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Effect of chemotherapy and radiotherapy on red blood cells and haemoglobin in cancer patients

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Abstract
Cells are the building blocks of living things. Cancer grows out of normal cells in the body. Cancer is the uncontrolled growth of abnormal cells in the body. Numerous patient, disease and treatment related factors contribute to the low level of red blood cells (RBCs) and haemoglobin (Hb). Cancer-related anemia described as a cytokine-mediated disorder of erythropoiesis. It reduces the ability of the bone marrow to increase production of red blood cells in response to the loss of red blood cells. The present study was conducted to compare the effects of chemotherapy and radiotherapy on the RBCs count and Hb level in different types of cancer patients. A total of 80 blood samples from control and cancer patients were collected and processed for RBCs count and Hb level. Hematological analyzer *Medononic 620* was used for RBCs count and Hb level. The instrument was a fully automated hematology analyzer. *Medononic 620* was designed to measure up to 20 parameters using whole blood from an open inlet, closed tubes, micro pipettes 20 microliter or pre-diluted blood. Significant difference was found in RBCs count as 4.5±0.4 value was found in normal and 4.1±0.7 was in cancer patients. On other hand, there was also decreased Hb level in cancer patients with 11.0±2.3 value as compared to normal samples where it was 12.6±1.1. It was concluded that cancer treatments such as chemotherapy and radiation therapy can result in decreased RBCs count and Hb level. Low Hb levels can result in immune-compromised body of the cancer patient. Erythropoietin (EPO) can be suggested to the patients during cancer treatment especially in case of chemotherapy and radiotherapy to maintain the RBCs count and Hb levels.
Keywords: Cancer, haemoglobin, erythropoiesis, chemotherapy, radiotherapy.

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Introduction

Cancer is the uncontrolled growth of abnormal cells in the body. Cells are the building blocks of living things. Cancer grows out of normal cells in the body. Normal cells are capable to multiply and die depending upon the needs of body. Cancer appears to occur when the growth of cells in the body is out of control and cells divide too quickly. It can also occur when cells “forget” how to die[1, 2]. Cancer is frequently associated with significant anemia, either as a result of the disease itself or the effects of cancer treatments particularly cytotoxic chemotherapy and radiation therapy [3].

Some patients with cancer respond to the single chemotherapy or combined chemotherapy and radiotherapy is effectively used in anal cancer and esophagealcarcinoma [4]. Radiation exposure to X-rays or gamma rays can kill cells or stop their growth. It can be effective in the treatment of cancerous growths, because malignant cells are more sensitive than normal body cells. The radiation can be applied to a particular area, whilst the rest of the body is shielded from it.Chemotherapy is used as a medicine to treat cancer. These medicines can destroy cancer cells and relieve cancer symptoms [5].

Cancer-related anemia is now thought to be caused by a complex interaction between the tumor cell population and the immune system, which finally disrupts normal erythropoiesis [6-8]. Recently completed, European Cancer Anemia Survey (ECAS), a large prospective survey that enrolled more than 15,000 treated and untreated patients with various forms of cancer. After enrollment, the patients were followed for up to 6 months and the data were analyzed to find out the incidence and occurrence of anemia (Hb<12.0 g/dl), as well as its treatment and impact on performance status [9].

Numerous factors can contribute to anemia;, including tumor-associated bleeding, hemolysis, hypersplenismwith hemophagocytosis, renal dysfunction resulting in low production of EPO, nutritional deficiencies and bone marrow damage from metastases or myelodysplasia, and toxicities associated with chemotherapy and radiotherapy [7, 8, 10]. In anemia of chronic disease, the organism is trying to recompense for the lowered Hb level by increasing EPO production. However, as long as the initial hinder of erythropoiesis is present, an

increased EPO production can never fully restore the Hb level. Instead the homeostatic mechanisms are set at a balance with a lowered Hb level as a requirement for an increased EPO production. The Hb level is then decided by the strength of the hinder and the capacity for EPO production, which is lowered in cancer patients [11].

Anemia is a well-known complication of chemotherapy in cancer patients and varies as a function of the extent of disease; the type, schedule and intensity of treatment, and whether or not the patient has received prior radiotherapy and/or chemotherapy. Overall anemic population, only about 25% of patients are receiving any anemia treatment. In Europe, the prevalence of treatment-related anemia, as determined in the ECAS enrollment population, was 51% [12, 13]. Present study was conducted to study the effect of chemotherapy and radiotherapy on Red Blood Cells (RBCs) and Haemoglobin (Hb) in cancer patients.

Material and method

Total eighty blood samples were collected. Out of them forty were cancer patients and forty were normal subjects. Blood samples of cancer patient were collected from Nuclear Institute of Medicine and Radiotherapy (NIMRA), Jamshoro. The patients under treatment by chemotherapy were using Doxorubicin (Adriamycin®), Paclitaxel (Taxol®), Docetaxel (Taxotere®), vinblastine (Velban®), vincristine(Oncovin®), and vinorelbine(Navelbine®) as chemotherapeutics for duration of 3 months to 1 year depending upon the type of cancer and its stage. The age group of samples as well as control was between 25-50 years.

Blood samples were typically drawn from a vein, usually from the inside of the elbow or the back of the hand. The site from which blood was taken was 1st cleaned with antiseptic. The health care provider wrapped an elastic band around the upper arm to apply pressure to the area and make the vein swell with blood. A needle was gently inserted by the health care provider into the vein. Blood was collected into an airtight vial or tube attached to the needle [14].

Complete blood count tests were carried on commercially available Hematological analyzer *Medononic 620*. The instrument was a fully automated hematology analyzer designed to measure up to 20 parameters using whole blood from an open inlet, closed tubes, micro pipettes 20 ml or pre-diluted blood. Detection was accomplished using the electronic impedance principle and occurs in the orifice of transducer. The blood was diluted to 1:400 (Hb) and 1:40000 RBCs through a precise shear system. The shear valve "cut" a very reproducible volume (25microlitre) from the aspired blood and dilute with an equal precise volume of diluents to achieve the final dilution rate. Two separate measuring chamber and transducer were used, one for RBC and one for Hb analysis. This excludes any possibility of cross contamination between the lyzer and the RBC/PLT dilution. A pressure was applied on top of the diluted sample and the diluted sample was pressed through an orifice (operature) of 80 micrometer diameter. The amplitude of the pulse was directly proportional to the volume of the represented cell. The number of pulses corresponds to the number of cells detected. RBC, parameters were measured on a precise aliquot of the sample. The amount of sample measured was determined by the volume of a precise glass column/metering tube. Two optical detectors were used to start and stop detection. This action stop the count an analyzing process and the parameters and distribution curves were displayed. All cells over this level were analyzed and counts are stored. The instrument has a dilution ratio for RBC of 1:40,000 and CV will therefore be less than 1% for sample with an RBC number within the normal range. The sizing was done in a matrix with the volume on the horizontal (x) axis and the number of the cells on the vertical(y) axis.

The hemoglobin (Hb) was determined from the same dilution as the RBCs. For each sample a blank was measured as a reference to eliminate any drift in reagent and cuvette-absorption or lamp. The photometer system consists of a tungsten lamp, a cuvette with a length of 15 mm and a filter at a wave length of 535 nm (band width 20nm). The results were statistically analyzed by using t-test and p-value (ANOVA).

Results and discussion

To compare the difference between the RBCs and Hb value in normal and cancer patients the results were analyzed statistically. Table 1 shows the mean values of RBCs and Hb of normal and cancer patients. Mean RBCs values of normal and cancer patients were 4.5 ± 0.4 and 4.1 ± 0.7, respectively. The results showed the decrease in the RBCs count in cancer patients. In other studies conducted by Schantz et al and Lavey et al also found the same results but the decrease in RBCs count was negligible[15, 16]. Similar kind of research was also

conducted by Vaupel et al and Kelleher et al and found the decrease in the RBCs level in cancer patients after the chemotherapy and radiotherapy treatment [17, 18]. It might be the reason that the life span of RBCs becomes reduced during chemotherapy and radiotherapy for cancer treatment. The comparison between the RBCs count of control and cancer patients is represented in Fig. 1.

Table 1: Statistical Analysis of Values b/w Control and Cancer Patient.

Parameters	Control samples (n=40) Mean±SD	Cancer patient samples (n=40) Mean±SD	*T* test	*P* value
RBC's (million/cmm)	4.5±0.4	4.1±0.7	1.06	0.3
Hb (g/dl)	12.6±1.1	11.08±1.1	1.94	0.1

The mean Hb of normal and cancer patient was 12.6±1.1 and 11.08±1.1, respectively. This indicates that Hb has significant difference in their level which is slightly low in cancer patients. The results of studies conducted by Lavey et al and Kelleher et al have also shown the low levels of hemoglobin (Hb) [16, 18]. Their results are correlated with our findings. Fig. 2 represents the comparison between the Hb levels of control and cancer patients. The reason of decrease in the Hb level might be due to diminished partial oxygen pressure (pO_2) in the tumor.

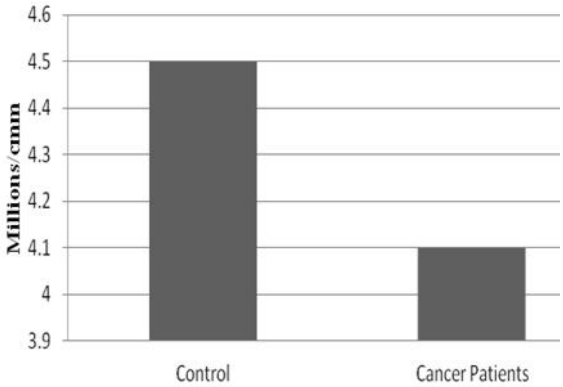

Fig. 1: Difference between RBCs counts of control and cancer patients.

Conclusively, some cancer treatments such as chemotherapy and radiation therapy can result in the decrease of RBCs count and Hb level. Blood loss in result of cancer treatment also can cause worsen anemia. Low Hb levels can result in the immune-compromise body of the cancer patient. Erythropoietin (EPO) can be suggested to the patients during cancer treatment especially in case of chemotherapy and radiotherapy to maintain the RBCs count and Hb levels.

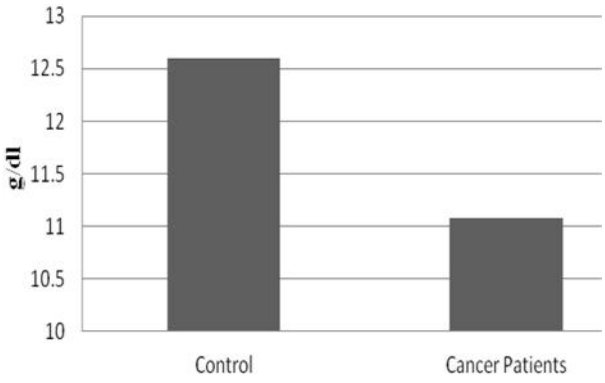

Fig. 2: Differences between Hb levels of control and cancer patients.

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