Abstract

This research work is aimed at investigating the effectiveness of the oral vaccination administered to Nigerian Air Force Staff and their families against typhoid fever between January 2003 and August 2003: Record of cases admitted in the various hospitals under training command (HQ TC) was extracted from 345 aeromedical hospital, NAF Hospital Jos, NAF Hospital 303FTS Kano and 305FTS Enugu for the analysis. Questionnaire was administered to 6 Units out of the 9 Units under HQ TC. These units include 301FTS, 320TTG, 325GTG, 333LOG, 335BSG and 345AMH. In the analysis, the statistical tools used are student t-test, chi-square test, analysis of variance (ANOVA) and Duncan multiple range test. SPSS was used to run the analysis. The result however, revealed that the vaccine was effective.

The idea of analyzing the vaccine (Vivotif-Berna) effectiveness comes when the vaccine had long been given to the Air Force Staffs.

In statistical analysis of vaccine effectiveness (VE). Different methods of statistical tools are used to measure the vaccine efficacy. Joines, J. A. (1999) revealed that the monte carlo experiment was used for analysis of HIV vaccine effects and Vaccine trials design. In the study, monte carlo simulation analysis conducted with HIVSIM indicate that the RPT (Retrospective Partner Trials) design was able to produce vaccine effect estimates with acceptable small bias, high precision and excellent statistical power under plausible HIV vaccine trial conditions.

On the other hand, the epidemiologic methods in immunization programmes carried out by Chem and Orenstein (1996), held that before a formal epidemiologic study of vaccine effectiveness is undertaken, it is useful to review whether the surveillance data permit a rapid screening analysis. If the surveillance system routinely collects information on the proportion of population vaccinated (PPV) and
proportion of cases vaccinated (PPV) in the same population, and there is a good confidence in the accuracy of these data, then vaccine effectiveness (VE) can be calculated as

\[ VE = 1 - \left[ \frac{PCV}{1-PCV} \right] \left[ \frac{1-PPV}{PPV} \right] \]

The magnitude of the error introduced by different levels of false positive case definitions is estimated by

\[ \frac{VE_{\text{observed}}}{VE_{\text{true}}} \approx \frac{x}{(x+y)} \]

Where \( x \) is the true incidence rate of the vaccine preventable disease in the population and \( y \) is the incidence of the condition misdiagnosed as the vaccine preventable disease. The screening method is a simple and rapid way of estimating VE which has been used to estimate “Pertussis” VE in the Netherlands, USA, Nova Scotia, UK and New Zealand. In Australia also it has been used to estimate the VE of Haemophilus influenza type b 27 and more recently, pertussis, 28 Torvaldsen and McIntyre (1999) used observation methods in epidemiologic assessment of vaccine effectiveness, in the study all VE studies involve comparison of the relative risks of disease in the vaccinated group(s) with the unvaccinated group(s), hence any study type from which relative risk can be estimated can be used to calculate VE. The same study indicated that, the standard equation for calculating VE as a percentage is:

\[ VE(\%) = \left( \frac{ARU - ARV}{ARU} \right) \times 100 \]

Where ARU is the arrack rate in the unvaccinated group and ARV is the attack rate in the vaccinated group.

In the analysis of the effectiveness of Haemophilus influenza b conjugate vaccine on childhood pneumonia in Brazil, categorical data were compared using Chi-Square test or fisher’s exact test and continuous covariates by using the student’s t – test. Other statistical tools used for estimating VE include: The mann – whitney rank sum test for including dropouts using a two – sided truncation model, kolmogorov smirnov (KS) test, Kruskal – wallis H test for comparing K probability distributions, Wilcoxon matched pairs signed rank test, Friedman Fr test (ANOVA) etc.

**Statement of Problem**

This exercise is aimed at revealing some of the indispensable statistical tools used for research to individuals or organizations for their policy formulation. However, if this was not done for the NAF, the following doubts may come to mind.

a) That the money expended on the project is not justified.
b) That the vaccine has lost its potency before bringing it into the country.
c) That the NAF should not embark on such future project since this is already a waste.

**Purpose of the Study**

The study enables us to determine the efficiency of the vaccine. To enable and encourage the NAF to make proper strategic plans on health matters. It will also serve as a literature review to researchers who may wish to carry out study on a similar topic. The study will also clear the doubts in the mind of the soldiers.

**Research Methodology**

The data was collected through records (documentary method) and administration of questionnaire. Information was extracted from the records of 345 AMH, NAFHospital Jos, NAFHospital Kano and NAFHospital Enugu.

Student t-test, chi-square test, Analysis of variance were tools used in achieving the result of the analysis which was computed using SPSS.

**Instrument Design/Data Analysis**

<table>
<thead>
<tr>
<th>Maths</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<td>B</td>
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<td>4</td>
<td>4</td>
<td>4</td>
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<td>4</td>
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<td>1</td>
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<td>2</td>
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</table>

*Source: Aeromedical Hospital NAF Base Kaduna.*

B = Rate of admission case before vaccination  
A = Rate of admission cases after vaccination.  
Using the t-test:  
Hypothesis:  
H₀: Rate of admission cases before and after vaccination are equal  
H₁: Rate of admission case before and after vaccination are not equal.
Interpretation

From the result, the correlation between cases A & B = 0.233; But this is not a significant correction because significant value = 0.466 > 0.01 or 0.05 which implies we accept the null hypothesis which says $\rho = 0$

The t value = 3.924. But since significant value (2-tailed) = 0.002 < 0.01 or 0.05, we do not accept $H_0$. Hence we conclude that there is evidence to say that there is improvement in the reduction of the typhoid cases of admission after vaccination.

Respondents response through questionnaire revealed the below chart.

<table>
<thead>
<tr>
<th></th>
<th>BSG</th>
<th>AMH</th>
<th>FTS</th>
<th>TTG</th>
<th>GTG</th>
<th>LOG</th>
<th>TC</th>
<th>total</th>
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<tbody>
<tr>
<td>VE*</td>
<td>40</td>
<td>22</td>
<td>29</td>
<td>58</td>
<td>24</td>
<td>45</td>
<td>24</td>
<td>242</td>
</tr>
<tr>
<td>FE*</td>
<td>18</td>
<td>7</td>
<td>9</td>
<td>22</td>
<td>5</td>
<td>5</td>
<td>15</td>
<td>81</td>
</tr>
<tr>
<td>NE*</td>
<td>5</td>
<td>0</td>
<td>2</td>
<td>9</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>29</td>
<td>40</td>
<td>89</td>
<td>35</td>
<td>55</td>
<td>40</td>
<td>351</td>
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</table>

E = very effective FE = fairly effective NE = Not effective.
Hypothesis
H₀: effective response is independent of the units
H₁: It is dependent of the units.

Crosstabs

<table>
<thead>
<tr>
<th>Response Units</th>
<th>Count</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Valid</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>Percent</td>
<td>N</td>
<td>Percent</td>
<td>N</td>
<td>Percent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>100.%</td>
<td>0</td>
<td>.05%</td>
<td>21</td>
<td>100.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
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Response Units Crosstabulation

<table>
<thead>
<tr>
<th>Units</th>
<th>AMH</th>
<th>BSG</th>
<th>FTS</th>
<th>GTG</th>
<th>LCG</th>
<th>TC</th>
<th>TTG</th>
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<tbody>
<tr>
<td>Response FE</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
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<tr>
<td>NE</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>VE</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>7</td>
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<tr>
<td>Total</td>
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<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>21</td>
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</table>

Chi-Square Tests

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>d</th>
<th>Asymp. Sig. (2- sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson\ Chi-Square</td>
<td>0.000</td>
<td>12</td>
<td>1.00</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>0.00</td>
<td>12</td>
<td>1.00</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At 21 cells (100.0%) have expected count less than 5. The minimum expected count 1.02

Interpretation
From the result, Chi – square value is 0.000, But since asymp. Sig value (2 – sided) = 1.00> .01 or .05, we do not reject Ho. Hence we conclude that the unit have similar view on the effectiveness of the vaccine efficacy.

Using ANOVA to know the effectiveness as responded by the questionnaire and units responses.

Hypothesis
Effectiveness Responses
H₀: There is no significance difference between effectiveness responses.
H₁: There is significance difference.
**Units Responses**

**H₀:** There is no significance difference between responses from various NAF units.

**H₁:** There is significance difference

(Taking $\alpha = 0.05$ (5%))

Computation;

Correcting factor $(c) = (351)^2 = \frac{5866.71}{21}$

$SST = (40^2 + 22^2 + 29^2 \ldots \ldots + 1^2) - 5866.71 = 4984.29$

$SS = 1/7 (242^2 + 81^2 + 28^2) - 5866.71 = 3548.86$

$SSb = 1/3 (63^2 + 92^2 + 40^2 + 89^2 + 35^2 + 55^2 + 40^2) - 5866.71 = 860.29$

$SSE = SST - SS - SSb = 4984.29 - 3548.86 - 860.29 = 575.14$

$p-1=3-1=2$

$b-1=7-1=6$

<table>
<thead>
<tr>
<th>Sv</th>
<th>Df</th>
<th>Ss</th>
<th>Ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trt</td>
<td>2</td>
<td>3548.86</td>
<td>1774.43</td>
<td>37.02</td>
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<tr>
<td>Block</td>
<td>6</td>
<td>860.29</td>
<td>143.38</td>
<td>2.99</td>
</tr>
<tr>
<td>Error</td>
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<td>575.14</td>
<td>47.93</td>
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</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>4984.29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Treatment at 5% level = 3.89 at 1% level = 6.93

Block at 5% level = 3.00 at 1% level = 4.82

Decision criterion

Reject $H₀$ if $F_{cal} > F_{tab}$ otherwise do not reject.

**Decision:**

**Treatment:** Since $F_{cal} = 37.02$ which exceeded $F_{tab}$ at both $\alpha$ level (3.89&6.93), we reject the $H₀$. Hence there is evidence to show that there is significance difference between effectiveness responses.

**Block:** since $F_{cal} = 2.99$ which does not exceed $F_{tab}$ at both $\alpha$ level (3.00&4.82) we do not reject $H₀$. Hence the researchers than concluded that there is no significance difference between responses from the various NAF units. This confirming the result form the chi-square.
We then employ the “Duncan multiple Range Test” to know the best out of the effective responses.

\[
Kr = \sqrt{\frac{S^2}{\gamma}} = \sqrt{\frac{msE}{\gamma}} = \sqrt{47.93} = 2.62
\]

From Duncan table with 1.2 d.f and \( \alpha = 5\% \)

- \( r = 2 \) \( k = 3.082 \)
- \( r = 3 \) \( k = 3.225 \)

\[
\begin{align*}
R2 &= 3.082 \times 2.62 = 8.07 \\
R3 &= 3.225 \times 2.62 = 8.45 \\
\end{align*}
\]

Arranging mean in ascending order

\[
\begin{align*}
NE^* &= 4.00 \\
FE^* &= 11.57 \\
VE^* &= 34.57 \\
\end{align*}
\]

Comparison will be

- \( VE^* \) vs \( NE^* \) = 3.47 - 4.00 = 30.57 > 8.45 (R3) significant
- \( VE^* \) vs \( FE^* \) = 3.47 - 11.57 = 23.00 > 8.07 (R2) significant
- \( FE^* \) vs \( NE^* \) = 11.57 - 4.00 - 7.57 < 8.07 (R2) not significant

**Summary of Findings**

From the analysis, it can be conclude that there is significant difference between all pairs of means except \( FE^* \) vs \( NE^* \)

**Result:** it is obvious that \( VE^* \) (very effective) is the best of all the other responses. We therefore, conclude that the vaccine is very effective. It is therefore note worthy that the money is expended on the vaccine is justified.

**Conclusion**

This research work revealed that the anti typhoid oral vaccine (vivotif-berna) purchased by the NAF from the WHO (World Health Organization) for her staffs, is effective. It is therefore note worthy that the money expended on the vaccine is justified and doubts should be removed from the minds of soldiers as to the non-potency of the vaccine.

**Recommendation**

This research has been given rise to recommendations which may help both the NAF and other organizations. They include:
1) Research of this kind needs to be encouraged since statistics is the bedrock of every effective planning in every organization.

2) A lot of drugs floods the market today by registered and non-registered manufacturers. The government and other private bodies should do more researches to detect drugs that have lost their potency and so ascertain which one should give way for others.

References


