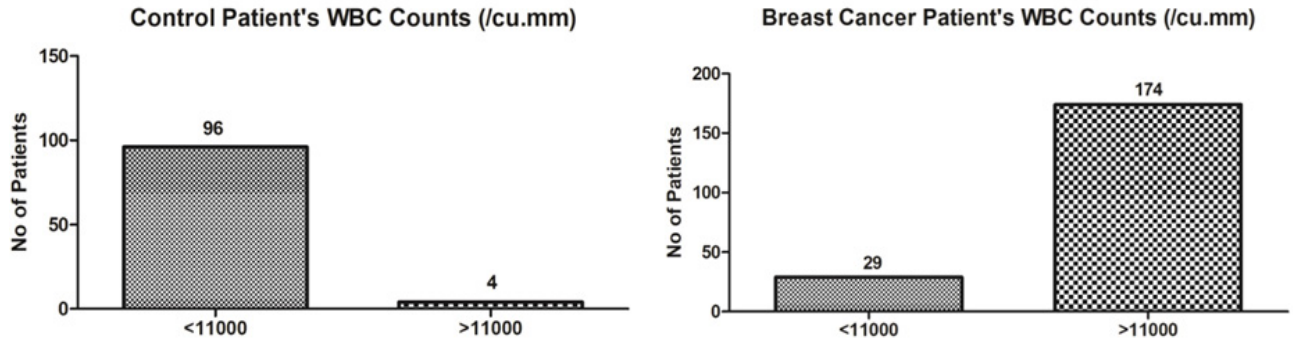

Figure 4: WBC counts of control patients versus breast cancer patients (ANOVA- Dunnett's Test, P<0.05)

which, in turn, produces hormonal imbalance in female subjects, arsenic poisoning has severe effects on female subjects. This is especially true for female subjects who are tested. Because of this, the levels of hormones including estrogen, leutenizing hormone, prolactin, and oxytocin increase. According to research published by [38-40], increased levels of prolactin are responsible for the development of breast lumps, which in turn may lead to breast cancer. Furthermore, owing to the instability of the compounds, the AsIII is more poisonous than the AsV [41-45]. In most cases, the liver and kidneys are the metabolic organs responsible for the removal of the arsenic from the body. In the present study, there was significant decrease ($p<0.05$) in the RBC counts in 92% of breast cancer patients in comparison to the control patients. Moreover, RBC indices were significantly fluctuated ($p<0.05$) in PCV%, MCV, MCH and MCHC levels in breast cancer patients in comparison to the control patients. The haemoglobin percentage in 94% in breast cancer patients had significant less levels ($p<0.05$) in comparison to the control patients. Finally, there was significant increase ($p<0.05$) in the WBC counts in 85% of the breast cancer patients in comparison to the control patients. This denotes that there haemotological parameters are highly affected. Moreover, these breast cancer patients were from the arsenic hotspot areas, where in the recent times the breast cancer disease burden has increased many folds. Various studies have correlated the significant association between the arsenic with cancer risk [46-48]. According to the International Agency for Research on Cancer (IARC), the Environmental Protection Agency (EPA), and the World Health Organization (WHO), arsenic is a category I carcinogen that may cause cancer of the gallbladder, skin, lung, kidney, bladder, and colorectal cancer [48-50]. Poisoning from arsenic brought on by chronic exposure causes signaling pathways to become dysregulated, which in turn leads to the development of breast cancer. Incorrect signaling plays a role in the gene transformations that lead to severe mutations caused by arsenic poisoning. These gene transformations include BCL-2, PTEN, MLH, MMP-2, and Bax. [44, 47, 51-61]. In the state of Bihar, in the arsenic hotspot regions, the exposed population are consuming arsenic contaminated water for very long time. This long-term exposure causes lowering down of their immunity as arsenic directly hits the bone marrow cells which in turn causes lowering down of the immunity due to the decrease in the WBC levels. Moreover, these levels are much lower in the breast cancer patients who are from these arsenic hotspot regions. Similarly, the other haemotological parameters such as RBC counts, haemoglobin percentage and RBC indices such as PCV%, MCV, MCH and MCHC levels are hampered in the breast cancer patients in comparison to the control patients. Hence, the first line of defense is breached in these patients due to arsenic exposure which in long-term causes serious implications in them. Similar studies, have been reported by various researchers [62-75]

Conclusions

The present study, demonstrates the significant fluctuation in the haemotological parameters in breast cancer patients from the arsenic hotspot regions in comparison to the control. The basic cause for the changes is due to the accidental arsenic exposure to the patients for very long term, which lowers down their immunity causing invitation to various diseases. Breast cancer disease has been found to be in very high number from these arsenic hotspot regions where unfortunately their immunity has significantly lowered down in comparison to the control group. Hence, there is need to make strategies to control the disease burden in these arsenic hotspot regions.

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Author contributions

Yerravarapu Vamsi Krishna, Chandrajeet Kumar and Arun Kumar conceptualized the entire work. Yerravarapu Vamsi Krishna is the principal author and had the major

contributions in writing the manuscript but support was also provided by Arun Kumar and Chandrajeet Kumar, literature search was done by Yerravarapu Vamsi Krishna, experimental work and data analysis was done by Yerravarapu Vamsi Krishna and Arun Kumar, final data interpretation was done by Yerravarapu Vamsi Krishna, Chandrajeet Kumar and Arun Kumar. All authors read and approved the final manuscript.

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Data availability

The data that support the findings of this study is available from the corresponding author upon reasonable request.

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