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# Assessment of Some Haematological Parameters of Mortuary Workers Exposed to Embalment Chemicals in Some Mortuaries in Anambra State-Nigeria

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## Abstract

The toxicity of embalmment chemicals especially formaldehyde to human system including carcinogenicity and other adverse health effects have been reported. This study was designed to ascertain the possibility of exposure to these chemicals in the disruption of haematopoietic functions. 100 apparently healthy individuals (all males) were recruited for this research. Out of this number, 20 who were not mortuary workers and thus not exposed to the embalmment chemicals served as the control. The test groups were categorized as follows: 48 workers exposed to the chemicals for 1-7 years; 13 workers of 8-14 years exposure and 19 workers exposed for 15 years and above. The results of this study showed that the alterations in the peripheral blood cell counts and Hemoglobin (HB) levels of the exposed mortuary workers when compared with the control were not statistically significant ($P>0.05$). However, there was strong and statistically significant negative correlation ($r=0.263$, $P<0.05$) between the total white blood cell (TWBC) count and the duration of exposure to the chemicals. There was also significant variation ($P<0.05$) in lymphocytes (LYM), neutrophils (NEUT) and mixed field differential (MXD) counts among the exposed groups. The blood film results showed no significant alteration in the number and morphology of the blood cells. This research has succeeded in demonstrating that exposure to embalmment chemicals is capable of disrupting haematopoietic functions.

**Keywords:** Embalmment chemicals; Mortuary workers; Hematological parameters

## Introduction

The process of formation of blood and development of the various types of blood cells and other formed elements is called haematopoiesis. There are three types of blood cells viz, the red blood cells (RBC) or erythrocytes, the white blood cells (WBC) or the leucocytes and the platelets (PLT) or thrombocytes. All the three cell lines are produced and derived from a multipotent cell in the bone marrow known as haematopoietic stem cell [1]. The various hematological indices assessed to determine the value of these cell lines are known as hematological parameters. Hence, hematological parameters are the blood measurable values obtained from whole blood such as Platelets (PLT), White Blood Cells (WBC), Mean Cell Volume (MCV), Heamatocrit (HCT)/Packed Cell Volume (PCV), Haemoglobin (HB), mixed field differential (MXD), absolute counts of the Neutrophils (NEUT), Basophils (BASO), Eosinophils (EOS), Lymphocytes (LYM) and Monocytes (MONO) etc in I µ of whole blood [2].

Egypt is credited with being the land where embalming began. During the period from 6000 BC to 600 AD approximately 400 million bodies were mummified. The Egyptians embalmed for religious and sanitary purposes and the process takes about 70 days. Egyptian embalmment begins with the body being washed and an incision cut made into the side. Through this incision the internal viscera are removed and placed in canopic jars, the brain is accessed via the nose, minced and pulled from the skin with hooks. Next the body cavity is stiffed with natron salt (sodium bicarbonate), the skull filled with resin and then allowed to stay for the period of about 40 days after which the body is anointed with perfume and then packed with herbs, linen and saw dust. Finally the body is wrapped in linens and placed in coffin for entombment [3].

In most modern culture, embalming is the art and science of temporarily preserving human remains to forestall decomposition and to make them suitable for public display at funerals. Therefore, embalming is defined as the preservation of the dead body by the introduction of chemical compounds that delay putrefaction [4]. Embalming chemicals are varieties of preservatives, sanitizing and disinfection agents and additives used in modern embalming to temporarily prevent decomposition and restore a natural appearance for viewing a body after death.

The three goals of modern embalming are thus disinfection, preservation and restoration of the body [5]. The embalming chemicals or fluids can be injected into the body arterially, hypodermically or be applied to the body surface as spray. Arsenic based solutions were the first generally accepted and frequently used embalming fluid in the 19$^{th}$ and early 20$^{th}$ centuries but has since been supplanted by more effective and less toxic formaldehyde [6].

The embalming fluid of today typically contains a mixture of formaldehyde, methanol, ethanol, phenol and other solutions. The formaldehyde content may range from 9 to 56%. Generally, there are

three types of embalming fluids viz, (i) Arterial or preservative fluids. (ii) Cavity fluids and (iii) Supplemental fluids. The general principle is that embalming fluids act to fix cellular proteins. Thus, formaldehyde fixes tissues or cells by irreversibly connecting a primary amine group in protein molecule with nearby nitrogen or DNA molecule through $CH_2$ linkage called Schiff base [5].

Of all the chemicals used in modern day embalming, formaldehyde and phenol have been found to have the most important exposure concern. While dermal absorption of formaldehyde appears not to be significant but readily absorbed via the respiratory and gastrointestinal routes, the primary route of entry of phenol is via the skin. However, both are irritant chemicals with possible genotoxic, carcinogenic, haematotoxic etc properties [7-10].

Formaldehude (Methanal) is an organic compound with the formula $CH_20$. It is colourless and strong smelling gas at room temperature. When dissolved in water, formaldehyde converts to $H_2C(0H)_2$. Aqueous solution of formaldehyde are referred to as formalin. 100% formalin consists of a saturated solution of formaldehyde (about 40% by volume or 37% by mass) in water, with a small amount of stabilizer usually methanol to limit oxidation and degree of polymerization [5].

Pure phenol consists of clear acicular crystals. At 41°C, phenol congeals into a solid that can be liquefied by mixing a very small amount of water (2 parts: 23 parts phenol). On exposure to air and light, phenol assumes a pinkish or reddish discolouration. This discolouration is accelerated by the presence of alkalinity or impurities [11]. Phenol has a characteristic sweet medicinal or tar-like odour. It is shipped in the molten state at elevated temperature or in the solid or crystalline form. It is also available as an aqueous solution [12].

The objective of this research was to deduce the effects of these embalming chemicals on some hematological parameters of exposed workers in some mortuaries in Anambra State-Nigeria.

## Materials and Methods

The participants were recruited from 13 randomly selected mortuaries in Anambra state-Nigeria. The apparently healthy participants totaled 100 in number and were all males. Out of this number, 20 who were not mortuary workers or the unexposed groups served as the control.

The test groups comprised 48 workers exposed to the embalming chemicals for 1-7 years; 13 workers of 8-14 years and 19 workers exposed for 15 years above. Their blood samples were collected with strict adherence to the provisions of informed consent. 3 ml of whole blood were collected from the cubital veins of each of these individuals delivered into the appropriate ethylene diamine tetra acetic acid (EDTA) containing tubes, mixed thoroughly and processed with in one (1) hour of collection using sysmex kx-21N automation.

The assessed hematological parameters included: Total and differential white cell counts, red cell count, platelet count, HB, PCV, and red cell absolute values or indices viz, MCHC, MCH, MCV. The blood films preparations and examinations were performed using standard hematological techniques [2].

## Results

Table 1 shows the mean and standard deviation of the age and the hematological parameters of the mortuary markers and the control group. Table 2 illustrates the result of the student t-test comparison of the mean values of the hematological parameters of the exposed workers and the control group and between 1-7 years and 15 years and above exposure groups.

Table 3 is the result of the analysis of variance (ANOVA) comparison of the mean values of the hematological parameters of the mortuary workers exposed for 1-7 years, 8-14 years and 15 years and above durations. Table 4 contains the result of the Pearson's correlation analysis between the duration of exposure in years and the hematological parameters.

Figures 1 and 2 are histograms demonstrating the variations in the mean values of the hematological parameters of the control and the exposed workers groups according to the duration of exposure. Figure 3 is the correlation curve that depicts the relationship between total white blood cell count and the duration of exposure to the embalming chemicals. These results are as shown in the tables and figures below:

| **Haematological parameters** | **Control group**<br>**N=20**<br>**Mean ± SD** | **Mortuary workers**<br>**N=80**<br>**Mean ± SD** |
|---|---|---|
| AGE (years) | 31.03 ± 7.80 | 36.31 ± 12.19 |
| TWBC (x $10^9$/L) | 5.14 ± 0.99 | 5.47 ± 1.33 |
| RBC (x $10^{12}$/L) | 5.11 ± 0.42 | 5.04 ± 0.40 |
| HB (g/dL) | 13.80 ± 1.14 | 14.57 ± 3.19 |
| HCT (%) | 40.75 ± 3.11 | 42.34 ± 5.01 |
| MCV (fL) | 79.83 ± 3.70 | 82.07 ± 8.15 |
| MCH (pg) | 27.54 ± 3.51 | 32.18 ± 33.82 |
| MCHC (g/L) | 33.83 ± 1.40 | 34.495 ± 2.05 |
| PLT (x $10^9$/L) | 199 + 55.05 | 205.8 ± 58.76 |
| LYMPH (%) | 49.38 ± 9.13 | 47.75125 ± 8.94 |

| | | |
|---|---|---|
| MXD (%) | 16.25 ± 14.76 | 14.90 ± 6.80 |
| NEUT (%) | 38.02 ± 8.93 | 37.40 ± 11.21 |

**Table 1:** The mean and standard deviations of the age and haematological parameters of mortuary workers and the control subjects.

| Haematological parameters | Mortuary workers and control group df=98 | | (1-7 years) and (15 years and above) exposure groups df=65 | |
|---|---|---|---|---|
| | t-values | P-value | t-values | P-value |
| TWBC (x $10^9$/L) | -1.053 | 0.295 | 2.122 | 0.038* |
| RBC (x $10^{12}$/L) | 0.671 | 0.504 | -0.112 | 0.911 |
| HB (g/dL) | -1.070 | 0.287 | 0.459 | 0.648 |
| HCT (%) | -1.351 | 0.180 | 0.866 | 0.390 |
| MCV (fL) | -1.196 | 0.235 | -0.541 | 0.590 |
| MCH (pg) | -0.612 | 0.542 | 0.604 | 0.548 |
| MCHC (g/L) | -1.380 | 0.171 | -1.060 | 0.293 |
| PLT (x $10^9$/L) | -0.479 | 0.633 | -0.590 | 0.557 |
| LYMPH (%) | 0.724 | 0.471 | 1.124 | 0.265 |
| MXD (%) | 0.608 | 0.545 | 2.651 | 0.010* |
| NEUT (%) | 0.231 | 0.818 | -2.456 | 0.017* |
| Significance = P<0.05; * = Significant; df = degree of freedom | | | | |

**Table 2:** Result of the student t-test for comparison of the mean values of the haematological parameters of mortuary workers and control group and between those exposed for 1-7 years and 15 years and above.

| Haematological paremeters | P-values |
|---|---|
| TWBC (x $10^9$/L) | 0.109 |
| RBC (x $10^{12}$/L) | 0.983 |
| HB (g/dL) | 0.634 |
| HCT (%) | 0.250 |
| MCV (fL) | 0.707 |
| MCH (pg) | 0.708 |
| MCHC (g/L) | 0.518 |
| PLT (x $10^9$/L) | 0.460 |
| LYMPH (%) | 0.007* |
| MXD (%) | 0.018* |
| NEUT (%) | 0.006* |
| Significance = P<0.05; * = Significant | |

**Table 3:** The result of the anova comparison of the mean values of the haematological parameters among the three groups of the workers based on the duration of exposure.

| Haematological parameters | r-value | P-value |
|---|---|---|
| TWBC (x $10^9$/L) | -0.263 | 0.018* |
| RBC (x $10^{12}$/L) | 0.031 | 0.788 |
| HB (g/dL) | -0.042 | 0.712 |
| HCT (%) | -0.090 | 0.426 |
| MCV (fL) | 0.048 | 0.672 |
| MCH (pg) | -0.82 | 0.470 |
| MCHC (g/L) | 0.095 | 0.403 |
| PLT (x $10^9$/L) | 0.083 | 0.464 |
| LYMPH (%) | -0.076 | 0.505 |
| MXD (%) | -0.255 | 0.062* |
| NEUT (%) | 0.202 | 0.072* |
| Significance = P<0.05; * = Significant | | |

**Table 4:** Result of the pearson's correlation analysis between the duration of exposure and the haematological parameters.

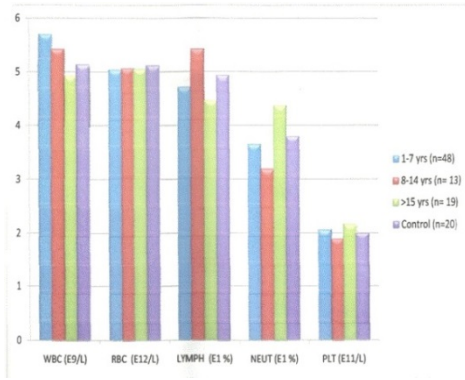


**Figure 1:** Histogram showing the variation in the mean values of some haematological parameters of the control subjects and the mortuary workers grouped according to duration of exposure to embalming chemicals.

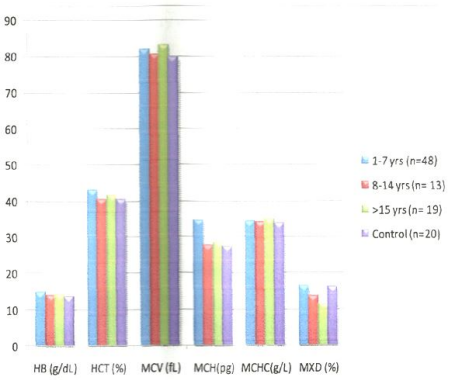


**Figure 2:** Histogram showing the variation in the mean values of some haematological parameters of the control subjects and the mortuary workers grouped according to duration of exposure to embalming chemicals.

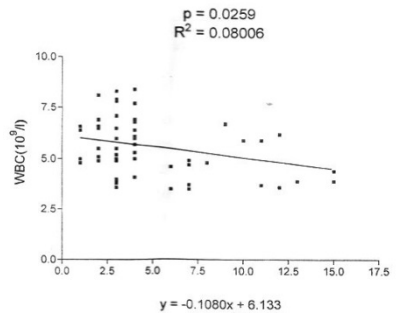


**Figure 3:** Showing linear regression curve of total white blood cell count and period of exposure of mortuary workers.

## Discussion

The adverse health effects of exposure to chemicals such as formaldehyde, phenol, methanol, ethanol, which are the ingredients of the modern embalming solutions, have been reported. However, there are few studies that focused directly on the assessment of the effects of these chemicals on haematopoietic functions. This research was therefore designed to detect possible alterations in the haematopoietic profiles and specifically the red cells, white cells and platelets of mortuary workers exposed to these embalming chemicals.

The result of the study showed that the mean white blood cell count of the exposed workers ($5.5 \times 10^9$/L) is higher than the control group ($5.1 \times 10^9$/L), but the percentage lymphocyte count (47.4%), neutrophil (37.4%) and mixed differential count (15.0%) were lower compared to control (49.4%, 38.0%, 16.3% respectively). However, the differences in the means of these parameters between the test and control groups were not statistically significant (P>0.05). The ANOVA comparison of the mean values of the hematological parameters of 3 categories of workers (1-7 years; 8-14 years and 15 years and above exposure durations) showed that there was statistically significant variation in the mean values of the lymphocytes (P=0.018).

The result of the independent t-test comparison of the mean values of the haematological parameters of the three exposure groups showed that total white blood cell count and mixed differential counts were significantly lower (P<0.05) and neutrophil count significantly higher (P<0.05) in those exposed for 15 years and above compared with those exposed for 1-7 years. The result of the correlation analysis showed that there was strong and statistically significant negative correlation (r=-0.203, P<0.05) between total white blood cell count and the duration of exposure. This implies that the total white blood cell count decrease as the duration of exposure increase. The above findings support the work of Lan et al and thus indicate that there are some degree of effects of these chemicals on the white blood cell count which may be due to the toxic effects of these embalming chemicals on the bone marrow cells [9].

The mean values of the haematocrit (HCT/PCV), haemoglobin (HB), mean cell volume (MCV), mean cell hemoglobin (MCH) and mean cell hemoglobin concentration (MCHC) were higher and red cell counts lower in the exposed workers compared with the control. However, the mean differences were not statistically significant (P>0.05). Also, there was no significant variation in the above parameters among the exposure groups as well as no significant correlation with the duration of exposure (P>0.05). The mean values of platelet count ($205.8 \times 10^9$/L) were higher in exposed workers when compared with the control ($198.9 \times 10^9$/L), but the difference in the mean values was not statistically significant (P>0.05). There was also no significant variation in the platelet count among the groups including no significant correlation with the duration of exposure (P>0.05). These imply that the toxic effects of the chemicals do not affect the red blood cell and platelet physiology significantly. The peripheral blood film results showed no significant alteration in the number and morphology of the white blood cells, red blood cells and platelets. These contradict the works Lan et al, which showed that peripheral blood cell counts were significantly lowered in workers occupationally exposed to formaldehyde. On the hand, the deductions on the white blood cell count of the workers support the report of Kuo et al, on the possible effects of the chemicals on immune functions [13].

## Conclusion

The results obtained in this research show that:

1. Mortuary workers exposed to the embalming chemicals when compared with the control (unexposed) group manifested significant variations in the total white blood cells (TWBC) counts, neutrophils (NEUT) counts, and lymphocyte (LYMPH) counts and based on the duration of exposure.

2. Alterations in the peripheral blood cell counts and haemoglobin (HB) levels of the mortuary workers when compared with the control values were found not to be statistically significant.

3. There was strong and statistically significant negative correlation between the TWBC count and exposure durations.

4. It can be gathered from the findings that as the duration of exposure increase, the TWBC count decrease.

5. This research has succeeded in demonstrating that exposure to embalming chemicals especially formaldehyde may cause alterations in some hematological parameters of the exposed mortuary workers.

## Recommendations

Based on the results associated with this study and from the literature, the following are proffered:

1. Mortuary workers should be strongly advised to ensure consistent use of protective materials such as hand gloves, clothings, face masks, respiratory filters, boots etc.

2. The embalming rooms should be designed to ensure adequate ventilation and whenever, possible, embalming process especially the injection stage should be done in the open air inorder to minimize inhalation exposure.

3. To explore the possibility of using low volatile chemicals like gluteraldehyde instead of formaldehyde which is very volatile and that poses the greatest exposure hazard.

4. There should be periodic and regular medical checkups for all mortuary workers with a view to ensuring early diagnosis and treatment of any adverse health implications.

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