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# JABS

**Journal of Applied and Basic Sciences**

**International coverage of all aspects of Sciences**

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**Vol. 11 No. 1 June, 2020**

# Journal of Applied and Basic Sciences (JABS)

Volume 11 Number 1 June 2020

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#### **Book Reviews**

JABS will review selected books in all aspects of sciences from time to time. Authors interested in having a book reviewed should send a copy to the Editor -in-Chief.

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## Update of the Abuja 1:100,000 Topographic Map Sheet 186 from Satellite Imagery

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### Abstract

The topographic map of Abuja (1:100,000) was updated using SPOT 2.5m and 5m resolution panchromatic and multispectral images, Landsat 15m and 30m resolution, as well as Google Earth images through a low-cost methodology. The overall objective was to ascertain, verify and evaluate the nature, extent and magnitude of changes that had taken place in Abuja, Nigeria between 1960 and 2015 and consequently produce an update map of the area. The software used were ILWIS 3.5 and ArcGIS 10.3. The methodology included field observation, GPS collection of ground control points, image processing and interpretation, overlying processes, oral interviews and detailed field verification of the updated map. Analysis of the 1960 and 2015 (updated) maps show that a total of 8 types of point features presented on the 1960 map changed to 17 in 2015; the linear feature changed from 6 to 9 while the polygon features changed from 16 to 34. Similarly, the total number of point of features increased from 68 to 614, representing a magnitude of 546; the linear features increased in total length from 531.87km to 1009km representing a magnitude of 477.13km; while polygon features increased in total area coverage from 132.35km<sup>2</sup> to 195.52km<sup>2</sup> representing a magnitude of 63.63 km<sup>2</sup>. The paper recommends the adoption of fast and cost-effective methods offered by geoinformatics for topographic mapping and updating particularly in the less developed nations.

**Keywords:** Topography, Map, Update, Remote sensing, GIS, Change

### Introduction

A map is a conventional picture of the earth's pattern as seen from above to which lettering is added for identification; or an image of the environment being a reproduction of so many transformations that is bound to be a distorted representation of the environment<sup>1,2</sup>. Balogun further notes that maps are the best and most efficient means of storing information and the spatial distribution of human and natural resources within their environment<sup>3</sup>. Perhaps the most useful map which shows natural and human resources as well as the terrain on which development takes place is the topographic map.

A topographic map is a map whose principal purpose is to portray and identify features of the Earth's surface as faithfully as possible within the limitation imposed by scale<sup>4</sup>. Bohme explained that the scales of topographic maps

are made to a distinct degree and standardized throughout the world<sup>5</sup>: They can be distinguished in three categories of scales: Large (basic) scale, 1:5,000-1:25,000; medium scale, 1:25,000-1:125,000, small scale, 1:200,000 and smaller.

Irrespective of their scale or form, maps need to be updated periodically at a pace commensurate with the dynamics in the environment. But according to Keates, the updating and maintenance of a map series has always been an intractable problem<sup>6</sup>. Topographic map updating has remained a contemporary issue as a result of its importance to nations, institutions, and map users. Consequently, a number of researches have been carried out on topographic mapping and map updating at different scales in many countries<sup>7</sup>. Hitherto map updating tasks were performed manually, but, today, Geoinformatics techniques that allow for digital mapping with its associated benefits have greatly reduced the arduousness of the tasks involved particularly in evaluating temporal changes as highlighted in a number of studies<sup>8,9,10</sup>.

In Nigeria, all the topographic maps which were produced

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over fifty years ago are now outdated and obsolete. The Office of the Surveyor General of the Federation (OSGOF) formerly known as Federal Surveys Department established in 1897 is the national agency charged with the responsibility of surveying and mapping the entire country. However, the Office has been unable to update the basic topographical maps produced in the fifties and sixties and complete the mapping of the country<sup>11</sup>. In spite of the huge financial investment and external aid by the Canadian Government, the 1:50,000 map series did not completely cover the entire country<sup>13, 3, 11, 14</sup>. Furthermore, the attempt to produce new series of 1:25,000 topographic maps in the mid-1970s by OSGOF essentially failed and map updating was abandoned due to financial constraints. Although aerial photography at the scale of 1:25,000 was made available at 20% production capacity, the field completion and cartographic processes were not executed<sup>15</sup>.

The lack of up-to-date maps in Nigeria in general is a major problem which has affected developmental activities and planning, as well as decision making and policy formulation processes for sustainable development<sup>16</sup>. Consequently several individual researches including update of the topographic map of Warri and environs in Nigeria and update of the topographic map of Esan Central Local Government Area, Edo State, Nigeria among others have been undertaken<sup>7, 14</sup>.

Abuja is the Federal Capital City of Nigeria. The

demographic structure of Abuja changes quickly, mainly due to migration and high birth rates which enhanced the rapid development of Abuja. The land use of Abuja is always changing emphasizing the need for regular update of the topographic map of the city in order to capture the changing topographic information using fast, reliable, and accurate tools offered by Geoinformatics techniques. The study reported here utilised the aforementioned techniques to undertake a complete update of the Abuja topographic map sheet 186 at the scale of 1:100,000 using SPOT 2.5m and 5m resolution and Google Earth data and Landsat images.

## Study Area

Abuja, the Federal Capital Territory of Nigeria is located in the central part of Nigeria defined by Latitudes  $8^{\circ} 25' 00''$  and  $9^{\circ} 20' 00''$  North of the Equator and Longitudes  $6^{\circ} 45' 00''$  and  $7^{\circ} 39' 00''$  East of the Greenwich Meridian, The Territory has a landmass of approximately 7,315 km<sup>2</sup>, of which the actual city occupies 275.3 km<sup>2</sup>. The territory is currently made up of six local councils, comprising the City of Abuja and five Local Government Areas, namely: Abaji, Abuja Municipal, Gwagwalada, Kuje, Bwari and Kwali (See Figures 1).

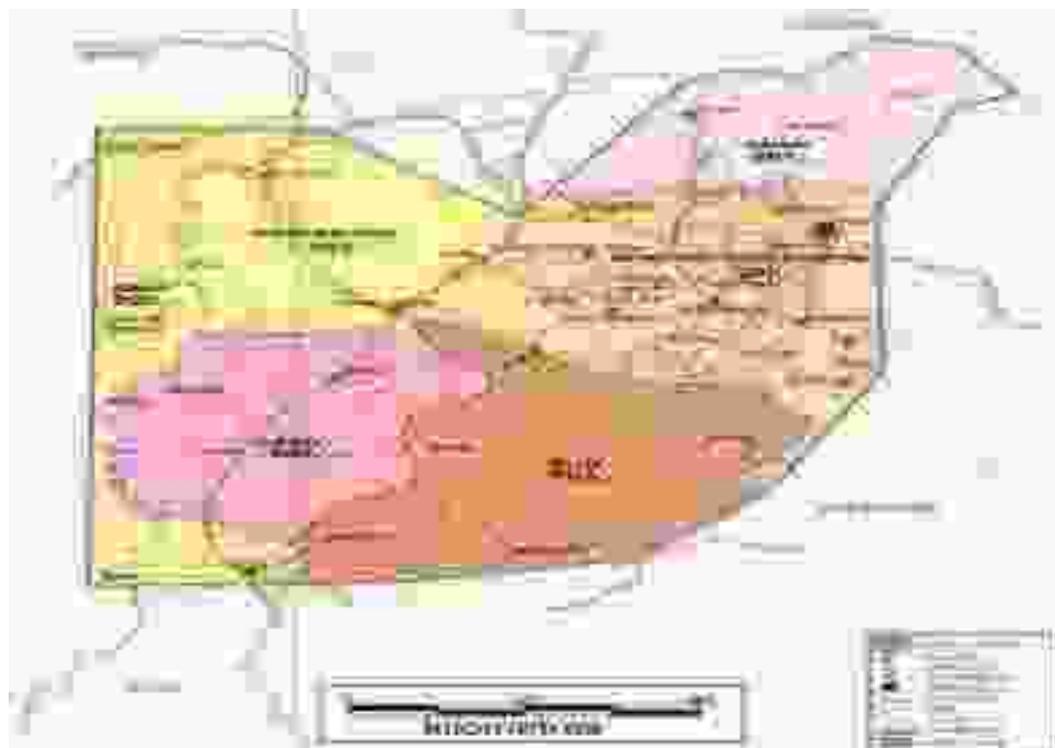


Figure 1: Administrative Map of Abuja

Source: Office of the Surveyor General of the Federation

## Research Methods

**Data required and their sources:** The study utilized both primary data and secondary data. The primary data were obtained from field survey which included GPS data collection for field completion and verification in Abuja environs as well as oral interview (to obtain socioeconomic data with regards to mapping and map update) which was carried out at different mapping agencies and organizations located in Abuja. The secondary data were the topographic map (1960 1:100,000: See Figure 2) of the study area, Landsat 30m resolution 2010, Landsat 8 15m resolution 2015, Spot 5m resolution 2005, Spot 2.5m resolution 2015 and Google Earth 2014 while other secondary sources were relevant thematic maps, statistics, textbooks, journals, conference papers and seminar proceedings.

**Data Collection:** A reconnaissance tour of the study area was undertaken to observe and gather general topographic

data and information and as well capture GPS coordinate points. To ensure actual access to each sample points, proximity to the road network was given high weighting in the sampling criteria. Structured interviews were conducted on the staff of the Office of the Surveyor General of the Federation (OSGOF), National Space Research and Development Agency (NARSDA), Nigerian Geological Survey Agency (NGSA), the National population Commission (NPC), the various arms of Military, and other selected relevant institutions, agencies and parastatals.

**Data Processing:** Pre-processing and post image processing and analysis were carried out to enhance the quality of the images and the readability of the features using the spatial analysis tools of Integrated Land and Water Information System (ILWIS 3.5 and ArcGIS 10.4). The topographical map was scanned georeferenced and digitized, while the satellite images of SPOT-5m, 2.5m 2015 and Landsat8, 2015 were geometrically corrected and the projection was set to Universal Transverse Mercator (UTM) projection system, zone 32. The spheroid and datum was referenced to WGS84.

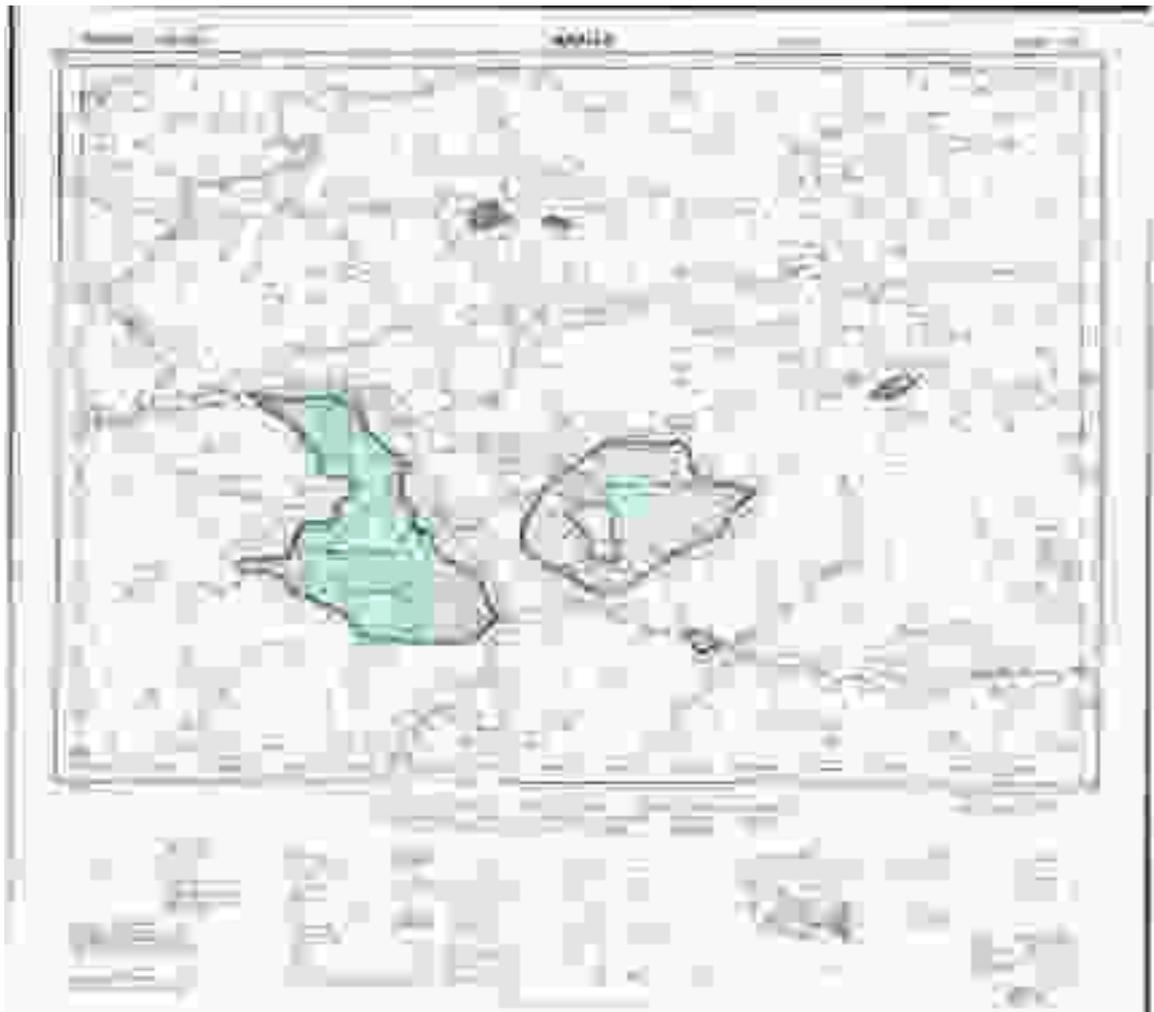


Figure 2: The Scanned Outdated Existing Topographic Map of Abuja Produced in 1960

Source: Office of the Surveyor General of the Federation

Visual interpretation of the SPOT and LANDSAT images covering the entire study area at scale of 1:100,000 sheet 186) was therefore conducted based on the implicit and explicit use of collateral information which included maps, photographs, reports and personal experience of the interpreters. Colour, tone, pattern, texture, association, shape, size, shadows, and site clearly enabled photomorphic delineation of line and polygon features to produce the preliminary map.

All the images were geometrically co-registered to each other using ground control points into UTM projection with geometric errors of less than one pixel, so that all the images have the same coordinate system. The Nearest Neighbourhood resampling technique was used to resample the topographic map and SPOT-5m and 2.5m into a pixel size of IKONOS during the image-to-image registration. The ground control points (GCPs) are known ground points whose positions could be accurately located on the digital imagery. Such features include road intersections, corners of open field or lawns. Co-ordinates of GCPs were obtained using Global Positioning System (GPS). Geometric transformation of map-to-map was used for the scanned/digitized topographical map of the study area, while image-to-map transformation was applied to the remotely sensed data of SPOT and IKONOS using Affine transformation. The result of the exercise was checked using Root Mean Square (RMS) error which is the process of measuring the deviation between the actual location and the estimated location of the control points in geometric transformation and was found to be 0.7 pixel<sup>3</sup>. The contour map was generated from NASA's 90m resolution SRTM (Shuttle Radar Topographic Mission) topographic (elevation) data covering the study area to provide a representation of the topography of Abuja. Field verification (ground truth) entailed the location of coordinates of the sample points acquired directly from the digital satellite images for entry into the GPS, as well as for field completion to verify information extracted from remotely sensing data.

**Map updating process:** The updating process entailed a series of overlays in the following order:

- Overlay of all the raster maps with all layers registered to the satellite image and digitally generate the changes,
- Overlay of the satellite image digitally to generate the changes of the polygons and lines; positives-new objects and negative objects deleted and form

the new combination overlay of the “changes” layer with maps layer and also separate each layer for the creation of the new updated layer using map algebra procedures.

- Overlay of the satellite image to each map layer (layer by layer for each layer separately using digital process of updating followed by integration of all map layers for the updated map production).
- Matching of each raster with the image using all the layers or only a part and realization of the updated digitally georeferenciation of the updated layer.

Evaluation and analysis of the changes established was undertaken after the overlaying process. Attribute and other users' specified data derived from oral interviews were summarized and analyzed descriptively, and the results integrated in the discussion of the overall results of the study

Field verification data were incorporated to refine image interpretation. Accuracy assessment was also undertaken before the final interpretation was done on a scene by scene and theme by theme basis in ArcGIS 10.3 software. Finally, adjacent digital themes were overlaid together to produce a single topographic map of the entire Abuja at the scale of 1:100,000 in line with the Nigerian topographic map series conventions and codes.

**Data Analysis:** The changes and magnitude of changes were analysed descriptively. The numbers of point features, lengths of linear features and polygon features shown on the map were subjected to Analysis of Variance (ANOVA) test in order to ascertain whether or not the changes in topographic features at a scale of 1:100,000 maps 1960-2015 are significant

## Results

The results show that the types of point features increased from 8 in 1960 to 17 in 2015. The new point features shown on the updated topographic map include the National Mosque, Airport, National Stadium, University, Satellite Towns, Police Stations, Communication Masts, Bridges and, Schools. Linear features also increased in number from 6 to 9. The new linear features were Transmission Lines, Expressways and Railway Lines. Polygon features as well increased from 16 to 34: the new features being the game village and several adjoining satellite towns that were

hitherto point features.

**The magnitude and rate of changes in point features between 1960 and 2015:** Table 1 show that the number of schools increased from 2 to 138 with a magnitude of 136, rate of change 13,600% and an annual rate of 247.27%. The

magnitude of change for Churches was 54; that of Dispensaries, 34, Market, 23, General Hospital 14, and Court 15: The annual rates of changes were 98.1%, 61.82%, 41.82%, 25.45% and 27.27% respectively. Whereas, the number of main Town increased from 1 to 6, the number of Villages increased from 48 to 98.

Table 1: The magnitude and rate of changes in point features

S/N	Point Feature	Number in 1960	Number in 2015	Magnitude of change	Rate of change in %	Annual Rate of Change %
1	Markets	2	25	23	2,300	41.82
2	Churches	4	58	54	5,400	98.18
3	Dispensaries	1	35	34	3,400	61.82
4	Gen Hospitals	2	15	13	1,400	25.45
5	Police stations	0	15	15	1,500	27.27
6	MTN Glo Airtel masts	0	25	25	2,500	45.45
7	Other Commu Masts	0	30	30	3,000	54.54
8	Courts	0	15	15	1,500	27.27
9	Rent House / Hotels	2	10	8	800	14.55
10	Schools	2	138	136	13,600	247.27
11	Satellite Towns	6	85	79	7,900	143.64
12	Main Town s	1	6	5	500	9.09
13	Villages	48	98	50	5,000	90.90
14	Bridges	0	14	14	1,400	25.45
15	Mosques	0	35	35	3,500	63.64
16	Nat Stadium	0	1	1	100	1.82
17	Airport	0	1	1	100	1.82
	TOTAL	68	614	546		

Source: Fieldwork. (2015)

**The magnitude and rate of changes in linear features between 1960 and 2015:** The length of Main Roads increased from 35.95km to 150km, representing the longest linear feature in the updated map. Table 2 clearly reveals that the magnitude of change which is 114.05km, is longer than the magnitude of change for minor roads (i.e. 9.48km), which increased from length of 100.52km to 150km. The annual rate of increase for main roads is 2.07 Km while that of minor roads is 0.17 Km. The length of Minor paths decreased from 305 Km to 100 km representing a decrease of 205 Km at an annual rate of 3.73 km. The length of boundaries changed; increased from 50km to 125km which gives a magnitude of 75km and rate of 1.36 Km. The change in length of boundaries is as a result of the new FCT areas created within the study area.

Table 2: The magnitude and rate of changes in linear features

S/No	Linear features	Length in 1960 (km)	Length in 2015 (km)	Magnitude of change (km)	Annual rate of increase (Km)
1	Main Roads	35.95	150	114.05	2.07
2	Secondary Roads	10.52	85	74.48	1.35
3	Minor Roads	90.52	100	9.48	0.17
4	Main Paths	24.33	25	0.67	0.01
5	Minor Paths	305	100	-205	-3.73
6	Power Transmission line	0	300	300	5.45
7	Expressways	0	85	85	1.55
8	Railway	0	4	4	0.07
9	Rivers	15.55	35	19.45	0.35
10	Boundaries	50	125	75	1.36
	<b>TOTAL</b>	<b>531.87</b>	<b>1009</b>	<b>477.13</b>	

Source: Fieldwork (2015)

**The Magnitude and rates of changes in polygon features:**

Table 3 show that the total area of polygon features increased from 132.35km<sup>2</sup> in 1960 to 195.52km<sup>2</sup> in 2015 with a magnitude of 63.63km<sup>2</sup>. The built-up area of Gariki increased from 12 km<sup>2</sup> to 24.50km<sup>2</sup> with a magnitude of 12.50km<sup>2</sup> and annual rate of 22.73%. Kubwa grew from area coverage of 11km<sup>2</sup> to 17.50km<sup>2</sup> with a change of 6.5km<sup>2</sup> and

annual rate of 11%; Kado Estate from 2.20km<sup>2</sup> to 4.75 km<sup>2</sup> representing a magnitude of 2,35km<sup>2</sup> and annual rate of 4.64%; Dawaki from 3.50km<sup>2</sup> to 5.25 km<sup>2</sup> which is a magnitude of 1.75 km<sup>2</sup> and annual rate of 3.18%; and Maitama from 9.02 km<sup>2</sup> to 10.75 km<sup>2</sup>, representing a magnitude of 1.73 km<sup>2</sup> and annual rate of 3.14% among others.

Table 3: The Magnitude and Rate of Changes in Polygon Features between 1960 and 2015

S/N	Polygon Features	Area in 1960 (km <sup>2</sup> )	Area in 2015 (km <sup>2</sup> )	Magnitude of Annual Change	Rate of Change (%)	Annual Rate of Change (%)
1	Garki	12	24.50	12.50	1250	22.73
2	Maitama	9.02	10.75	1.73	173	3.14
3	Kubwa	11	17.50	6.5	650	11.81
4	Lugbe	10	11.50	1.5	150	2.73
5	Wuse	10	10.60	1.06	106	1.93
6	Jabi	5	7.5	2.5	250	4.54
7	Kado	4	5.53	1.53	153	2.78
8	Bwari	8	10.19	2.19	219	3.98
9	Dutse Alhaji	4	5.28	1.28	128	2.33
10	Dutse Baupma	5.40	6.20	0.8	80	1.45
11	Kagini	4	5.06	1.06	106	1.93
12	Paipe	4.30	5.23	0.93	93	1.69
13	Jiko	1.33	3.22	1.89	189	3.44
14	Asokoro	2	4.05	2.05	205	3.73
15	Wuye	4	4.13	0.13	13	0.24
16	Durumi	2	2.50	0.5	50	0.91
17	Apo	2	3.19	1.19	119	2.16
18	Game Village	0	2.30	2.30	230	4.18
19	Mabushi	3	4.75	1.75	175	3.18
20	Utako	4	5.85	1.85	185	3.36
21	Jahi	1	3.58	2.58	258	4.69
22	Kado Bmiko	2	2.63	0.63	63	1.15
23	Gwarimpa	5.20	6.25	1.05	105	1.91
24	Kagini	1	2.33	1.33	130	2.36
25	Dawaki	3.50	5.25	1.75	175	3.18
26	Dutse Makaranta	2.10	3.40	1.30	130	2.36
27	Kuchiko	2	3.30	1.30	130	2.36
28	Maji	1.20	2.13	0.93	93	1.69
29	Fura	1	3.05	2.05	205	3.73
30	Kado	1	1.05	0.05	5	0.09
31	Dashape	1	2.33	1.33	133	2.42
32	Kado Kuchi	3	3.09	0.09	9	0.16
33	Kado Estate	2.20	4.75	2.55	255	4.64
34	Lokogoma	1.10	2.55	1.45	145	2.64
	<b>TOTAL</b>	<b>132.35</b>	<b>195.52</b>	<b>63.63</b>		

Source: Author's Fieldwork (2015)

**Topography of Abuja:** The results obtained from the Shuttle Radar Topographic Mission (SRTM) and Digital Elevation Model (DEM) shows the characteristics of the terrain of Abuja. Figure 3 shows the elevation map of Abuja Nigeria. It displays a range of elevation using colours which gives the impression of the topography of the area. The digital topographic map data employed in the study were points, lines and polygons and raster image. The vector topographic data are called Digital Line Graphs (DLGs) while the raster topographic data are called Digital Raster Graphics (DRGs). The shape-files adapted in this study contain the point, line, and polygon data found on a traditional paper topographic map, including the Public Land Survey System (township and range boundaries),

contour lines, rivers, lakes, roads, railroads, towns, land cover, survey control points, etc. The advantage of using DLGs in a GIS setting is that the vector features can be rendered at any scale, such that zooming in and out on the map does not change the quality of the topographic data representation. The disadvantages of the DLG format are that the importation of the data to a GIS requires more effort than importing a Digital Raster Graphics (DRG) raster image, and that the DLG data are quite large, sometimes slowing down the screen refresh rate of the GIS software. Figures 4, 5 and 6 respectively show the Digital Terrain Model (DTM), the 1960 contour map, and the 2015 contour, while Figure 7 is the final updated topographic map.

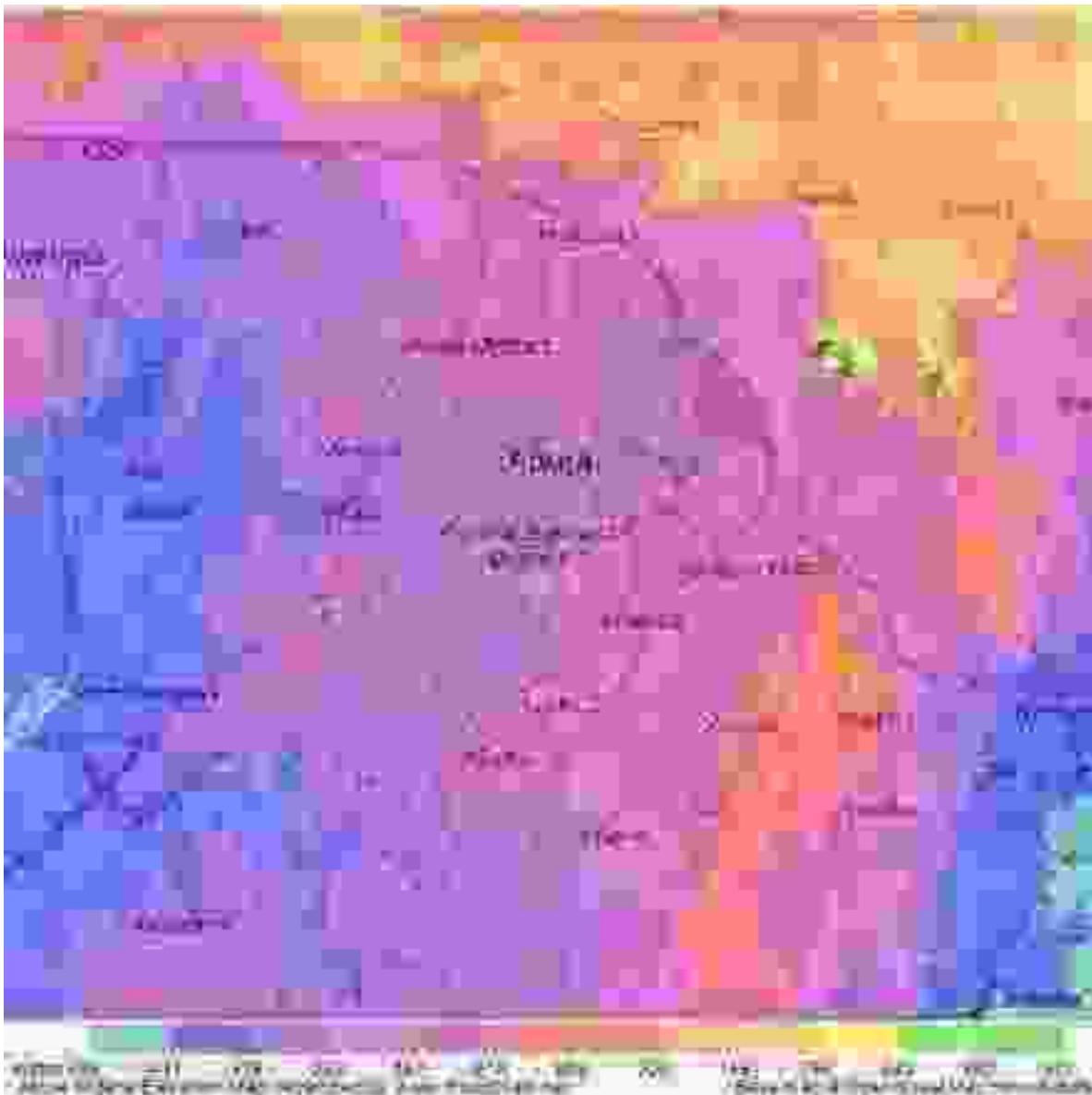


Figure 3: Shuttle Radar Topographic Mission of Abuja (srtm of Abuja)

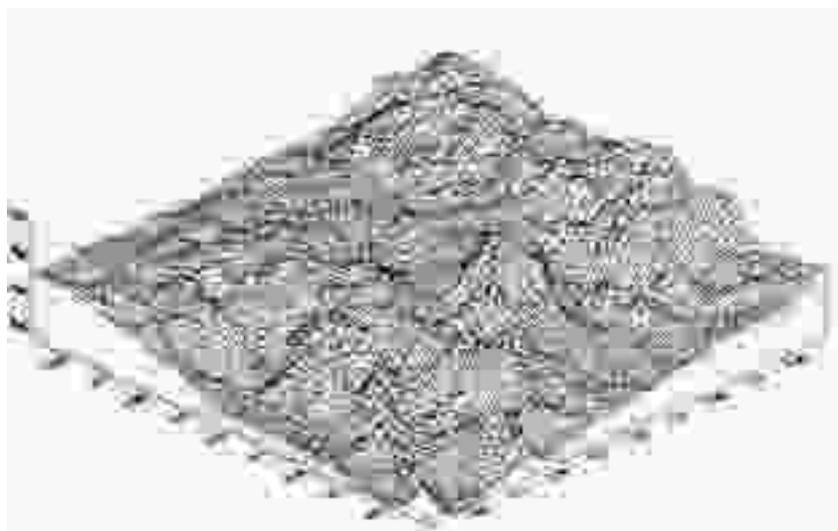


Figure 4: DTM of the Study Area.

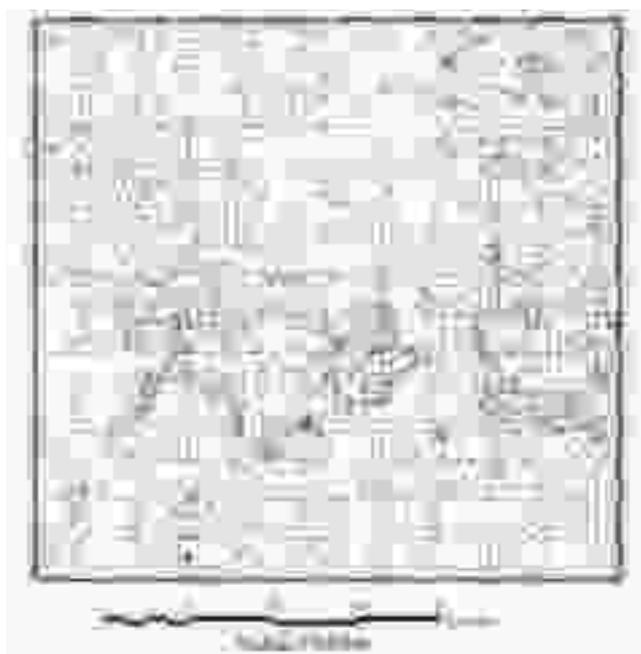


Figure 5: 1960 Contour map of the Study Area.

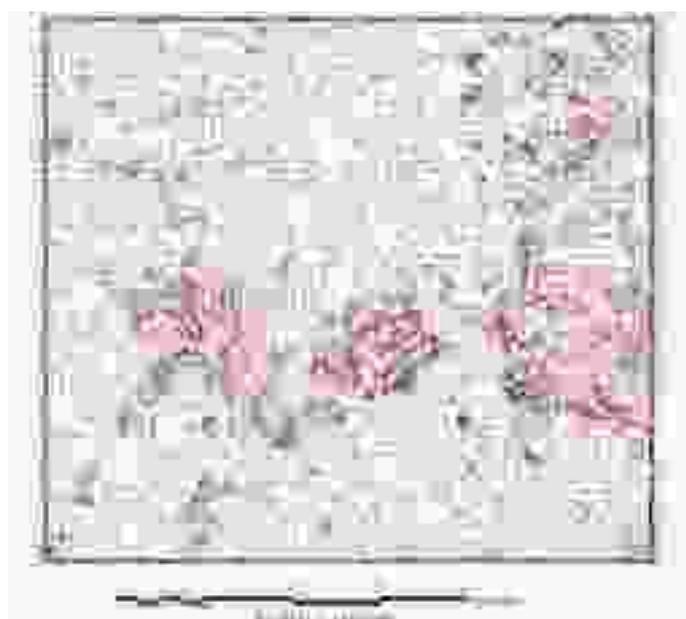


Figure 6: 2015 Contour of the Study Area  
Source: 2015 Landsat Imagery by 20m

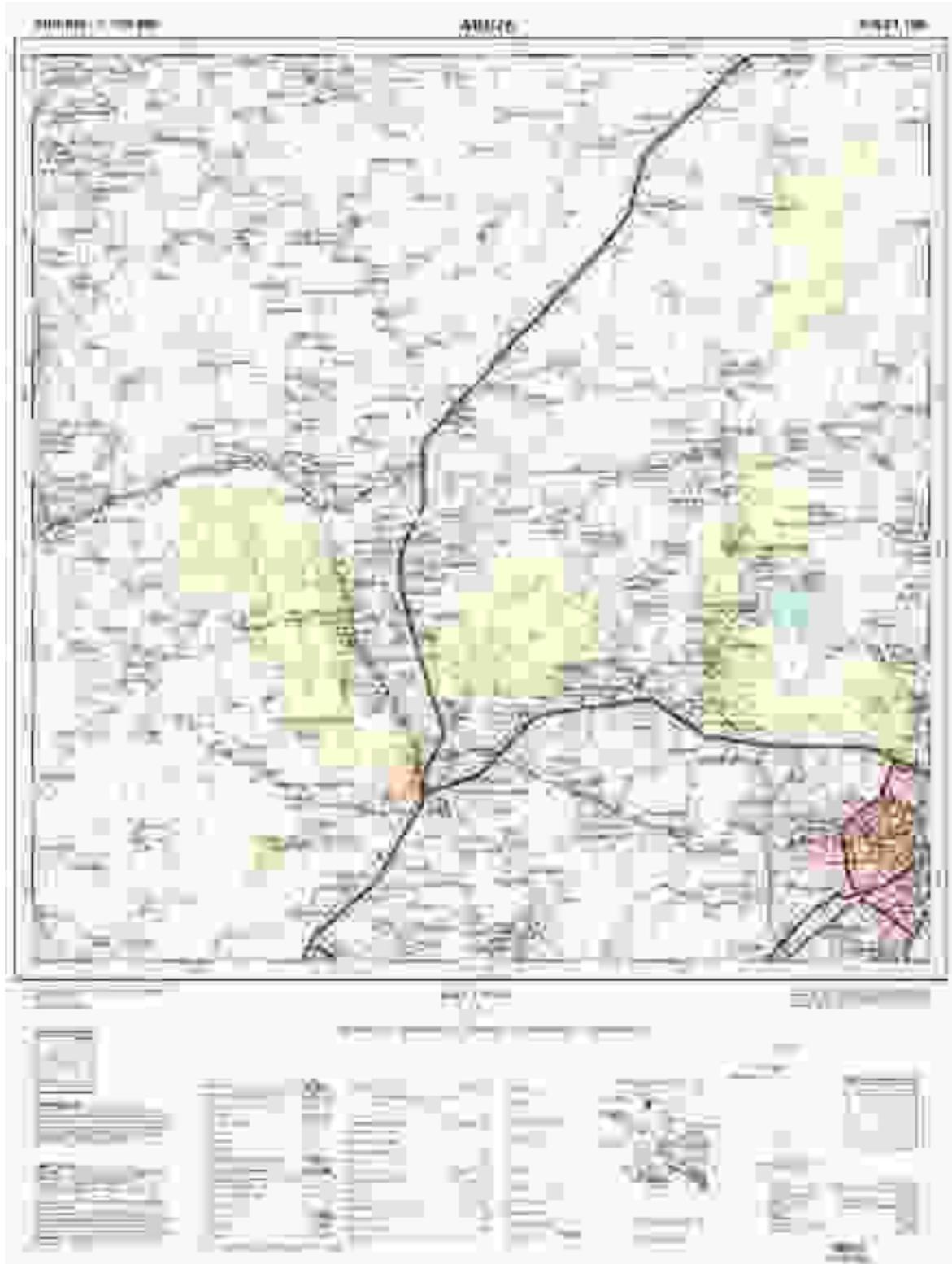


Figure 7: Updated Topographical Map of Abuja, Nigeria (1:100,000)

**Results of Statistical Analysis:** The null ( $H_0$ ) hypotheses which state that: the dynamic changes of topographic features at the scale of (1:100,000 maps) 1960-2015 are not significant was tested using the Analysis of Variance (ANOVA) statistical technique, The results shown in Tables 4 to 9 indicates that the rate of change for point, linear and area features between 1960 and 2015 were significant ( $P=0.05$ ).

Table 4: Result of ANOVA test for change s in point features from 1960-2015

Point Features	Sum of Squares	df	Mean Square	F	Sig.
Between Groups 1960-2015	5904.039	2	2952.020	6.772	.003
Within Groups	20922.941	48	435.895		
Total	26826.980	50			

Table 5: Post Hoc Tests with multiple Comparisons

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	-12.88235	7.16113	.078	-27.2808	1.5161
	3.00	-26.35294*	7.16113	.001	-40.7513	-11.9545
2.00	1.00	12.88235	7.16113	.078	-1.5161	27.2808
	3.00	-13.47059	7.16113	.066	-27.8690	.9278
3.00	1.00	26.35294*	7.16113	.001	11.9545	40.7513
	2.00	13.47059	7.16113	.066	-.9278	27.8690

\*. The mean difference is significant at the 0.05 level.

Table 6: Result of ANOVA test for change s in linear features from 1960-2015

LINEAR FEATURES	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups 1960-2015	38915.602	2	19457.801	3.419	.049
Within Groups	136594.159	24	5691.423		
Total	175509.761	26			

Table 7: Post Hoc Tests with multiple Comparison

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	45.97778	35.56347	.208	-27.4216	119.3772
	3.00	-47.01444	35.56347	.199	-120.4138	26.3850
2.00	1.00	-45.97778	35.56347	.208	-119.3772	27.4216
	3.00	-92.99222*	35.56347	.015	-166.3916	-19.5928
3.00	1.00	47.01444	35.56347	.199	-26.3850	120.4138
	2.00	92.99222*	35.56347	.015	19.5928	166.3916

\*. The mean difference is significant at the 0.05 level.

Table 8: Result of ANOVA test for change s in polygon features from 1960-2015

POLYGON FEATURES	Sum of Squares	df	Mean Square	F	Sig.
Between Groups 1960-2015	95.607	2	47.804	3.657	.029
Within Groups	1294.262	99	13.073		
Total	1389.869	101			

Table 9: Post Hoc Tests with multiple Comparisons

(I) time	(J) time	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	.34735	.87694	.693	-1.3927	2.0874
	3.00	-1.85794*	.87694	.037	-3.5980	-.1179
2.00	1.00	-.34735	.87694	.693	-2.0874	1.3927
	3.00	-2.20529*	.87694	.014	-3.9453	-.4653
3.00	1.00	1.85794*	.87694	.037	.1179	3.5980
	2.00	2.20529*	.87694	.014	.4653	3.9453

## Discussion

The study area was created as the Federal Capital Territory of Nigeria in 1976 and built all through the 1980s. However massive growth and changes in land use land cover of the area started when the Federal seat of government was officially moved from Lagos to Abuja in December, 1991. Thus, the changes observed in the study area are attributable to the fact that land was used to build new residential houses, housing estates and barracks, government institutions, company buildings and workshops, commercial houses, markets and other servicing facilities. Many people who came to settle and work in the various establishments also decided to buy land and develop for various purposes. In particular, the built up areas of Garki, Maitama, Asokoro and Wuse, increased tremendously in area coverage and transformed to a new large conurbation of Abuja city. Thus, more housing estates and residential houses, schools, hospitals, clinics, markets, filling stations, banks, hotels churches, and so on, have been built in the study area to meet the needs of the people. There was and still is massive development of roads infrastructure, communication and other services for the efficient functioning of the city,

In order to ascertain if the differences in the changes observed were significant or not an Analysis of variance (ANOVA) was carried out. The results show that significant differences exist particularly in point and polygon features in 55 years, whereas the difference in linear features though significant was less. This is due to the fact that during the period, the increases in lengths of linear features were small compared to point and polygon features. Again, it was observed that what really happened during the period was mainly the conversation of routes to higher grades, compared to the actual distance of new ones constructed. This study has equally revealed that there were some changes in the hydrographic features. For instance, there is

now Jabi Lake, Danko Lake and Usman Dan Lake along Dutse and Jabi village as well as a fresh “cut off” resulting from prolonged meandering along Abuja River which is sharply different from what it used to be in the 60s.

## Recommendations and Conclusion

Based on the findings of this study, the following recommendations are made: That a national policy to update exiting topographic maps at various scales on a regular basis be formulated and implemented (rather than making new ones) using fast and cost-effective methods as demonstrated in this study. The Federal Surveys Unit in the Office of the Surveyor General of the Federation should be adequately equipped with requisite tools and personnel to coordinate survey activities in the country.

The study reveals that there were great changes and development in the study area from 1960 to 2015 both in the point, linear and polygon features. For the point features a geometric change from 75 in 1960 to 608 in 2015 was observed particularly for schools. Similarly, linear features increased in lengths from 531.87 Km to 1009 Km while polygonal features as well increased from 136.35 Km<sup>2</sup> to 195.76 Km<sup>2</sup>. The changes were found be significant for the three categories of features. The study equally highlights the usefulness of satellite data (SPOT 2. 5, SPOT 5, and LANDSAT TM 30 m resolutions complimented with LANDSAT 8 ETM images) in map updating process when integrated with GPS and GIS technologies.

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## Evaluation of the Clinico-haematological Characteristics and Pattern of Presentation of Acute Myeloid Leukemia in Ilorin, North Central Nigeria

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### Abstract

Acute myeloid leukemia (AML) is a malignant haematological disorder of the myeloid lineage in the bone marrow resulting from clonal proliferation of haemopoietic progenitor cells with accumulation of myeloblasts in the blood, bone marrow and tissue infiltration. The aim of this retrospective study was to determine the pattern of presentation, clinical features and haematological parameters of AML patients diagnosed at the Haematology Department of U.I.T.H, Ilorin between 1<sup>st</sup> January 2008 and 31<sup>st</sup> December 2018. The study materials included Bone marrow registers from the department and case folders of all AML patients diagnosed within the study period. Relevant data including socio-demographic characteristics of patients, clinical features at presentation and laboratory tests results were extracted, documented and analyzed. Diagnosis of AML was made based on the findings of 20% blasts in the bone marrow and/or peripheral blood and classified using FAB classification criteria. There were forty-six patients and their median age at diagnosis was  $20.6 \pm 15.9$  years. The highest prevalence of the disease was found in the 11 – 20 years age group. The most common presenting symptoms were fever (91.3%), pallor (84.8%), bleeding diathesis (52.2%), and body weakness (45.7%). The mean  $\pm$  SD values of haematological parameters in the patients were – PCV ( $19.9 \pm 5.8\%$ ), Hb conc. ( $6.6 \pm 1.9$  g/dL), Total WBC ( $48.1 \pm 54.8 \times 10^9/L$ ) and Platelet Count ( $39.6 \pm 24.0 \times 10^9/L$ ). The commonest subtype of AML in our study was M4 which was seen in 26 (56.5%) patients, followed by M5 observed in 10 (21.7%) patients. In resource-limited settings such as ours, the diagnosis and monitoring of patients with AML still rely on the clinical and laboratory features of the disease to a large extent, hence the need for Haemato-oncologists and Physicians to be conversant with these features.

**Keywords:** Acute myeloid leukemia, clinical features, haematological, parameters, Ilorin

### Introduction

Acute leukemias (AL) are a heterogenous group of haematological neoplasms of the haemopoietic progenitor cells of the bone marrow which are characterized by excessive abnormal proliferation and accumulation of malignant, immature white blood cells in the bone marrow, peripheral blood and various tissues<sup>1</sup>.

Acute leukemias are divided into two main morphological types – Acute myeloid leukemia (AML) and Acute lymphoblastic leukemia (ALL) based on the type of white blood cells involved. They are clonal neoplasms which are

induced by genetic damage or mutation in haemopoietic progenitor cells from environmental agents such as chemicals, ionizing radiation or viral agents and are often associated with fundamental genetic and molecular abnormalities<sup>2</sup>.

Acute myeloid leukemia is a malignant haematological disorder which results from clonal proliferation of myeloid precursors in the bone marrow with excessive abnormal accumulation of immature white blood cells (myeloblasts) in blood, bone marrow, various organs and tissues<sup>3</sup>.

The most common clinical features which are observed in patients with AML at presentation are mainly due to the excessive accumulation of the myeloblasts in the bone marrow with suppression of haemopoietic activities thereby resulting in bone marrow failure and paucity of

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matured red blood cells and platelets in circulation, functional neutropenia, infiltration of various tissues and organs by the leukemic cells; and the hypermetabolic state from increased cell turnover. These include fever, anaemia, infections, bleeding diathesis, body weakness, pallor, hepatomegaly, splenomegaly, lymphadenopathy and gum hypertrophy<sup>4</sup>. The pattern of clinical presentation is variable and depends to a large extent on the nature and extent of disease, sex and age of patients at presentation and presence of cytogenetic abnormalities at diagnosis.

Acute myeloid leukemia has a worldwide distribution and is known to occur at all ages and in both sexes but with a male preponderance. In the Western countries, AML accounts for about 30% of all leukemias in adults above 60 years of age, and is more common in males than females with a Male: Female ratio of 2.5:1<sup>1,5</sup>, but some other studies have reported higher prevalence in much younger age groups<sup>6,7</sup>. In Ibadan, Nigeria, the annual incidence of AML had been reported to be 1.9 per 10<sup>6</sup> per year<sup>8</sup>. Acute myeloid leukemia was also reported to be the commonest form of acute leukemias in Ethiopia, constituting 63.8% acute leukemia cases studied<sup>9</sup>. A previous study in Ilorin, Nigeria, reported that Acute myeloid leukemia constituted 12.7% of all cases of haematological malignancies, and 57.5% of acute leukemias<sup>2</sup> and also, in India, Ramprasanth et al<sup>3</sup> reported AML in 55% of patients with leukemias in their study.

Diagnosis of AML is often made based on morphology, cytochemistry, cytogenetics and immunophenotyping while classification is made using FAB or WHO Working Party criteria<sup>10, 11</sup>. In many centres in Nigeria, and other resource limited settings, cytogenetics and molecular methods of diagnosis are not readily available, or the high costs make them unaffordable to majority of patients, so diagnosis of Acute myeloid leukemia is still made to a large extent based on the clinical features at presentation and routine full blood counts and bone marrow examinations.

It is therefore imperative for haematologists and other clinicians in our centres within Nigeria and in other resource limited settings to be conversant with the clinical features and haematological profile of the disease which are still being commonly used in the diagnosis and management of patients with Acute myeloid leukemia.

The aim of this study, therefore, is to describe the pattern of presentation and the clinical and laboratory features of patients with diagnosis of Acute myeloid leukemia at the University of Ilorin Teaching Hospital, Ilorin, north central

Nigeria, and compare our findings with reports from other centres within and outside Nigeria.

## Materials and Methods

This study was a retrospective review of all cases with diagnosis of AML which were seen and managed at the Department of Haematology and Blood Transfusion, University of Ilorin Teaching Hospital (UIITH), Ilorin between 1<sup>st</sup> January 2008 and 31<sup>st</sup> December 2018 inclusive. The UIITH is a 650 bedded tertiary health institution located in Ilorin, North central geo-political zone of Nigeria. It serves as a referral center for neighboring states of Oyo, Osun, Ekiti, Kogi and Niger states of Nigeria. Ilorin, the capital city of Kwara State, Nigeria, is located on the latitude 8.5<sup>o</sup> North and longitude 4.55<sup>o</sup> East with a total population of 908,490 and an annual growth rate of 2.3%<sup>12</sup>.

The Haematology department of U.I.T.H is involved in the investigations, clinical evaluation and management of blood and blood related disorders. It also carries out laboratory services, interpretation of laboratory test results and receives consultations from other clinical departments of the hospital.

The materials used for this study were data obtained from patient's case folders. The case folders of all the patients that were included in our study were retrieved from the Medical Records department of the hospital, and relevant information extracted from the case notes included the demographic characteristics of patients, clinical features at presentation, laboratory investigation results which include peripheral blood film examination result, bone marrow aspiration reports, full blood count results and the FAB classification subtypes of the Acute myeloid leukemia and treatment given were also documented.

The diagnosis of AML in the patients was made based on the clinical and laboratory features at presentation and classification into the various subtypes was done using the FAB Classification method<sup>10</sup> and final diagnosis was arrived at by consensus among the Consultants and Senior Residents in the department.

The data generated from the above sources were entered into Excel Sheet and analyzed using the Statistical Package for the Social Sciences (SSPS) version 21 (IBM Corporation, Armonk, NY, USA) and results were presented in the form of frequency tables.

## Results

A total of 46 patients were diagnosed and managed for AML at the center during the study period. There were 24 males and 22 females giving a male: female (M:F) ratio of 1.1:1.

The median age of the patients at diagnosis was  $20.6 \pm 15.9$  years (range = 16 months – 60 years), and the highest prevalence of the disease was found in the 11 – 20 years age group (n = 20, 43.5%), followed by 0 – 10 year age group (n = 13, 28.3%). There were 4 (8.7%) patients in the 51 – 60 years age group. Table 1 shows the age and sex distribution of AML patients in our study.

The most common presenting symptoms were fever (n=, 91.3%), pallor(n=, 84.8%), bleeding diathesis (n=, 52.2%), and body weakness(n=, 45.7%). The most common clinical signs included gum hypertrophy(n=, 30.4%), lymphadenopathy (n=, 23.9%), splenomegaly (n=, 13%) and hepatomegaly (n=, 6.5%). Table 2.

The FAB classification method was used to characterize the patients into the different subtypes of AML, and the commonest subtype of AML in our study was M4 (Acute myelomonocytic leukemia) which was seen in 26 (56.5%) patients, followed by M5 (Acute monocytic leukemia) observed in 10 (21.7%) patients. The other FAB subtypes seen were M1 (n =4, 8.7%), M2 (n = 4, 8.7%) and M3 (n = 2, 4.4%). There were no cases of M0, M6 and M7 recorded in this study. Table 3.

The mean±SD values of haematological parameters in the AML patients were PCV ( $19.9 \pm 5.8\%$ ), Hb conc. ( $6.6 \pm 1.9$  g/dL), Total WBC ( $48.1 \pm 54.8 \times 10^9/L$ ) and Platelet Count ( $39.6 \pm 24.0 \times 10^9/L$ ). The means±SD of percentage of myeloblasts (% blasts) in peripheral blood and bone marrow films were  $38.1 \pm 9.3\%$  and  $43.5 \pm 15.6\%$  respectively. The diagnosis of AML in our patients was made when 20% myeloblasts were found in both the peripheral blood and bone marrow smears examination, in addition to the morphological characteristics of the myeloblasts. The presence of thrombocytopenia (low platelet count) was the commonest haematological finding in our patients at presentation (n = 44, 95.7%) followed by anaemia (haemoglobin concentration < 10 g/dL) in 39 (84.8%) patients and leucocytosis in 38 (82.6%) patients. Table 4 shows the haematological parameters of the AML patients at diagnosis.

Table 1: Age and Sex distribution of Patients with Acute Myeloid leukemia in Ilorin

Age(Years)	Sex		Total number of patients (%)
	Male	Female	
0 – 10	7	6	13 (28.3)
11 – 20	9	11	20 (43.5)
21 – 30	1	1	2 (4.3)
31 – 40	3	2	5 (10.9)
41 – 50	2	0	2 (4.3)
51 – 60	2	2	4 (8.7)
<b>Total</b>	<b>24</b>	<b>22</b>	<b>46 (100)</b>

Table 2: Frequency (%) distribution of common Clinical features of AML at presentation.

Clinical Features	Number of patients (n)	Percentage (%)
Fever	42	91.3
Pallor	39	84.8
Bleeding diathesis	24	52.2
Body weakness	21	45.7
Bone /Joint Pain	11	23.9
Abdominal pain/swelling	6	13.0
Cough/Dyspnoea	6	13.0
Leg swelling	4	8.7
Weight loss	4	8.7
Jaundice	3	6.5
Gum hypertrophy	14	30.4
Lymphadenopathy	11	23.9
Splenomegaly	6	13.0
Hepatomegaly	3	6.5

Table 3: FAB Classification and frequency of AML subtypes among patients in UIITH.

FAB Subtype of AML	Number of patients (n)	Percentage (%)
M0 (AML undifferentiated)	0	0
M1 (AML differentiated, no maturation)	4	8.7
M2 (AML with maturation)	4	8.7
M3 (Acute promyelocytic leukemia)	2	4.4
M4 (Acute myelomonocytic leukemia)	26	56.5
M5 (Acute monocytic leukemia)	10	21.7
M6 (Erythroleukemia)	0	0
M7 (Acute megakaryoblastic leukemia)	0	0
<b>Total</b>	<b>46</b>	<b>100</b>

Table 4: Haematological parameters of AML patients at Diagnosis in UITH.

Parameter	Mean	SD	Range
PCV (%)	19.9	5.8	8 – 34
Haemoglobin concentration (g/dL)	6.6	1.9	2.6 – 10.5
Total White Blood Cell Count (x 10 <sup>9</sup> /L)	48.1	54.8	2.5 – 180.6
% Blast in peripheral blood Smear	38.1	9.3	19.2 – 52.5
% Blast in bone marrow Smear	43.5	15.6	21.6 – 58.7
Platelet Count (x 10 <sup>9</sup> /L)	39.6	24.0	10 – 122.0

## Discussion

Acute myeloid leukemia is a heterogenous malignant haematological disorder which results from clonal proliferation of myeloid precursors in the bone marrow with excessive abnormal accumulation of immature white blood cells (myeloblasts) in blood, bone marrow and tissue infiltration. The clinical features which are observed in patients with AML at presentation are mainly due to the suppression of haemopoietic activities in the bone marrow resulting in bone marrow failure and paucity of mature red blood cells and platelets in circulation, and infiltration of various tissues and organs by the leukemic cells<sup>1,3</sup>.

Acute myeloid leukemia affects all ages and is found in both sexes but incidence varies in different populations all over the world. There is a male preponderance in the incidence of AML; and though the disease can occur at any age, it has been reported to be more common in the elderly above 60 years of age in the Western countries<sup>5</sup>.

In the present study, AML was found to have the highest prevalence in children and adolescents (0 – 10 and 11 – 20 years age groups) constituting 71.8% of the patients. Similar findings were reported in Ibadan, Nigeria where it was found that the mean age of their AML patients to be 21.4 years, and 56% of their patients were in the 0 – 20 years age bracket. Also, Ramprasanth et al<sup>3</sup> in India reported AML to be most prevalent in the 15 – 30 years age group in their study. However, our finding was at variance with the study of Khan which found the highest prevalence of AML in the 60 – 67 years age group<sup>1</sup>.

The incidence of haematological malignancies, AML inclusive, is said to be increasing worldwide, and this has been associated with geographical, socio-economic and genetic factors<sup>13</sup>. Given the marked disparity in the physical and social environment between the developed and developing countries, and the increased life expectancy above 70 years in the Western countries, this may possibly account for the higher age at presentation found in studies from the Western countries compared to the much lower age found at presentation in this study<sup>14,15</sup>.

In our study, a slight male preponderance was observed, the M:F ratio being 1.1:1. This finding was in agreement with M:F ratio reported in similar studies by Arber et al (1.05:1)<sup>16</sup>, Harani et al (1.15:1)<sup>17</sup> and Appelbaum et al (1.2:1)<sup>18</sup> but at variance with those reported by Olaniyi et al (2.1:1)<sup>6</sup>, Oyesakin et al (1.5:1)<sup>7</sup> and Ramprasanth et al (3:1)<sup>3</sup>.

The most common clinical features at presentation in this study were fever (91.3%), pallor (84.8%), bleeding disorders such as petechial and purpuric rashes, subconjunctival haemorrhage, gum bleeding and menorrhagia (52.2%) and body weakness (45.7%). This finding was similar to the reports by Ramprasanth et al, Preethi CR and Gosh et al<sup>3,13,19</sup>. Gum hypertrophy, as a result of infiltration of gum by the myeloblasts was documented in 14 (30.4%) patients in our study. Gingival hypertrophy is known to occur more commonly with Monocytic leukemias<sup>20</sup> and this finding was found to be consistent with the higher proportion of monocytic subtypes of AML (M4 and M5) recorded in our study. Similar finding was reported in the study by Preethi CR which found gum hypertrophy in 27.2% of patients with M4 and 75% of patients with M5 subtypes<sup>13</sup>, but differs from the report by Khan MI which found gum hypertrophy in only 5% of patients with M4<sup>1</sup>.

Also, organ enlargements due to infiltration by the leukemic blasts was observed as lymphadenopathy, splenomegaly and hepatomegaly in 29.3%, 13% and 6.5% of patients respectively. This finding was similar to the report of Khan MI but differs from the studies of Preethi CR and Mathur et al where higher percentage of hepatomegaly and splenomegaly at presentation was reported in their patients<sup>1,13,21</sup>.

Anaemia and thrombocytopenia are common features in AML, and in the present study, the mean haemoglobin concentration was 6.6 g/dL while the mean platelet count was 39.6 x10<sup>9</sup>/L. These changes in the haematological parameters of AML patients are attributable to the suppression of erythroid and megakaryocytic precursors by the leukemic blasts in the bone marrow resulting in paucity of mature red blood cells and platelets in

circulation<sup>1</sup>. The total WBC count was significantly increased (mean =  $48.1 \times 10^9/L$ ), while the mean blast percentage in the peripheral blood (38.1%) and bone marrow (43.5%) smears were equally elevated. In a normal bone marrow, the proportion of blasts to other nucleated marrow cells is less than 5%. But with the uncontrolled proliferation of the malignant white cell precursors in the bone marrow, the immature white cells accumulate in the blood and marrow giving rise to leucocytosis and increased blast count. Similar pattern of changes in the haematological parameters had been reported previously by several authors<sup>1,5,7,13</sup>.

The FAB classification method is still being used by haematologists in many centres for diagnosis and classification of AML subtypes for prognostic purposes because it is readily available, quick and cost effective when compared with the WHO classification method which requires cytogenetics and molecular studies which may not be readily available in resource-limited settings. AML M4 was the commonest subtype seen in our patients (n = 26, 56.5%), followed by M5 subtype (n = 10, 21.7%). AML M1 and M2 constituted 8.7% each while M3 was seen in 2 (4.4%) patients. There were no patients with M0, M6 and M7 subtypes in our study. This finding is at variance with some previous studies which reported highest prevalence of M2 subtypes<sup>1,13</sup> and M1<sup>22</sup>. The different subtypes of AML are associated with different prognosis and it is of utmost importance to determine the correct FAB subtype at diagnosis. While AML M0, M1, M6 and M7 are associated with poor prognosis, the FAB subtypes M2, M3 and M4 have good prognostic value<sup>1,21</sup>.

## Conclusion

In the index study, the diagnosis of AML was made based on the clinical presentation and laboratory features of the disease. There were no facilities for cytogenetics or molecular diagnosis. Since many centres in Nigeria and other resource limited countries still rely to a large extent on the clinical features and routine haematological tests for diagnosis, treatment and follow-up of patients with AML, it is imperative for Haemato-oncologists and other clinicians to be conversant with these clinical features and laboratory investigations for prompt referral, diagnosis and management of patients with the disease in our environment.

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## Determination of Haemoglobin Concentration of Prospective Voluntary Blood Donors using Digital Haemoglobinometer in North Central Nigeria

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### Abstract

Haemoglobin estimation is one of the most important criteria in donor selection so as to safeguard the health of donors. To achieve this, reliable and cost-effective methods should be employed during blood donation drive. The aim of this study was to determine the haemoglobin concentration of voluntary blood donors using digital haemoglobinometer.

This study was a prospective, community based conducted in five tertiary institutions in Kwara and Kogi States. Blood samples were taken from consecutive male and female donors within the age of 15-63 years following blood donation campaign. Assessment of haemoglobin concentration was done using Diaspect haemoglobinometer.

A total of 905 students and staff of five tertiary institutions participated in this study. The mean age of the respondents was 21.98±5.17 years and 96.3% were below 30 years of age. The mean, median, and standard deviation of haemoglobin level were 13.22, 13.20, and 1.62 g/dl respectively. Using the WHO haemoglobin cut-off value of 12.5g/dl for donor selection, about 64.1% of the prospective donor had haemoglobin value of greater. There was a statistically significant difference between haemoglobin level of male and female donors ( $p=0.001$ ).

This study revealed that 64% of blood donors had haemoglobin concentration greater than 12.5g/dl and were fit for blood donation. Students of tertiary institutions could therefore be encouraged for regular blood donation to meet WHO vision 2020 towards attaining 100% voluntary non-remunerated blood donors.

**Keywords:** Haemoglobin Concentration Voluntary blood donor Nigeria

### Introduction

Blood donation is relatively a safe procedure when stringent measures are put in place in donor selection. Of all the criteria in donor selection, the most crucial and significant is the level of haemoglobin of the prospective donors. This is because the donation should not cause harm to the donor and the recipient of such blood should benefit maximally from the blood transfusion.<sup>1</sup> The primary purpose of haemoglobin screening is donor protection so that such an individual does not become anaemic thereby jeopardizing the health and the second purpose is to ensure the patient receives a minimum infused haemoglobin dose per red blood cell transfusion.<sup>2</sup>

Various methods of haemoglobin estimations are available depending on the setting and how buoyant institutions are. The methods vary from simple paper scale reading especially in rural setting to a more advanced method of Photometry. Each of these methods has its own advantages and limitations.<sup>3,4</sup> In most developing countries of the world, Nigeria inclusive, Copper Sulphate specific gravity is the traditional method used for donor screening.<sup>3</sup> The solution is prepared and specific gravity of 1.053 and 1.055 are set to determine haemoglobin concentration of 12.5g/dl and 13.5g/dl for female and male respectively.<sup>4</sup> Despite its wide applicability, it is faced with a lot of false positive and false negative results and does not give quantitative result of haemoglobin as compared with digital haemoglobinometer.<sup>5</sup>

Common sources of error in its usage include incorporation of air bubbles and the use of an inadequate height for

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dropping the blood. In some circumstances, donors with high plasma protein or high white cell count could be accepted due to false positive result whereas in some situation it could result in unnecessary donor rejection or deferral with attendant consequences of serious blood shortage.<sup>5</sup> Proficiency testing methodology for this method is also not well established. In most setting in developing world, majority of blood donations are less safe because they are gotten from family replacement and commercial donors who donate blood too frequently for monetary gain and are thus prone to anaemia.<sup>6</sup> According to the Indian Drugs and cosmetics Act, 1940, for blood donation the minimum acceptable haemoglobin is 12.5g/dl or haematocrit of 38% for both male and females.<sup>7</sup> In the Canada and the United States the minimum value for donor Hb concentration is set at 12.5g/dl regardless of gender, age, race and ethnicity<sup>8</sup>, while in European countries the cut off is 12.5g/dl and 13.5g/dl for female and male respectively.<sup>9</sup> In view of higher false positive and false negative results of Copper Sulphate in determining donor fitness, a more quantitative methods will be most suitable to determine haemoglobin concentration and thereby prevent unnecessary donor rejection or acceptance. Although there is no consensus among blood banks about what is the best method, the International Committee for Standardization in Hematology proposes the measurement of hemoglobin by an automated technique using the cyanmethemoglobin method.<sup>10</sup>

The aim of this present study was to determine the quantitative haemoglobin concentration of prospective blood donors recruited during voluntary blood donation campaign in Kwara and Kogi States, North central geopolitical zone of Nigeria with newly acquired quantitative digital haemoglobinometer.

## Materials And Methods

This was a descriptive community-based study conducted in Kwara and Kogi States, North Central Nigeria between August 2016 and January, 2018. It involved blood donation campaign which was carried out in five tertiary institutions in the two states. Letters were written and feedback obtained from the various institutions and organizations informing them of blood donation campaign and blood donation exercise to be carried out in their schools. This was done some weeks before the donation day. Approval was also obtained from Ethical committee of University of Ilorin Teaching Hospital. After obtaining approval from those organizations and communities, a day was set aside to

create awareness prior to the day fixed for the blood donation exercise. Blood donor recruiters were employed in passing information to the audiences. Emphasis on the need to be a voluntary blood donor and the importance of having blood from voluntary non-remunerated donors as against blood from commercial or touts was stressed.

This awareness day was a day before the donation proper. Various concerns of prospective donors were attended to and most of them went home satisfied. On the day of the donation exercise, the phlebotomists, counselors, donor recruiters, donor retention officers, scientists, technician and other people concerned including doctors were on ground early to set the stage for the blood donation. The prospective blood donors comprised of adult males and females between 15-63 years living in the North-Central Geopolitical zone of the country.

A brief biodata and physical examination (Checking for pallor, jaundice, blood pressure, pulse, weight and height) were done for each prospective donor before 10ml of venous blood sample was taken following strict antiseptic procedure. The blood sample was used in analyzing haemoglobin level and the remaining sample used for other investigations. Haemoglobin levels were determined using portable Diaspect Haemoglobinometer product of DiaSpect Medical GmbH, Sailauf, Germany (EKF Diagnostics, GmbH, Barleben, Germany) in accordance with manufacturer's instruction to check for donor fitness. The haemoglobin concentration of 12.5g/dl and above was considered as adequate and termed as fit for blood donation for both male and female especially when other physical examinations were perfect. The prospective donors that were fit for donation were moved to the bleeding couch. Those found not fit especially in term of haemoglobin level, tattooing of skin, signs of needle pricks or marks or any sign of alcoholism were counseled by the counselors in our team.

## Data collection, vetting, auditing, entry and analysis

The various data instruments for the study were utilized. Research assistants and laboratory staff collected the data from the communities during administration of questionnaire and in the field during blood donation drive. The data generated from the study were entered into the computer. Similarly, data cleaning was done before analysis to detect possible errors during entry. The data was subjected to appropriate statistical analysis using IBM

SPSS version 20. Level of significance was set at  $p < 0.05$ . Results were illustrated with tables and charts.

## Results

A total of 905 students and staff of five tertiary institutions participated in this study. The mean age of the participants was  $21.98 \pm 5.17$  years (ranging from 15 to 63 years) and 96.3% of the respondents were below 30 years of age. There were more male respondents {541(59.8%)} than female {364(40.2%)} in this study. Most respondents were students of tertiary institutions (97.6%) and single (95%). Majority of the respondents were Muslim {634 (70%)} while 271(30%) were Christian. Yoruba-speaking respondents were the highest constituting 769 (85%) while Igbo/Edo was the least ethnic group in this study {18 (2%)}. Table 1. Only 17.2% of the prospective donors had donated voluntarily in the past while a greater percentage have not donated blood in the past before this particular blood donation campaign. Figure 1

The haemoglobin level of the participants followed normal Gaussian curve (Figure 2). The mean, median, and standard deviation were 13.22, 13.20, and 1.62 g/dl respectively (Range 8.1- 17.6g/dl). There was a statistically significant difference in the level of haemoglobin concentration among different age groups with those less than 20 years of age having the lowest haemoglobin concentration of  $12.73 \pm 1.64$ g/dl while age 40 years and above had the highest value of  $13.76 \pm 1.47$  g/dl ( $p$  value 0.001) Table 2. The mean haemoglobin level of the male donors was significantly higher than that of the female donors ( $14.15 \pm 1.24$ g/dl vs  $11.85 \pm 1.05$ g/dl;  $p=0.001$ ) Table 3. Using the World Health Organization haemoglobin cut-off value of 12.5g/dl for donor selection, about 35.9% of the prospective blood donor had haemoglobin concentration of less than 12.5g/dl and 64.1% had values greater than 12.5g/dl. Also noted in this study was a significantly higher number of male donors (92.0%) compared with female donors (23.3%) having haemoglobin concentration of  $>12.5$  ( $p=0.001$ ).

Table 1: Socio-demographic characteristics of voluntary blood donors during campaign N=905

Variables	Frequency	Percentage
<b>Age group</b>		
< 20	121	13.4
20 – 29	597	82.4
30 – 39	20	2.2
$\geq 40$	18	2.0
Range	15 – 63	
Mean $\pm$ SD	$21.98 \pm 5.17$	
<b>Gender</b>		
Male	541	59.8
Female	364	40.2
<b>Ethnic group</b>		
Yoruba	769	85.0
Hausa	24	2.7
Igbo	9	1.0
Nupe/ Igala/ Ebira	57	6.3
Others	18	2.0
Not stated	28	3.0
<b>Literacy level</b>		
Secondary	7	0.7
Tertiary	887	98.0
Quranic	6	1.0
None	5	0.3
<b>Occupation</b>		
Student	863	95.4
Lecturer	12	1.3
Teacher	10	1.1
Others	20	2.2
<b>Marital status</b>		
Married	38	4.1
Single	860	95.0
Widowed	7	0.9
<b>Religion</b>		
Islam	634	70.1
Christian	271	29.9
<b>Designation</b>		
Staff	42	4.6
Student	863	95.4

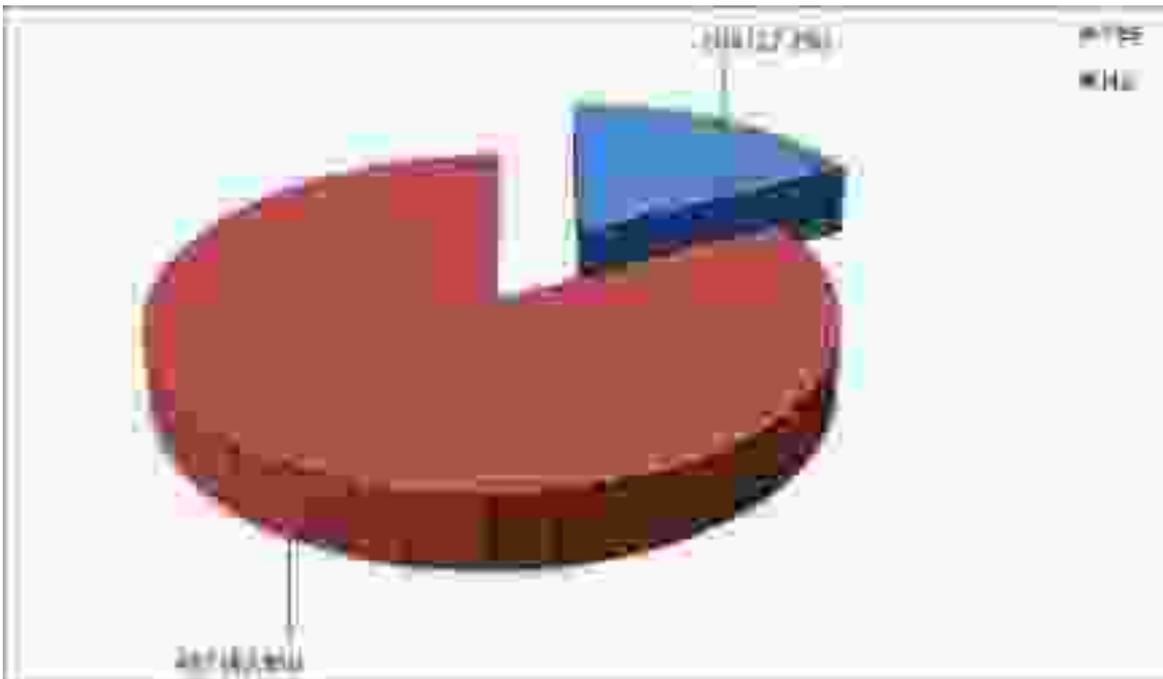


Figure 1: Ever donated blood  
 More than three quarters of the donors had never donated blood in the past before the blood donation campaign

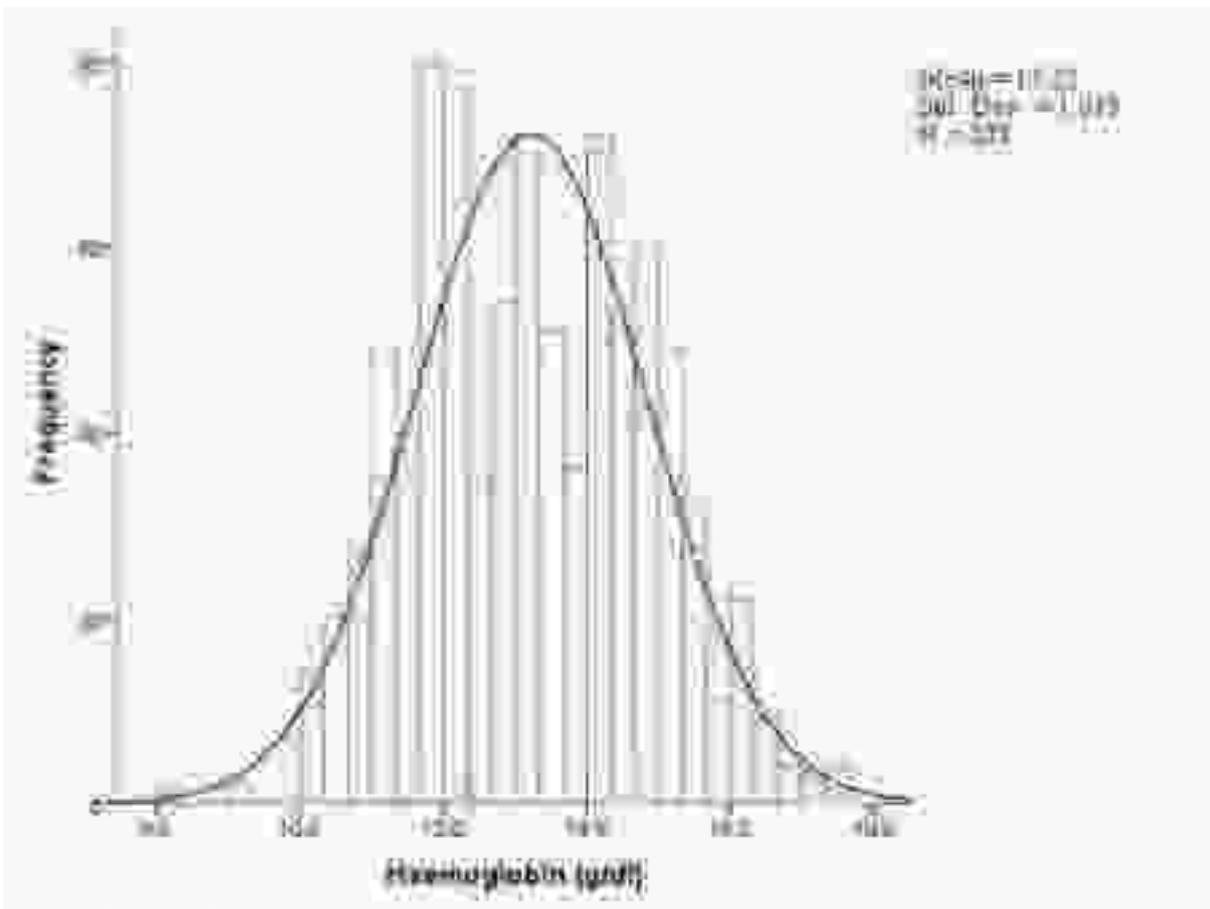


Figure 2: Distribution of mean haemoglobin concentration among blood donors

Table 2: Comparison of haemoglobin concentration of blood donors based on age range

Age (years)	N = 878 (%)	Haemoglobin (Mean ± SD)	F	p value
< 20	262 (29.8)	12.73 ± 1.64 <sup>a</sup>	12.446	<0.001*
20 – 29	580 (66.1)	13.41 ± 1.56 <sup>b</sup>		
30 – 39	18 (2.1)	13.73 ± 1.82 <sup>b</sup>		
≥40	18 (2.1)	13.76 ± 1.47 <sup>b</sup>		

F: ANOVA (Analysis of Variance); \*: p value < 0.05

NB: Mean values with different alphabets indicates significant difference using Least Significant Difference (LSD) post-hoc test.

Table 3: Comparison of haemoglobin concentration of donors based on gender

Haemoglobin	Gender			<sup>2</sup>	p value
	Male	Female	Total		
	n (%)	n (%)	N (100.0%)		
< 12.5 g/dl	42 (8.0)	273 (76.7)	315 (35.9)	433.454	<0.001*
> 12.5 g/dl	480 (92.0)	83 (23.3)	563 (64.1)		
Total	522 (100.0)	356 (100.0)	878 (100.0)		
Mean ± SD	14.15 ± 1.24	11.85 ± 1.05		28.691 <sup>t</sup>	<0.001*

<sup>2</sup>: Chi square test; t: Independent Samples T test; \*: p value <0.05

## Discussion

The World Health Organization (WHO) recommends that all countries should be self-sufficient in all blood products and that every blood donation should be voluntary, anonymous, and non-remunerated. Nigeria as a signatory to these resolutions has envisioned reaching 100% voluntary non- remunerated blood donation by the year 2020. This was a community-based study carried out in five tertiary institutions among students and staff in Kwara and Kogi States, North-central, Nigeria. The mean age of the blood donors was 21.98± 5.17 years and majority were between 20-29years (82.4%). This finding is similar to what was reported by Salaudeen et al <sup>13</sup> and Shittu et al <sup>14</sup> in Kwara State, and in other part of Nigeria <sup>15</sup> as well as some other West Africa countries like Ethiopia<sup>16</sup> and Sri Lanka.<sup>17</sup> This perhaps could be due to the increasing population of youth not only in Nigeria but Africa in general. It was also reported

that this age bracket constituted ~15% of the nation's population.<sup>18</sup>This was expected as most people within the age group are strong and healthy. The young population structure in Nigeria provides a window of opportunity for youths to serve as change agents in blood donation drive. The majority of respondents in this study were Muslims 634 (70.1%) while Christians constituted 29.9%, this could be due to the fact that Muslims are the majority in the geographic area of the study. Males constituted 59.8% of the donors and 40.2% were female. Surprisingly many females presented themselves for blood donation and showed enthusiasm and willingness to donate blood unlike in the hospital settings where majority of females are always turned down as being unfit for blood donation. This is also at variance with the study conducted by Shittu et al where a greater percentage of the donors were males (89.7%).<sup>14</sup> In previous studies outside Nigeria also noted that significant numbers of blood donors are males. In

Greece and Ethiopia 94% and 62% respectively of the donors were males<sup>19,20</sup>

The haemoglobin level of the participants followed normal Gaussian curve thus confirming the validity of defining the reference range as the mean  $\pm 2$  standard deviations. The mean, median, and standard deviation were 13.22, 13.20, and 1.62 g/dl respectively (Range 8.1- 17.6g/dl). There was a statistically significant difference in the level of haemoglobin concentration among different age groups with those less than 20 years of age having the lowest haemoglobin concentration of  $12.73 \pm 1.64$  while age 40 years and above had the highest value of  $13.76 \pm 1.47$  (p value 0.001). This could be due to the fact that those less than 20 years are actively growing and need more iron for their development. Using the World Health Organization haemoglobin cut-off value of 12.5g/dl for donor selection, 35.9% of the prospective blood donor in this present study had haemoglobin value of less than 12.5g/dl. This percentage is quite higher than what was reported in Libya where only 16.9% had haemoglobin concentration of less than the US cut-off value of 12.5 g/dl.<sup>21</sup> This finding emphasises the importance of including quantitative haemoglobin estimation as an integral part of the donor selection process. The DiaSpect Hemoglobin T [DiaSpect Medical GmbH, Sailauf, Germany] which uses reagent-free cuvettes, and measure the absorbance of whole blood photometrically at the 506 nm wavelength was used in this study and it was found to be easy to operate and give a reliable result. It makes use of reagent-free polystyrene cuvettes that is not affected by the wide range of temperatures (10°C–40°C) and humidity. This haemoglobinometer do not require special storage conditions and thus suitable for use in outdoor blood donation camps in tropical counties.<sup>22</sup> In addition, these cuvettes are cheaper and provide results more rapidly (<10 seconds).

Also noted in this study was a significant higher number of female prospective donors (76.7%) compared with male donors(8%) having haemoglobin value of <12.5g/dl (p=0.001) The mean haemoglobin level of the male donors was also significantly higher than that of the female donors ( $14.15 \pm 1.24$ g/dl vs  $11.85 \pm 1.05$ g/dl; p=0.001) The mean haemoglobin concentration of 14.15g/dl among males in this study is similar to what was reported in Ghana, South Africa, Uganda and Libya but slightly lower than what was reported among males in Western Countries.<sup>23,24,21</sup> The dominance of males in this study could be due to the low hemoglobin level and the monthly physiologic menstrual

cycle in females which make them unfit for blood donation. Greater percentage of females (76.7%) have haemoglobin less than 12.5g/dl so chances of female to donate is quiet less compared with the male counterparts. In a similar study carried out among blood donors in Brazil about 11.3% of female compared with 4.2% male donors were unfit to donate blood as a result of low haemoglobin level.<sup>25</sup>The study however identified women as being more predisposed to anaemia due to menstruation and pregnancy which is intensified by blood donations and that such a level of unsuitability observed in most studies would compromise blood supply and affect meeting the WHO Vision 2020.

Majority of blood donors were single 95.0% and students of tertiary institutions. The reason could be due to the fact that students constituted majority 95.4% of volunteered blood donors in this study compared with staff of each institution and the fact that some adults can have chronic health conditions that prevent them from blood donation. In Israel research findings indicates that married native Israeli men, aged 26–45 years, who are highly educated and are familiar with someone who needs a blood donation, are more likely to donate blood than the rest of the population.<sup>26</sup> This study revealed that only 17.2% had donated voluntarily in the past this is quite unacceptably low especially in meeting the vision 2020 of each country to be self-sufficient and to attain 100% voluntary blood donor. There is need to create more awareness about blood donation among the populace. More than half of the population is fit however greater percentage do not donate blood as a result of myths and misconceptions about blood donation.

## Conclusion

This study revealed that more than half of blood donors had haemoglobin concentration greater than 12.5g/dl and were fit for blood donation with males and students of tertiary institutions constituting the majority. Students of tertiary institutions could therefore be encouraged for regular blood donation in order to meet World Health Organization vision 2020 toward attaining 100% voluntary non-remunerated blood donors.

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## Myths and Reality of Febrile Convulsion Among Care Givers in a Sub Urban Community of Kulende Area Ilorin, Kwara State, Nigeria

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### Abstract

Febrile convulsion is seizures disorder that occur between the ages of 6 and 60 months with a temperature of 38°C (100.4°F) or higher, that are not as a result of central nervous system infection or any metabolic imbalance and occur in the absence of a history of prior febrile seizures. The study accessed the care givers myth and reality of the causes and management of febrile convulsion. It was a descriptive cross-sectional study conducted among randomly selected 195 care givers in Kulende community. Large number (53.8%) of the care givers had a good reality of the meaning of febrile convulsion. With only 15.4% relate fever as the cause of febrile convulsion, while majority (71.8%) of the care givers attributed spiritual attack to be the cause of febrile convulsion. Consequently, (20.5%) of the care givers used native ointment and pepper while 41% used native concoction and 12.8% of the care givers consult oracles. The study therefore, recommends that the care givers in the community should be given health education on prevention and management of febrile convulsion.

**Key words:** Febrile Convulsion; Myth; Reality; Ilorin; Nigeria

### Introduction

Febrile convulsion (FC), or febrile seizure, is broadly defined as 'a seizure accompanied by fever, without central nervous system infection, occurring in infants and children between six months and five years'<sup>1</sup>. Onset after the age of 7 years is rare<sup>2</sup>. It is important to note that this definition excludes fever which occurs in conjunction with neurological disease such as meningitis and encephalitis.<sup>3</sup> Febrile convulsions occur in 2%-5% of all children, making them the most common convulsive event in children less than five years old.<sup>4</sup> Incidence and prevalence of FC is thought to vary depending on geographic, socioeconomic variations, and genetic disposition. They can be classified as simple which mean a single generalised seizure which lasts less than 15 minutes

or complex that is a seizure lasting longer than 15-20 minutes with focal features. The complex febrile convulsion often recurs within a 24-hour period. The origin of FCs is associated with viral infections in approximately 80% of cases; it may be associated with various causes such as upper respiratory tract infection or pharyngitis, acute otitis media, lower respiratory tract infection, urinary tract infection, acute gastroenteritis, roseola infantum and non-infectious diseases<sup>5</sup>. Convulsions appearing with 2 weeks of vaccination exhibit similar characteristics to FC, and frequently develop in association with high fever after diphtheria-tetanus-pertussis vaccination and measles vaccination<sup>6</sup>. Epidemiology of the disease has shown that between 2 and 4% of children will have a febrile convulsion and about 4% of cases arise before 6 months old, 90% between 6 months and 3 years and the other 6% over three years thus, between 2 and 5% of children experience at least one febrile convulsion before the age of 5 years<sup>7</sup>. Febrile convulsions can be extremely frightening, emotionally traumatic and anxiety provoking when witnessed by parents for fear of death<sup>8</sup>. This coupled with ignorance, is often responsible for the various forms of intervention

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offered by parents and caretakers when a child has an episode of convulsions. These interventions include the administration of cow's urine concoction and application of substances to the eyes and mouth such as palm oil, kerosene, eucalyptus oil<sup>9</sup> etc. Some make incisions on the body while others inflict burns injury on the child in an effort to rouse the unconscious child. In an earlier study about three decades ago, Familusi and Sinnette reported a high number of parents (52%) administering native concoction as home treatment for febrile seizures<sup>10</sup>. Majority of parents have gross misconceptions about febrile convulsions and hence take inappropriate or even harmful actions in an attempt to control the convulsions.<sup>11</sup> It is believed that their social attitudes and behavior contribute immensely to the high morbidity and unfavorable prognosis of febrile seizures in the developing countries of the world.<sup>12</sup> It has been reported that parents often have several misconceptions about febrile seizures.<sup>13</sup> It has also been suggested that the socioeconomic status of the parents/caregivers of children with febrile seizures and the maternal level of education affect the interventions given at home and this could in turn affect the outcome of febrile seizures. Prior awareness of febrile seizures and the appropriate measures to be taken in a convulsing child were found to be significantly higher in the upper and middle social class. However, febrile convulsions carry a good prognosis around the world but, associated with a high morbidity and mortality in Nigeria due to the administration of various indigenous remedies before children are brought to hospital. This study therefore accessed myth and reality on knowledge, causes, and management of FC among the care givers in sub urban community of Kulende area of Ilorn east LGA, of Kwara State Nigeria.

**Methodology**

It was a descriptive cross-sectional study conducted among one hundred and ninety-five (195) care givers within the Kunlede community of Ilorin east local government of Kwara State Nigeria. Multi-stage sampling technique involving selection of the LGA by convince sampling method, then random sampling of a community from the list of wards and communities that exist within the local government were randomly selected. The PHC facilities within the randomly selected community were listed and selected. All the care givers that come for clinic were sampled and selected for the study. The pre-tested questionnaire was administered to eligible care givers. The items in the tool were structured to achieve the objectives of the study and answer the research questions raised in the study. The instrument used has four sections from (A, B, C & D). Section A contained items that were used to divulge information on the demographic variables of the

respondents while sections B,C and D contained items that were used to generate data on the respondent's knowledge of management of febrile convulsion, causes of febrile convulsion and management modalities of under 5 children. The items in the instrument were structured in close ended format. Before meeting the care givers, permission was obtained from the head of each PHC facilities within the community. The purpose of the study and its goals were explained to the mothers and their consent obtained before administering the instrument to the respondent care givers. The questionnaires were administered to the respondents by the researcher and a volunteer research assistance that was trained by the researcher for uniformity. Data collection lasted for four weeks. A total of 195 care givers participated in the study. All the administered questionnaires were sorted, collated and analyzed using SPSS software package. Statistical analysis was then carried out at p<0.05 level of significance

**Results**

Table 1: Socio-Demographic variables of the respondent n=195

Variable	Frequency(F)	Percentage (%)
<b>Age (Years)</b>		
Under 20	15	7.7
20-30	37	18.9
30-40	91	46.7
40 and above	52	26.7
<b>Marital Status</b>		
Single	14	7.2
Married	140	71.8
Divorced	23	11.8
Widowed	18	9.2
<b>Educational Level</b>		
None	12	6.2
Primary	63	32.3
Secondary	89	45.6
Tertiary	31	15.9
<b>Religion</b>		
Christianity	160	82.1
Islam	10	5.1
Traditional Religion	25	12.8

Table 2: Respondents knowledge and myths of febrile convulsion n=195

Variable	Frequency (F)	Percentage (%)
<b>Meaning of febrile convulsion</b>		
Shaking of hands and legs	20	10.3
Violent uncontrolled shaking	105	53.8
A vibration of body	20	10.3
A type of epilepsy	50	25.6
A mild loss of consciousness	0	0
<b>Ever seen a convulsion attack?</b>		
Yes	190	97.4
No	5	2.6
<b>If yes, what is the pattern?</b>		
Shaking of hand and feet	90	47.4
Generalized body shaking	100	52.6
Shaking of the right side only	0	0
Shaking of the left side only	0	0
<b>Will it endanger the child's future health?</b>		
Yes	95	48.7
No	100	51.3
<b>If yes, what will it result to?</b>		
Epilepsy	20	21.1
Brain damage	60	63.2
Retarded growth	15	15.7
Mental disorder	0	0

Table 3: Respondents understanding of the causes of febrile convulsion n=195

Variable	Frequency (F)	Percentage (%)
<b>Causes of febrile convulsion?</b>		
Fever	30	15.4
Poverty	20	10.3
Spiritual attack	140	71.8
Headache	5	2.6
<b>Does immunization cause febrile convulsion?</b>		
Yes	100	51.2
No	95	48.8
<b>Does infection cause febrile convulsion?</b>		
Yes	150	76.9
No	45	23.1
<b>Is febrile convulsion genetic?</b>		
Yes	150	76.9
No	45	23.1

Table 4: Respondents management modalities of febrile convulsion n=195

Variable	Frequency (F)	Percentage (%)
<b>What did you do at sight of convulsing child?</b>		
Scared	100	51.2
Did nothing	65	33.3
Refrain the child	10	5.1
Remove any object from the child	20	10.3
<b>What treatment will you give?</b>		
Remove the cloth	10	5.1
Bath the child with cold water	10	5.1
Rub pepper & hot ointment	40	20.5
Give native concoction to drink	80	41.0
Consult an oracle	25	12.8
Give ibuprofen and paracetamol	10	5.1
Take the child to the chemist	10	5.1
Rush to the hospital	10	5.1
<b>What do you think is the management modality for febrile convulsion?</b>		
Medical management	60	30.8
Nursing management	4	2.1
Home management	61	31.3
Spiritual management	70	35.9

Table 1 showed that 91 (46.7%) of participants were between 30-40 years of age, 52 (26.7%) are 40 years and above while 37 (18.9%) were 20-30 years of age only 15 (7.7%) were under 20 years respectively. By religion distributions, it showed that out of 195 participants, 160 (82.1%) were Christians, 10 (5.1%) were Muslims, traditional religion participants 25(12.8%).

Respondents educational level showed that majority had secondary education 89 (45.6%), 63 (32.3%) had primary education, those with tertiary education were 31 (15.9%) and only 12 (6.2%) had no form of education. On marital status, 14 (7.2%) of the respondents were single, 140 (71.8%) were married, 18 (9.2%) of them are widowed while 23 (11.8%) were divorced.

Table 2 revealed that Twenty 20 (10.3%) of the respondents defined febrile convulsion as shaking of hands and legs, while 105(53.8%) of the respondents defined it as violent uncontrolled contractions of muscle, 20 (10.3%) of the respondents defined it as a vibration, 50(25.6%) of the respondents defined it as a type of epilepsy and none of the respondents defined it as a mild loss of consciousness. However, 190 (97.4%) of the respondents observed a child having a convulsion attack while 5(2.6%) have not though

90(47.4%) of the respondents chose shaking of hand and feet as the pattern of seizure, 100 (52.6%) of the respondents chose generalized body shaking as the pattern of seizure while none of the respondents chose right side only and left side only as the pattern of seizure. Also 95(48.7%) of the respondents says febrile convulsion will endanger the child future health while 100(51.3%) says febrile convulsion will not endanger the child's future health. Only 20(21.1%) of the respondents says the effect of febrile convulsion on the future health of the child is epilepsy, 60(63.2%) of the respondents says is brain damage, 15(15.8%) of the respondents says is retarded growth and none of the respondent says is mental disorder. From Table 3, 30(15.4%) of the respondents chose fever as the cause of febrile convulsion, 20(10.3%) of the respondents chose poverty as the cause of febrile convulsion, 140(71.8%) of the respondents chose spiritual attack as the cause of febrile convulsion, while 5(2.6%) chose headache as the cause of febrile convulsion. 100(51.2%) of the respondent chose immunization to be a cause of febrile convulsion while 95 (48.7%) of the respondents says immunization is not a cause of febrile convulsion. Also, 45(23%) of the respondents chose infection to be a cause of febrile convulsion while 150(76.9%) of the respondents says infection is not a cause

of febrile convulsion and 150 (76.9%) of the respondents says febrile convulsion is genetic while 45(23%) says febrile convulsion is not genetic.

Table 4 shows that 100(51.2%) of the respondents were scared at the sight of the convulsing child, 65(33.3%) of the respondents did nothing, 10(5.1%) of the respondents refrained the child while 20(10.3%) of the respondents remove object around the child body. Also 10 (5.1%) of the respondents do remove the child clothing during convulsion, 10(5.1%) of the respondents washes the child with cold water, 40(20.5%) of the respondents rub pepper and other hot ointment on the child, 80(41.0%) of the respondents gives the child native concoction to drink, 25(12.8%) of the respondents consult an oracle 10(5.1%) of the respondents give the child ibuprofen or paracetamol, 10(5.1%) of the respondents take the child to the chemist while 10(5.1%) of the respondents rush the child to the hospital. The table also revealed that 60(30.8%) of the respondent thinks febrile convulsion management modality is medical management, 4(2.1%) of the respondents thinks is nursing management, 61(31.3%) of the respondents thinks is home management while 70(35.9%) of the respondents thinks febrile convulsion management modality is spiritual management.

## Discussion

Febrile convulsions (FC) are the most common cause of convulsion in the pediatric age group. They are reported in 2–5% of children.<sup>14-16</sup>. FCs are generally regarded as benign, although they also involve risks of recurrence and leading to afebrile convulsions, and are therefore of considerable importance. Findings from the study revealed that majority of mothers demonstrated good knowledge of febrile convulsion, this is similar to study from other centers that observed very high levels of knowledge (81.2%) which may not be unrelated to the better educational status of their respondents compared to the ones in our study<sup>17</sup>. However, very low knowledge (4%) was observed in a rural community of Northwest Nigeria<sup>18</sup> while study from Benin City, Nigeria observed low but higher proportions (25%,) of knowledge on febrile convulsion compared to the figure observed in our study<sup>19</sup>. The knowledge of FC was lower among mothers with a low socioeconomic and cultural level which emphasized that the main reasons was lack of information about FC and inadequate access to health services. Similarly, a higher knowledge of FC has been reported in developed countries compared to developing countries most especially in rural

sub urban communities like the study site<sup>20-23</sup>. Regarding the myth and beliefs of mothers on febrile convulsion in children under five years, the findings show that substantial number of mothers described febrile convulsion as a sickness in children which is normally caused by spiritual attack, headache and poverty with less than one-third of the respondents agreed that FC can be due to fever or post immunization injection. The findings of this study confirm a study by Anigilaje<sup>24</sup> who also found that Subjects attributed angry gods, evil spirit (49.0%), constipation (36.8%) and black blood to be causes of childhood convulsion. The gross misconceptions about febrile convulsions by mothers informed mothers' decision to take inappropriate or even harmful actions in an attempt to control the convulsions. In most African countries including Nigeria, the beliefs system of parents greatly influences their health seeking behaviour for sick children. This explains the reason why some of the mothers rub pepper and other hot ointment on the child with FC while some mothers give their children native concoction to drink, consult an oracle and few gave children with FC paracetamol or rush them to patent medicine shop. Additionally, the findings further point to the fact that some mothers gave various first aid treatment or interventions when their children had febrile convulsion at home. The actions mothers gave to children having seizures included bathing the child with cold water, use of Ibuprofen, or paracetamol. This peculiar finding confirms a study in Nigeria by Jarrett, al et. <sup>25</sup>, which showed that fifty-nine (40.1%) of the children received at least one form of intervention believed to be capable of aborting the seizure during the attack at home. It is believed that mothers' attitudes and behaviour contribute immensely to the high morbidity and unfavourable prognosis of febrile seizures in the developing countries of the world.<sup>25</sup> It is important that health care providers especially nurses understand potential parental misconceptions, anxieties and fears about fever and febrile seizures so that they may allay those fears effectively.

## Conclusion and Recommendation

Febrile convulsion in children under five years is a common illness. In this study it was found that mothers whose children have ever suffered from febrile convulsion even though, have adequate knowledge regarding the meaning of FC febrile convulsion, negative beliefs still persist amongst mothers who attribute the cause of febrile convulsion in children to spiritual attack. These beliefs of parents informed their decision regarding the type of remedy or treatment to be given to the child who has the febrile

convulsion. There is a need for parents and care givers to be educated about the causes and appropriate home care or management of febrile convulsion in children under five years is paramount to reduce under five mortality.

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## An Audit of Childhood Epilepsy in a Tertiary Hospital in Ilorin, North-Central Nigeria

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### Abstract

Childhood epilepsy needs committed care by the managing health care team as well as the patients' relatives in achieving a great outcome as it is of medical and social importance. Audit of the available care for such children is necessary to improve the institutional practice in this regard. Records of children aged 2 months to 14 years managed for epilepsy over two years were retrieved. Their socio-demographic characteristics, duration of epilepsy, periodicity, type of seizures, the frequency of its occurrence, level of control and EEG findings, where applicable, were documented into an excel spreadsheet. Frequency and cross tabulation of various variables were generated. Appropriate statistical tools were used to check the significance of the findings or otherwise. A *p* value of <0.05 was significant. A total of 155 children (94 male and 61 female) were retrospectively studied. The mean age was  $7.4 \pm 4.8$  years. Thirty-four (21.9%) had positive family history of epilepsy while 121 (78.1%) had negative family history. Carbamazepine was the commonest anti-epileptic drug (AED) used either as monotherapy or in combination. Out of the 88 of them that had an EEG, 39 (44.3%) showed normal findings, while 49 (55.7%) showed epileptic form discharges. Childhood epilepsy in our out-patient specialist clinic demonstrated male predominance. The mostly used AED being carbamazepine and majority of cases being focal seizure with secondary generalization. About a third of them have poor seizure control, with nearly half of their population unable to procure EEG. There is therefore the need for continuous medical, social and financial support for the families of children with childhood epilepsy.

**Keywords:** Audit, Childhood, Clinic, EEG, Epilepsy

### Introduction

Epilepsy is a common medical and social disorder or group of disorders with unique characteristics which is usually defined as a tendency to recurrent seizures. It affects about 50 million people globally, out of which about 40 million live in the developing countries and over 60% of cases has its onset in childhood.<sup>1,2</sup> It is a chronic disorder marked by intermittent, often unpredictable seizures which may be embarrassing and disruptive to the normal activity of daily living.<sup>1,3</sup> It cuts across age groups and may have a limiting effect on the quality of life of the sufferer.<sup>2</sup> It is remarkably uniformly distributed around the world with no absolute racial, geographical or social class boundaries, although, it

is more common in less developed countries of the world.<sup>1,3</sup> It occurs in both sexes, at all ages, especially in childhood, adolescence and increasingly in ageing populations.<sup>6</sup>

At times, care givers of children with epilepsy may not be forthcoming with the needed commitment to the care of such children; especially as regards follow up and other care due to frustrations, poverty and stigmatization.<sup>4,6</sup> The cost and availability of care and investigation may be part of the contributory factors to such lack of continued commitment.<sup>6,7</sup> In terms of availability of medications and other forms of care, it has been documented that 80% of the available antiepileptic drugs (AEDs) are consumed by 20% of the world's epilepsy population.<sup>1,7</sup> This is also evident in that several newer AEDs are scarcely available in the less developed nations.<sup>1,6,7</sup>

In view of the foregoing, a review of the socio-demographic characteristics and audit of Paediatric

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epilepsy seen in our institution was carried out.

## Methods

Departmental records of children (2 month – 14 years) managed for epilepsy (more than two unprovoked seizures more than 24hours apart) over two years (1<sup>st</sup>January 2012-31<sup>st</sup>December, 2013) were retrieved. Their socio-demographic characteristics such as age, gender and family history of epilepsy were extracted. Duration of their epilepsy, period of the day seizure occur frequently, type of seizures, the frequency of its occurrence, level of control and EEG findings (among those that had the test done) were all documented into an excel spreadsheet. Frequency and cross tabulation of various variables were generated.

Appropriate statistical tools were used to check the significance of the findings or otherwise. A *p* value of <0.05 was significant.

## Results

A total of 155 children (94 male and 61 female) were retrospectively studied over the study period. The mean age of the subjects was 7.4±4.8 years. Thirty-four (21.9%) had positive family history of epilepsy while 121(78.1%) had negative family history. Carbamazepine was the commonest anti-epileptic drug (AEDs) used either as monotherapy or in combination, while Phenyntoin Sodium, Clonazepam and Ethoxusimide were the least commonly used AEDs. The details are as shown in Table 1

Table 1: Baseline data of children with epileps

Factors	frequency	%
<b>Age – mean ± SD</b>	<b>7.4±4.8</b>	
<b>Sex</b>	Male	94
	Female	61
<b>Family history of epilepsy</b>	Yes	34
	No	121
<b>Education attainment</b>		
None	68	43.9
Primary/Qur’anic	23	14.8
Secondary	40	25.8
Tertiary	24	15.5
<b>Antiepilepsy Drugs (some in Combination)</b>	Carbamazepine	110
	Phenobarbitone	42
	Valproate36	23.2
	Phenytoin	2
	Clonazepam	2
	Ethoxusimide	2
	On drug holiday	9
<b>Number of AED</b>	1	106
	2	46
	=3	3

The types of the epilepsy were; focal with secondary generalization in 86 (55.5%) subjects, Generalized in 59 (38.1%); simple partial and complex partial epilepsies were recorded in 3 (1.9%) and 7 (4.5%) patients respectively. Duration of disease was less than one year in 23 (14.9%), between 1-5 years in 82(52.9%). Also, frequency of clinic attendance was 2-6 times per year in 86 (55.5%) subjects, 7-11times per year in 42 (27.1%) and 12 times or more per year in 6 (3.9%) of them. The level of

control was good – no seizure activity recorded in a year - among 38 (24.5%); moderate (less than 11 seizure episodes per year) in 56 (36.1%); poor control (one or more episode of seizure activity per month) was observed in 61(39.4%). Anti-epileptic drug was changed from a type to another in 54 (34.8%) cases and reasons for change are as shown in Table 2. Of the 88 of them that had an EEG, 39(44.3%) showed a normal finding, while 49 (55.7%) showed epileptiform discharges. (Table 2)

Table2: Characteristics of Epilepsy among the Subjects

Parameters	N=155	%
<b>Seizure types</b>		
Generalized	59	38.1
Focal with secondary generalisation	86	55.5
Simple Partial	3	1.9
Complex Partial	7	4.5
<b>Disease Duration</b>		
< 1 year	23	14.9
1-5 years	82	52.9
6-10 years	33	21.3
>10 years	17	0.9
<b>Clinic attendance per year</b>		
2-6 times	86	55.5
7-11 times	42	27.1
= 12 times	27	17.4
<b>Level of Seizure Control</b>		
Good (0 episode per year)	38	24.5
Moderate (= 11 episode per year)	56	36.1
Poor (= 1 episode per month)	61	39.4
<b>Change of medication</b>		
Yes	54	34.5
No	101	65.2
<b>Reason for change (n=54)</b>		
Continued / worsening seizure despite maximum dose	36	66.7
Side effects/ Poor tolerance	18	33.3.
<b>Electroencephalogram (EEG)</b>		
Yes	88	56.8
No	67	43.2
<b>EEG finding (n=88)</b>		
Normal	39	44.3
Epileptiform discharges	49	55.7

## Discussion

Several studies have shown no gender difference in the frequency of epilepsy, the difference in the male to female epileptics as seen in this study could be due to the hospital based nature of the study. It could as well be due to the well established global phenomenon of gender bias as it affects the environment of the study, in which case male are preferentially taken to hospital to access care better than their female counterpart. Also, few studies have also shown gender variation in the occurrence of specific types of epilepsy.<sup>13,14</sup> They found significant differences between the sexes as they reported atonic seizures to be more common in males with generalized epilepsy while, autonomic, visual, psychic symptoms associated with non acquired focal epilepsy, were more common in females.<sup>13,14</sup> The presence

of family history of epilepsy in about one in five of the subjects, this is within the reported frequencies<sup>15</sup> The fact that epilepsy affects all level of socio-economic level was also demonstrated with this study. Most of the parents belonging to lower socio-economic class may be due to reduced cost for the care for epilepsy in Government hospital compared to specialized private health institution., First generation anti-epileptics are the most widely used as it is seen in many developing countries.<sup>1,4,6,9</sup> This is likely due to easy availability, efficacy, its use in varied seizure types and relative affordability of most of the first generation AEDs especially carbamazepine as revealed in this study.

Monotherapy was the rule in most of our patients in this audit. This is in accordance with the recommended dosage pattern of using the highest dose of a monotherapy before

adding a second and subsequently a third one if the seizure control was not satisfactory.

This study also revealed that most children have localization related (partial) epilepsy which were secondarily generalized, then a generalized epilepsy syndrome. This is in agreement with studies from Saudi Arabia<sup>9</sup> and other parts of the world.<sup>16</sup> Earlier studies in Nigeria however found a predominance of generalized tonic clonic seizure<sup>2,5-6</sup>. The reduction in the number of the children on follow-up for over ten years is probably as a result of the children becoming too old for paediatric clinic or getting controlled and being discharged from the clinic. It may also be due to loss to follow up as reported by some authors<sup>2,10,11</sup> on account of seeking alternative therapy or other reasons.

Most of the patients were more than one year on follow up and this is in accordance with the chronic nature of the condition. Majority of children presented for follow up between twice and six times in a year. This probably includes those with good and moderate control whereas those requiring more frequent follow-up had moderate and poorly controlled seizure episodes.

As basic as EEG is, over 40 percent of children on treatment for epilepsy did not have an EEG done on them probably on account of financial difficulty of the parents / care givers. Also, it has been documented that paediatricians especially from resource constraint settings will rely on their clinical acumen to decide on diagnostic and treatment issues without the help of an EEG. Among those that had EEG, over 40 percent also had normal wave patterns. Though, the EEGs in this study were not classified into either initial or on follow-up, it may be of prognostic importance as Gatzonis *et al* suggested that patients with normal initial recordings had good clinical outcomes and satisfactory social adjustment and deterioration of the recordings over time was associated with unfavourable results in a significant proportion of patients (90%), while stable or improved EEG findings predicted a favourable outcome.<sup>17</sup>

## Conclusions

Paediatric epilepsy in our Paediatric Neurology out-patient clinic demonstrated male predominance. The main AEDs in use are the first generation AEDs with carbamazepine being the mostly used. Majority were focal seizure with secondary generalization. The rate of loss to follow up increases after 5 years. About a third of them have poor seizure control.

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## Combined use of Geophysical and Geochemical Investigation for the Assessment of Groundwater Vulnerability around Cassava Processing Sites at Ibillo Community, Akoko-Edo, Edo State, Nigeria.

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### Abstract

Geophysical and geochemical investigations were carried out around the vicinity of three cassava processing sites in Ibillo community, Akoko-Edo, Nigeria, with a view to ascertaining the vulnerability of the groundwater, due to the cassava effluent arising from the cassava processing activities of the inhabitants within the area. Subsurface geophysical investigation was carried out to determine the water level, sorption of the subsoil and ground water flow direction using electrical resistivity method and employing the Schlumberger electrode configuration. For the geochemical investigation, a total of six water samples were collected from six hand dug wells distributed across the study area and analyzed using atomic absorption spectrometry. This was done to ascertain the presence and concentration of cyanide and heavy metals in the groundwater. The VES derived geoelectric section, identified four lithological layers which comprised the top soil (18? m-30? m), regolith (100? m), fractured basement (20? m-80? m) and fresh basement rock (130? m -10000? m). The resistivity of the cassava effluent in the area ranges from 20? m to 22? m. The migration of the effluent may have been seamless because of the poor sorption of the topsoil. The result of the hydrogeochemical study showed the presence of cyanide with total cyanide concentration and free cyanide concentration values varying from 2mg/l to 55mg/l and 0.07mg/l to 0.86mg/l respectively. The presence of cyanide in the analyzed water sample is attributable to the cassava processing activities carried out in the community, while the hydrogeologic setting of the area, coupled with sorptionless aquifer (with shallow water table) enhanced the cyanide infiltration. Higher values of total cyanide concentration that are over 50mg/l (far above the WHO permissible limit) were noticed in the northeastern part of the area when compared with results of other parts. The result further showed the presence of heavy metals such as Cd, Fe, Ni, Cu, Pb, and Mn in the analyzed groundwater. The occurrence of these heavy metals in the groundwater gave an indication to the presence of metallic-cyanide complex, resulting in the high level of toxicity in the area. The major source of these heavy metals is the acidic leaching of the minerals that are associated with the rocks that underlie Ibillo. The leaching was further enhanced by the acidic medium formed by cyanide at the surface which infiltrates the aquifer through seepage.

**Key words:** Cyanide, metallic-cyanide complex formation, Ibillo, hydrogeological setting

### Introduction

Cassava effluent produced during cassava processing activities usually contains cyanide; a very toxic and harmful fluid when it infiltrates water bodies. Ibillo, one of the major towns located in Akoko Edo Local Government Area of Edo State lies between latitude 7° 25' N and 7° 30' N and longitude 6° 03' E and 6° 06' E, covering an area of

about 121km<sup>2</sup>. The inhabitants of the town are predominantly farmers whose choice produce is cassava. The cassava is majorly processed into garri which is either sold at the town or transported to other parts of the country for sale. Almost every house in Ibillo has cassava processing unit, which they usually site either at the front or beside their houses. Most worrisome is the fact that most of the hand dug wells used by the inhabitants are at shallow depth and these are mostly sited within the vicinity of each cassava processing unit. This calls for serious concern, as this mode of operation can allow for direct infiltration of cassava effluent into the water table. This can be very toxic and inimical to one's health when consumed at exceeded permissible concentration levels. More so, the rate of infiltration can be catalyzed for an unconfined aquifer.

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Cyanide is a carbon-nitrogen chemical unit which combines with some organic and inorganic compounds<sup>1</sup>. It forms complexes with some metals such as cadmium, gold, copper, iron, zinc, cobalt, and nickel thus makes it more toxic. Cyanide is a singly-charged anion containing unimolar amounts of carbon and nitrogen atoms triply-bonded together: C<sup>o</sup>N<sup>-</sup> or CN<sup>-2</sup>. The health and survival of plants and animals are dependent on the transport of these heavy metals through their tissues and as such cyanide is very toxic<sup>2</sup>. The mean lethal dose to the human adult is between 50 and 200 mg/l<sup>3,4</sup>. U.S. Environmental Protection Agency (EPA) standards for drinking and aquatic-biota waters regarding total cyanide are 200 and 50 ppb, respectively, where total cyanide refers to free and metal-complexed cyanides<sup>5</sup>. Cyanide occurs as a groundwater contaminant at various current and former industrial sites, including electroplating facilities, aluminum production plants, manufactured-gas plants (MGP), and gold mining industries<sup>6</sup>.

Speciation of the cyanide presence in groundwater is very important when determining groundwater toxicity. Cyanides are toxic and their toxicity is related to their physicochemical speciation<sup>1</sup>. Cyanide can exist in aqueous solution as free cyanide (HCN, CN<sup>-</sup>) or as complexes with metals such as cadmium, copper, iron, gold and nickel among others, or as thiocyanate. Free cyanide, and weak acid dissociable cyanide (CNWAD) (complexes with metals such as copper, zinc, nickel) are classified as the most toxic because of their high metabolic inhibition potential whereas strong acid dissociable cyanide (CNSAD) (complexes with cobalt, iron, gold) are considered to be relatively less toxic<sup>6,1</sup>.

There are several literatures<sup>7,8,9</sup> on inorganic cyanides; gold, aluminum and other minerals while literatures on organic

cyanides are scanty. Hydrogeochemical evaluation of groundwater at Ibillo has been carried out<sup>10</sup>. Other literatures on Ibillo only adopted hydrogeochemical method to evaluate the suitability of groundwater, without considering the geological and hydrogeological setting of the area, in order to adequately determine the ground water quality. Therefore, this work will attempt to address these gaps initiated by the methods used in the existing literatures by characterizing the aquifer properties as well as integrating the geological, geophysical, hydrogeological, and hydrogeochemical information of Ibillo. The Electrical resistivity and geochemical methods which have been successfully used to determine the groundwater quality at Ozalla, Edo State, Nigeria<sup>11</sup>, was brought to the fore in this work, so as to determine the groundwater quality and proffer mitigating measures in a bid to promoting healthy living amongst the inhabitants of Ibillo, Edo State, Nigeria.

## Local Geology

The study area falls within the Basement Complex of Nigeria. It is underlain by three major rock units; biotite schist, quartzite, and meta-conglomerate, with the biotite schist covering the largest portion of the area. It runs from the northwest to the southwest extending to the central (Fig. 1). The foliation of the biotite schist has high dips that vary from 35° to 65° with westerly dip pattern. It is weathered in major areas while in some very few cases, it is fresh with imprints of Pan-African orogeny events that varies from ptymatic folds, lit-par-lit injection, paleosome, veins, and veinlets of quartzo-feldsparitic materials. The quartzite overlies the schist covering the extreme north east and south east of the area (Fig. 1). The quartzite is highly fractured and segmented by meta-conglomerate.

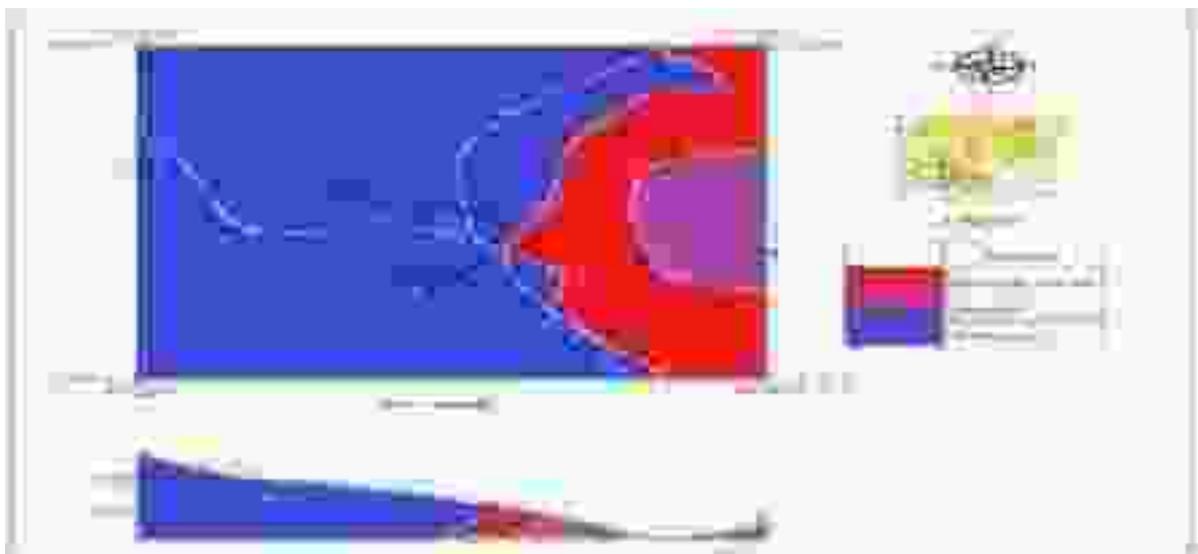


Figure. 1. Geological map of the study area.

## Methods and Materials

Detail geological setting of the area was carried out to delineate the underlying rock units and reveal the mineralization and mineral origin of the area. Water samples were collected from six hand-dug wells (Fig. 2) in the area for hydrogeochemical analysis. The aim was to identify the Ph, heavy metals, and cyanide concentration, as these parameters give information on metallic-cyanide complex

formation which is the bane for determining toxicity of cyanide in groundwater. Vertical Electrical Sounding was carried out at selected points in the area using Geotron Tetrameter. This was done to determine the aquifer parameters, and integrate the information obtained with the geological information in the area so as to properly characterize the hydrogeological setting of Ibillo. Res1Dinv software was used to carry out the inversion model of the acquired resistivity field data.



Figure. 2. Transverse map of the study area showing point of water samples collection and VES point

## Results and Discussion

The resistivity field data acquired for the study is presented in Table 1. The inversion resistivity model (Fig. 3 to Fig. 5) result shows that Ibillo has a water table which ranges from about 5m to 7m in depth, and has an aquifer thickness that varies from about 3m to 7m. The groundwater flows towards the northeast direction where the aquifer becomes shallower. The shallow portion was shown to be highly saturated from the interpreted resistivity data. Further observation shows that the hydrogeologic setting of Ibillo is a shallow aquifer without sorption. This easily allows direct flow of cassava effluent into the groundwater. The shallowness of the aquifer depth and the thinning-out of the aquifer thickness towards the northeast of the study area is attributed to the geologic setting and topography of the area.

Geological studies revealed that Ibillo is underlain by biotite schist that is predominant in the southwest and northwest direction, with the northeast side underlain by quartzite and meta-conglomerate. The schist is weathered and fractured from a distance of about 4m to 12m from the surface downwards, while the other rocks are fractured

from about 4m to 8m. This explains why the water table is shallow without sorption. The topography of the area complements the geology in controlling the groundwater flow direction towards northeast area and directional flow of contaminants that infiltrates the aquifer.

**Table 1: Field resistivity data acquired in Ibillo, Akoko-Edo, Nigeria**

S/N	AB/2	MN/2	VES1	VES2	VES3
1	3	2	32.2	64.18	26.9
2	5	2	33	44.8	40.65
3	10	2	46.6	53.7	75.6
4	15	2	72.8	76.3	102
5	20	2	104	102	138
6	25	5	134.5	139.3	155
7	30	5	163.5	170	192

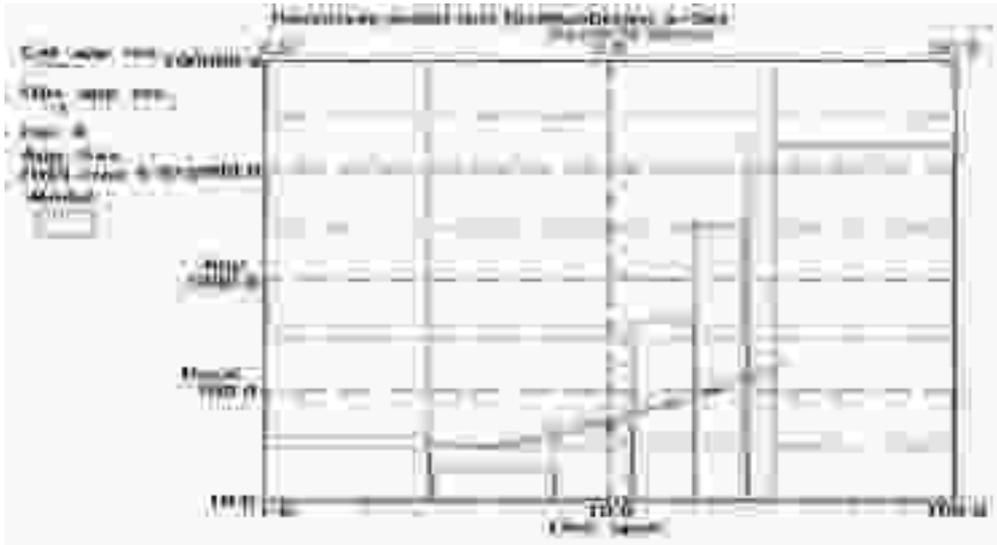


Figure 3. Inversion model for VES 1

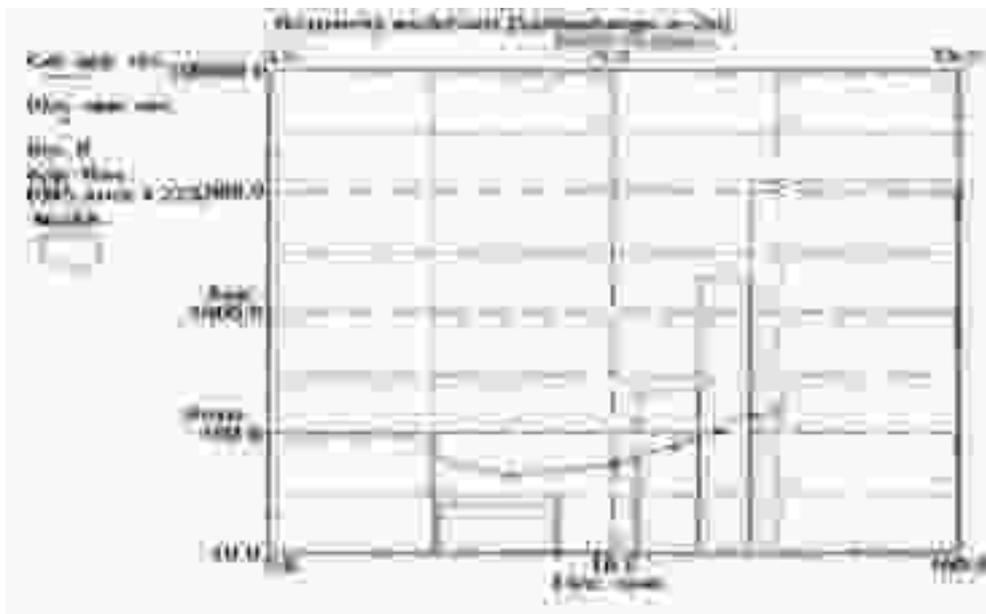


Figure 4. Inversion model for VES 2

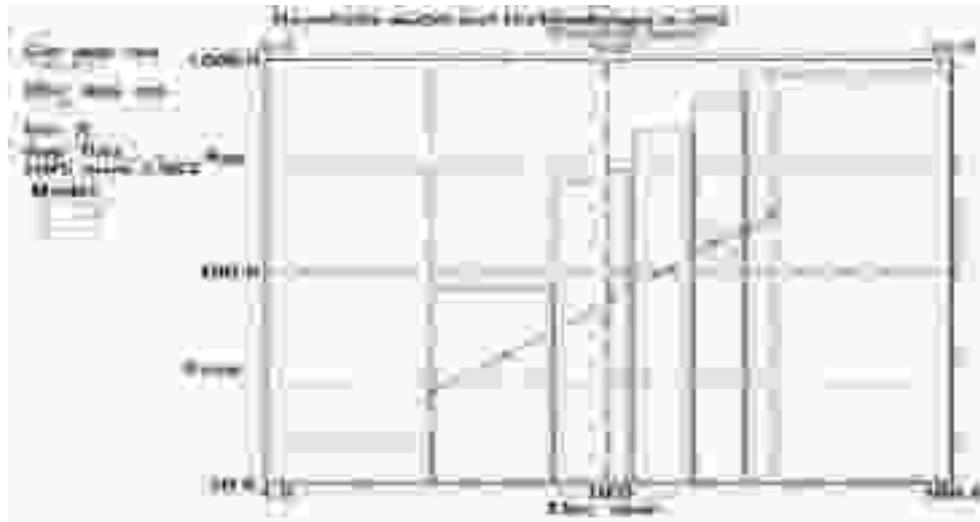


Figure 5. Inversion model for VES 3

The result of hydrogeochemical analysis of the six water samples shows the presence of free cyanide with concentration that varies in value from 0.07mg/l to 0.86mg/l, and a total cyanide concentration which varies in value from 2mg/l to 55mg/l (Table 2). The level of cyanide concentration shows that cassava effluent easily infiltrates the aquifer. The infiltration was catalyzed by the geology and the hydrogeological setting of the area as observed from the geophysical and geological results. The rock strata which overlie the aquifer lacks sorption, as such, cannot resist direct infiltration of the disposed cassava effluent. The shallowness of water table in the area enhances the flow of cyanide from the cassava processing points in the study area.

The analyzed water samples results show that wells 4 and 5 have the highest free cyanide concentration values; 0.81mg/l and 0.86mg/l and total cyanide concentration values of 52.mg/l and 55mg/l respectively (Table 2). These values are well above the World Health Organisation (WHO)

permissible limits<sup>3</sup>. The electrical resistivity results correlated well with geochemical result, since VES 2 and VES 3 sample points falls toward the northeast direction with low resistivity signature ranging from 20? m to 22? m (Fig.6). Both VES show the signature of high concentration of cyanide from depth of 3.5m to 4m (Fig. 6). However, VES 3, which is located in the southwest direction of the study area has low concentration of cyanide according to the geochemical result. The resistivity result also corroborates the findings gotten from the geochemical analysis; as it has a value of about 80? m, which is higher than that containing high cyanide concentration within the aquifer (Fig. 6).

This implies that the inhabitants in the area could be exposed to any of the following health condition(s) like rapid breathing, tremors, and other neurological disorder; for short term usage of the water, and; thyroid effect, nerve damage, and weight loss; for long term usage<sup>3</sup>.

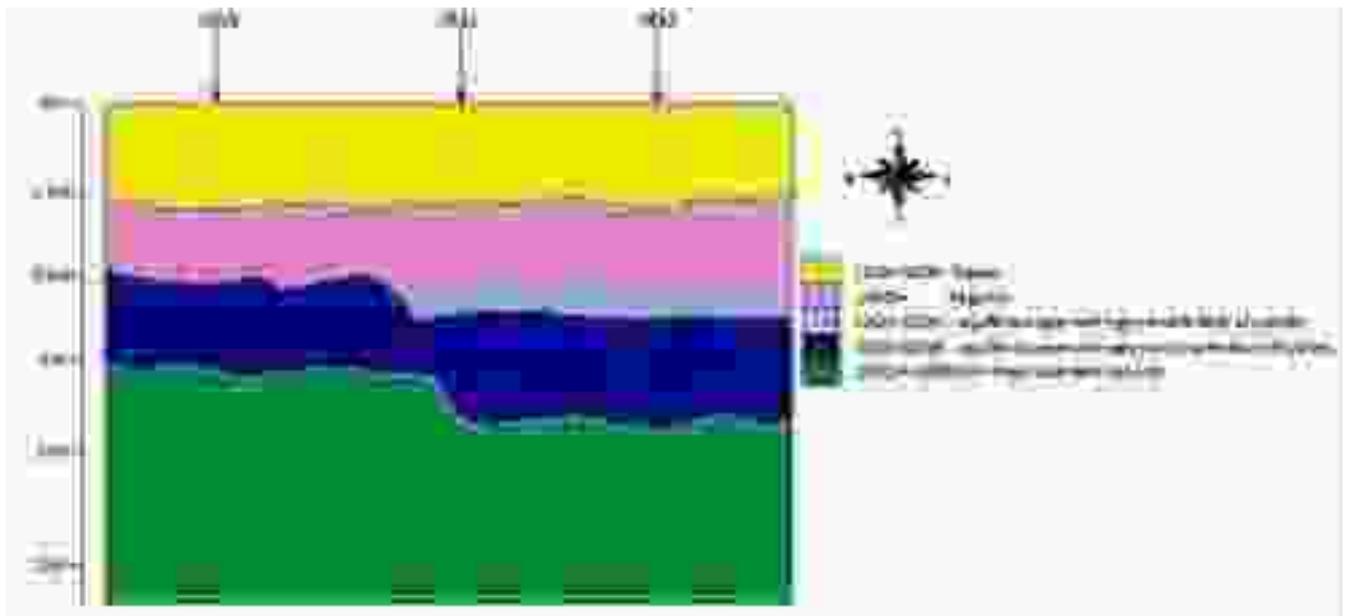


Figure. 6: Geoelectric section of the area studied in Ibillo, Edo State

The presence of heavy metals; iron, lead, cadmium, manganese, nickel, and copper, in the groundwater (Table 2) shows that cyanide has formed metallic complexes with these heavy metal. The presence of cadmium must have originated from the underlying rocks in Ibillo by acidic dissolution. In addition, the concentration of cadmium increases across the area for wells 1,2,3,6; which are located in the southwest and northwest direction to wells 4 and 5. Increase in cadmium concentration in the study area occurred with a change in pH. The more acidic the

groundwater becomes the higher the concentration of cadmium (Table 2). The trend in the concentration of total cyanide concentration mimics that of cadmium concentration. This suggests complex metallic formation with cyanide. Wells 4 and 5 have the highest cadmium concentration which exceeds the permissible limit for human consumption (Table 2). The concentration is highest in well 4 and well 5, and it follows the trend of total cyanide concentration. Their pH values are mostly acidic in all the six wells (Table 2). In an acidic medium, cyanides form metallic complexes with metals. Well 4 and Well 5

experienced the most metallic complex formation with cyanide because their acidic level is higher among the six wells. Thus, high cadmium injection will lead to serious health related problem like kidney, testicular, tissue, and red blood cell damage<sup>12</sup>.

The iron concentration in the six well gives evidence of iron metal complex formation with cyanide in the study area with well 5 having the highest concentration (Table 2). The presence of iron must have occurred in Ibillo groundwater by leaching from mineral component such as biotite,

amphiboles or pyroxenes of the rock that underlies the study area. The leaching must have been enhanced by acidity of the area resulting from cyanide production. Iron concentration in the six wells falls within permissible limit<sup>4</sup>, except for well 5 (Table 2). High iron concentration will affect red blood cell chemistry, delay normal physical and mental development in babies<sup>13</sup> and it causes stains in fabrics. The concentration of lead and nickel in the groundwater gives evidence of metallic complex formation with cyanide. Their concentration is slightly above the recommended value for human consumption.

**Table 2: Hydrogeochemical result of water samples collected from six wells in Ibillo, Akoko-Edo, Edo, Nigeria**

Variables	Well 1	Well2	Well3	Well 4	Well 5	Well 6	WHO value (2012)
<b>Ph</b>	6.33	6.28	6.01	6.00	6.00	7.03	6.5-8.5
<b>Mn<sup>+</sup> (mg/l)</b>	0.08	0.03	0.02	0.01	0.01	0.03	0.2
<b>Fe<sup>2+</sup> (mg/l)</b>	0.12	0.19	0.17	0.18	0.7	0.13	0.3
<b>Cd<sup>2+</sup> (mg/l)</b>	0.011	0.016	0.017	0.018	0.016	0.010	0.003
<b>Pb<sup>2+</sup> (mg/l)</b>	0.036	0.041	0.031	0.029	0.028	0.017	0.01
<b>Ni<sup>2+</sup> (mg/l)</b>	0.040	0.008	0.081	0.071	0.072	0.026	0.02
<b>Cu<sup>2+</sup> (mg/l)</b>	0.106	0.119	0.109	0.100	0.170	0.149	
<b>Total Cyanide (mg/l)</b>	2.00	3.00	20.00	52.00	55.00	8.00	<50
<b>Free cyanide (mg/l)</b>	0.08	0.11	0.75	0.81	0.86	0.07	

### Conclusion

The study of cyanide in Ibillo has shown that the northeast direction of the study area has been adversely affected by cyanide infiltration as a result of the cassava processing activities in the area, when compared to other parts of the study area. There is therefore the urgent need to curtail the menace of indiscriminate disposal of cassava effluent at Ibillo due to the adverse health implications and we hereby propose as follows:

- i. that government at every level in Nigeria should immediately formulate policies that would regulate activities of cassava processors in Ibillo and other parts of Nigeria where cassava processing is being practiced, to curtail the excesses that could lead to cyanide contamination of the groundwater; and
- ii. the inhabitants of Ibillo should rely on deep aquifer as source of groundwater, where natural purification easily occur, rather than shallow aquifer that easily allows direct infiltration of contaminants due to their unconfined nature and lack of sorption.

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## An Analysis of Hydraulic Conductivity Effect on Microbial Contaminants Infiltration in Aquiferous Layers with varying Geologic Properties

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### Abstract

This study aims at investigating the effect of non argillaceous upper geologic layer hydraulic conductivity on microbial contaminants seepage into an aquifer underlain by lower geologic layer of thick shale sequence. Field data comprising of soil and water samples were collected from three hand-dug wells that are evenly distributed within the study area. Sieve analysis, hydrogeochemical analysis, and geological study were carried out on the samples. GIS was used to give the spatial distribution of the hydraulic conductivity (HC) and microbial contaminants in the study area to know the effect of HC on contaminant seepage into the aquifer. HC and coefficient of uniformity ( $C_u$ ) were computed from the sieve result using Hazen empirical formula. The HC result ranges from 0.04 - 0.002m/s, while that of  $C_u$  ranges from 3.47-4.64. The result showed that areas where HC value fall between 0.026-0.04 m/s have high concentration of microbial contaminants while areas with 0.002 and less have no microbial infiltration.

**Key Words:** Hydraulic conductivity, GIS, Microbial contaminants, Anambra Basin

### Introduction

Prior to this study, we observed that in a geologic setting where the upper geologic layer that precedes an aquifer comprises non-argillaceous sediments such as sandstones, in which the sequence ranges from less than 10m to 30m, is often characterized by high concentrations of microbial (bacteria) contaminants such as E-coli, Coliform and other bacteria within the aquifer. Beneath the aquifer lies a thick sequence of argillaceous sediment which often ranges between 50m to over 300m.

In Anambra Basin several cases have been observed within hand-dug wells in Enugu Shale and Imo Formation where a stratigraphic motif of this geologic setting occurs. The concentrations of microbial contaminants in aquifers that exist in this kind of stratigraphic motif is far more than those which exists in other geologic setting where thick shale does not underlie the aquifer. Therefore, this study is intended to unravel the reason(s) for this type of occurrence by analyzing the effect of upper layer hydraulic conductivity on microbial contaminants infiltrations into aquiferous zone. Hydraulic conductivity is one of the most important and useful parameters in the study of the seepage process of

porous media<sup>1,2,3</sup>. It is one of the soil properties that are important and necessary in water, mass transport models, irrigation and drainage studies<sup>4</sup>. Effect of heterogeneity is particularly relevant in geologic media of low hydraulic conductivity<sup>5</sup>. However, heterogeneity is arguably the most singular feature of hydrogeology that controls groundwater flow and transport<sup>6</sup>. Effect of hydraulic conductivity on the flow pathway between bedrock have been studied using different methods by several authors<sup>7,8,9,10,11,12,13,14</sup> without looking at its effect on microbial contaminants flow into the aquiferous layer which this research focuses on. This study also intend to look at the effect of the underlying thick sequence of argillaceous sediments on the aquiferous layer.

### Methods

#### Site Description, Geologic and Stratigraphic Setting

Field data (water and soil samples) were collected from Agbede (Fig.1) as it consist geologic stratigraphic motif which suits our purpose of study. Agbede is located in Edo State, Nigeria. It falls within the Anambra Basin and underlain by Imo Formation. The stratigraphic (Fig. 2) section of the area comprises Upper Geologic Layers (UGL) and Lower Geologic Layers (LGL). The UGL comprises lateritic top soil, poorly sorted medium-coarse grained sandstone, and silt-shaly sand (Fig 2). Beneath the silt-shaly sand lies an aquifer unit whose water table

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occurrence ranges from 8m to 23m. Below the aquiferous layer is LGL which comprises thick deposits of shale sequence that is over 200m.



Figure. 1: Satellite map of Agbede showing sample collection points.

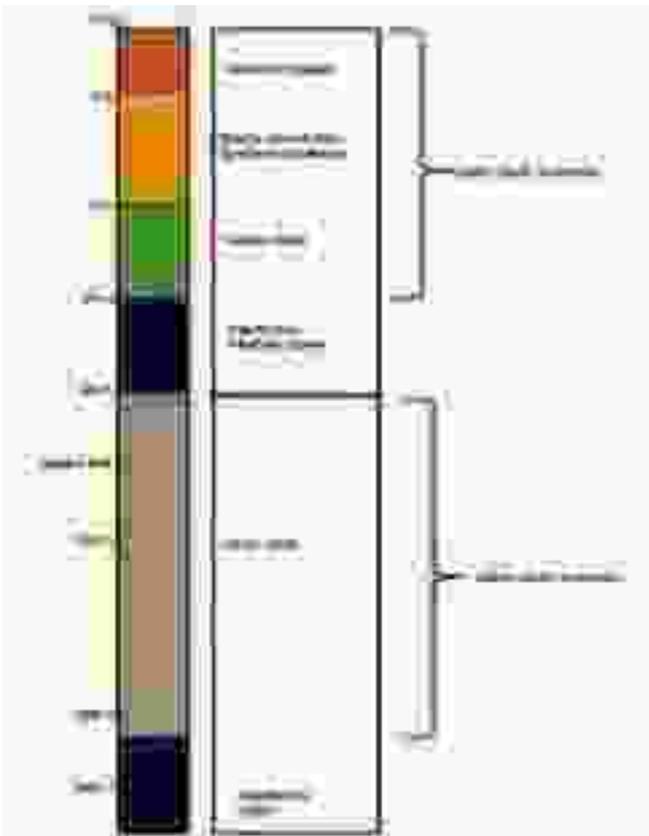


Figure. 2: Stratigraphic section of rock units in Agbede, Edo State showing the Upper Geologic Layer and Lower Geologic Layer.

Three hand-dug wells located at the northern, central, and southern parts of Agbede served as sources of water samples for this study. Geolical, stratigraphical, and hydrogeological data were collected and geo-referenced for the purpose of generating GIS map which will aid in proper delineations of spatial distribution of hydraulic conductivity and microbial contaminants in the area of study. Rock samples were collected from each stratum along the hand-dug wells in the UGL. Thereafter, the samples were disaggregated, weighed, and placed on sieve machine for granulometric analysis using ASTM D422-63 standard. From the result of the sieve analysis (Table 1-3), the percentage finer was plotted against the particles size on a semi-logarithmic graph (Fig. 3-Fig. 5). From the above results the coefficient of uniformity ( $C_u$ ), the coefficient of curvature ( $C_c$ ) and the hydraulic conductivity ( $K$ ) were calculated as follows:

where 
$$C_u = \frac{D_{60}}{D_{10}}$$

and 
$$C_c = \frac{D_{30}^2}{D_{10} D_{60}}$$

Therefore, the hydraulic conductivity  $K$  was computed using Hazen's Empirical formula<sup>16</sup> as given in equation (3). Hazen formula<sup>16</sup> was originally developed for determination of hydraulic conductivity of uniformly graded sand but is also useful for fine sand to gravel range, provided the sediment has a uniformity coefficient less than 5 and effective grain size between 0.1 and 3mm<sup>15</sup>.

$$K = FC^2 D_{10}^2 \tag{10}$$

where  $C$  is Hazen's empirical coefficient, which takes a value between 0.0 and 1.5 (depending on the parameters values), with an average value of 1.0.

The results obtained were analyzed using relevant statistical tools for proper interpretation to know the relationship of the geological media with contaminants infiltration into the aquiferous layer. Water samples were collected from the three wells and investigated for biological parameters using standard method. GIS was used to create spatial map of the hydraulic conductivity of Agbede and spatial distribution of bacterial contaminants with special attention on the spatial hydraulic conductivity distribution of the area and the underlying thick sequence of shale below the aquiferous layer in the UGL.

Table 1: Sieve analysis result for well 1

<b>Sieve Size</b>	<b>Mass of Soil Retained(g)</b>	<b>Percentage Retained</b>	<b>Percentage passing</b>
<b>1.18 (mm)</b>	300	10.1	89.9
<b>0.6 (mm)</b>	550	18.5	71.4
<b>0.425 (mm)</b>	420	14.1	57.3
<b>0.300 (mm)</b>	540	18.1	39.2
<b>0.212 (mm)</b>	420	14.1	25.1
<b>0.150 (mm)</b>	390	13.1	13.1
<b>Pan</b>	360	12.1	0.1

Table 2: Sieve analysis result for well 2

<b>Sieve Size</b>	<b>Mass of Soil Retained(g)</b>	<b>Percentage Retained</b>	<b>Percentage passing</b>
<b>1.18 (mm)</b>	630	20.3	79.7
<b>0.6 (mm)</b>	460	14.8	64.9
<b>0.425 (mm)</b>	450	14.5	50.4
<b>0.300 (mm)</b>	440	14.2	36.2
<b>0.212 (mm)</b>	430	13.9	22.3
<b>0.150 (mm)</b>	380	12.3	10
<b>Pan</b>	310	10	0.0

Table 3: Sieve analysis result for well 3

<b>Sieve Size</b>	<b>Mass of Soil Retained(g)</b>	<b>Percentage Retained</b>	<b>Percentage passing</b>
<b>1.18 (mm)</b>	620	17.9	82.1
<b>0.6 (mm)</b>	590	17.0	65.1
<b>0.425 (mm)</b>	570	16.4	48.7
<b>0.300 (mm)</b>	550	15.9	32.8
<b>0.212 (mm)</b>	410	11.8	21
<b>0.150 (mm)</b>	380	10.9	10.1
<b>Pan</b>	350	10.1	0

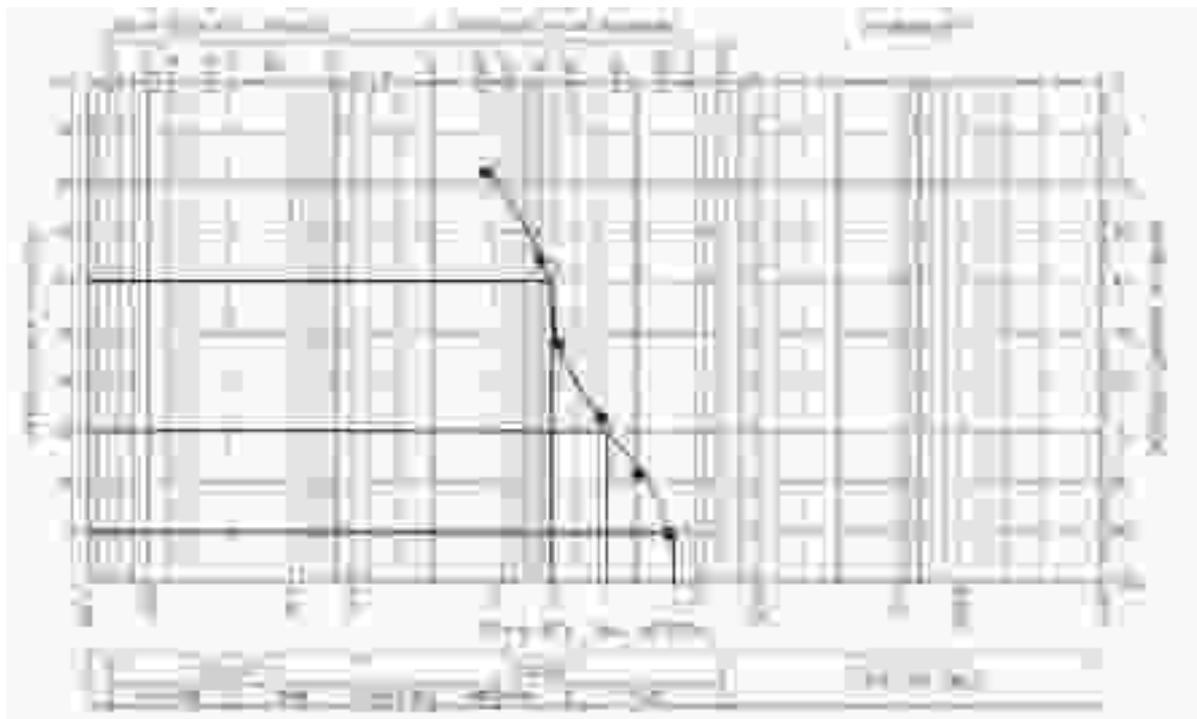


Figure. 3: Sieve curve plot for soil samples collected from well 1

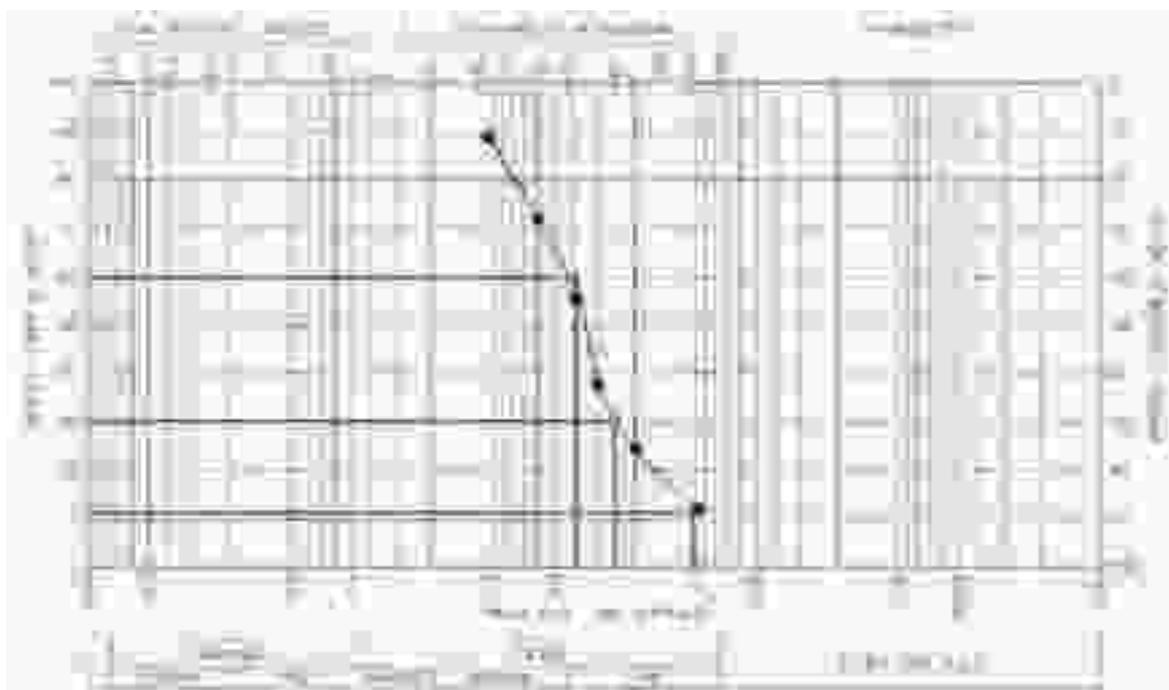


Figure.4: Sieve curve plot for soil samples collected from well 2



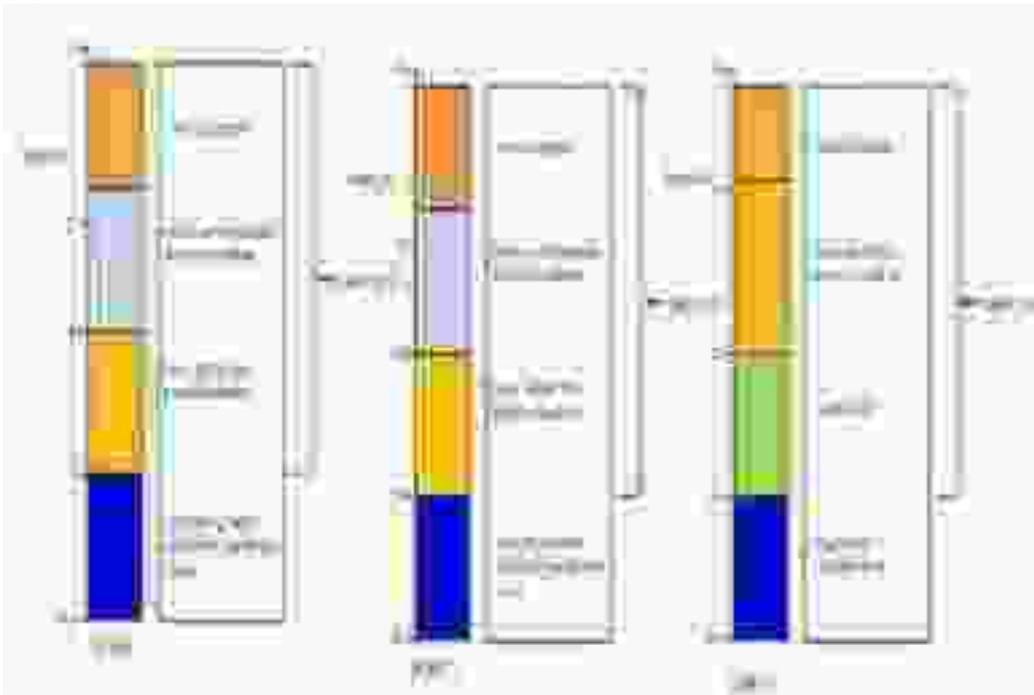


Figure.6: Litho-logs of Hand-dug wells studied in Agbede, Edo State.

Table 4: Result showing the calculated value for K, Cu and Cc respectively

Wells	K (m/s)	C <sub>U</sub>	C <sub>C</sub>	Depth to Water Table
Well 1	0.04	3.55	0.64	7
Well 2	0.026	3.47	0.49	10
Well 3	0.002	4.64	0.58	22

Table 5: Hydrogeochemical result of water samples from hand-dug wells in Agbede, Edo State.

Wells	Total Coliform (Ecoli+Coliform count)	Si	Na	K	Colour	Turbidity
Well 1	8.2x10 <sup>5</sup>	0.45	0.54	3.8	4.5	4.5
Well 2	6.5x10 <sup>5</sup>	0.52	0.91	0.01	4.6	5.2
Well 3	0.00X10 <sup>5</sup>	0.50	0.12	1.8	4.7	5.0

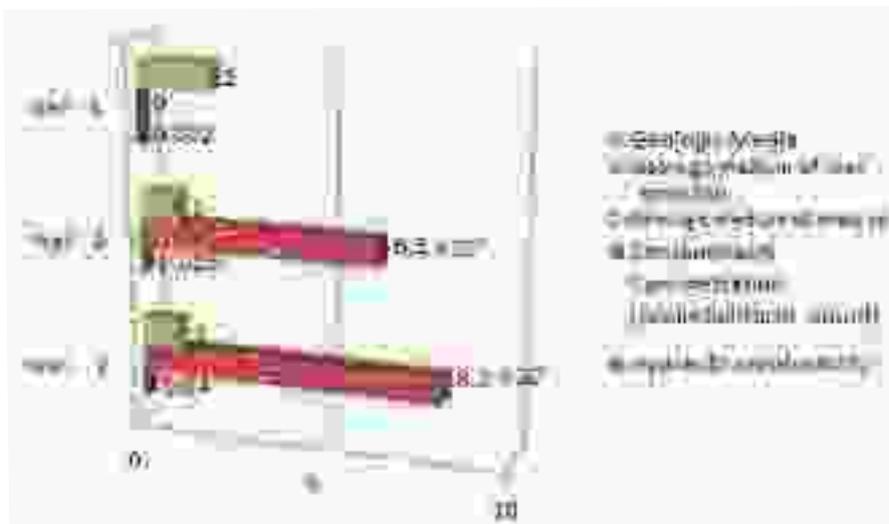


Figure. 7: 3D bar chart plot of hydraulic conductivity, contaminant concentration and geologic media for the three wells.



Figure. 8: Pattern diagram of hydraulic conductivity, contaminant concentration and geologic media for the three wells.

**Effect of Upper Geologic Layers Hydraulic Conductivity on Infiltration of Contaminants in the Underlying Aquiferous Layer**

The result of the hydraulic conductivity, water analysis, and litho-log of the three wells in the study area showed that depth variation in the heterogeneity of the geologic layer above the aquifer of the UGL resulted to variation in hydraulic conductivity. Well 1 which has the highest hydraulic conductivity value ease the rate at which bacteria contaminants infiltrate the aquifer as shown in Fig. 9A. Towards well 2 (Fig.9B), a slight reduction of hydraulic conductivity is observed. This promotes the presence of fewer contaminants into the underlying aquifer (Fig. 9B). As we moving towards well 3 (Fig.9C), the hydraulic conductivity value of the geologic layer overlying the aquifer reduces drastically to about 0.002 m/s (Fig. 9C). The recorded low value is attributed to the presence of sequence of shale which the layer is composed of. This layer is impervious to contaminants from suck-away, dumpsite, and waste drainage from the surface around the study area.

The entire extreme region of south west and south east becomes devoid of contaminants (Fig 11). The aquifers in the three wells are underlain by thick sequence of shale and these prevent free flow of contaminants into the formation so as to undergo attenuation.

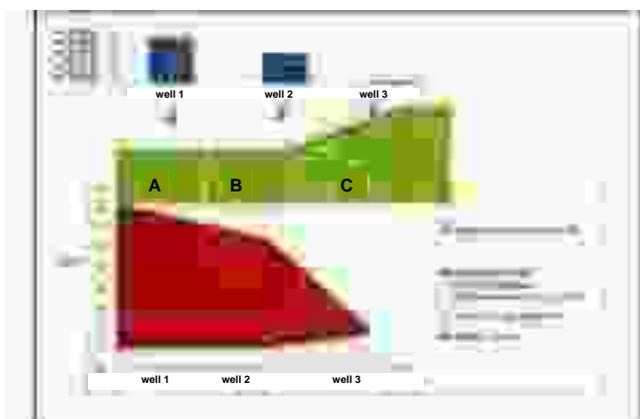


Figure. 9: A model of effect of hydraulic conductivity of geologic media on contaminant infiltration in the underlying aquifer.

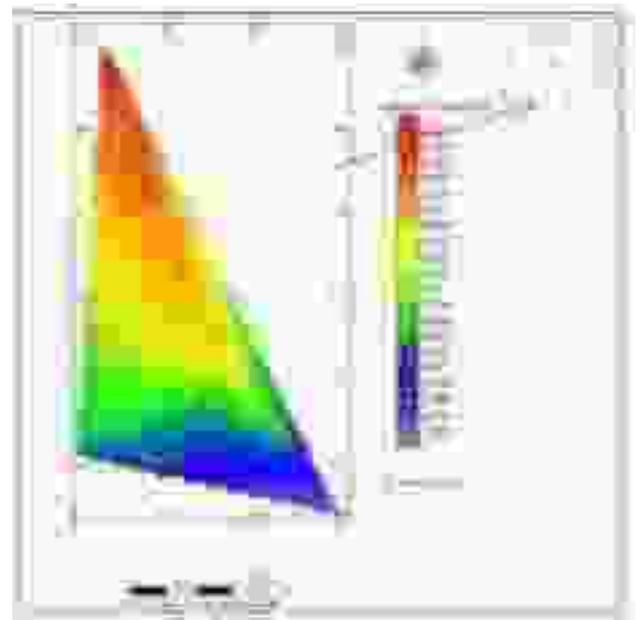


Figure.10: GIS map showing spatial distribution of hydraulic conductivity in Agbede, Edo State.

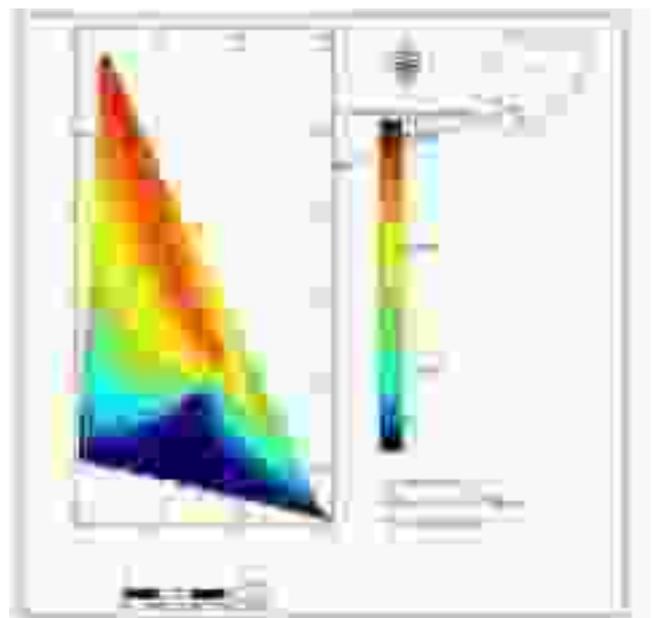


Figure. 11: GIS map showing spatial distribution of microbial contaminants in Agbede, Edo State.

**Conclusion**

This study has shown that there is always both lateral and vertical facie change in geologic media in a given geologic setting. This change causes heterogeneity in hydrogeological material and determines the hydraulic conductivity which subsequently determines the rate and manner in which bacteria and other biological contaminants infiltrate an aquiferous layer. The study has

also shown that the concentration of bacteria will always be high in a shallow aquifer that is underlain by thick sequence of shale because of its shallowness, hydraulic conductivity which allows quick infiltration through short distance within non-argillaceous unit where the aquifer lies. The thick argillaceous (shale) sequence which directly underlies the aquifer in a non-argillaceous sequence provides impermeable medium that act as barrier and prevents the infiltration of microbial contaminants in the aquiferous layer from further infiltrating the formation below, where they can easily get attenuated by geothermal heat due to geothermal gradient. However, the contaminants are retained in the aquifer within the non-argillaceous layer and the concentration continuous to build up.

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## The Effects of Upper Layer Hydraulic Conductivity and Elevation on Water Table

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### Abstract

Ehanlen and Ozalla are two communities that are located in Edo State, Nigeria. While Ehanlen is located in Ekpoma which is situated in Esan West Local Government Area of Edo State, Ozalla is located in Owan East Local Government Area of Edo State. Geological studies have shown that Imo Formation is the main source of groundwater in both localities. However, Ozalla is chiefly characterized by the Imo Formation while Ehanlen consists of the Bende-Ameki Formation underlain by the Imo Formation. This results to variation in depth to water table in both communities. This research therefore aims at determining the effect(s) of upper layer hydraulic conductivity and elevation on the water table occurrence of both areas by carrying out hydrogeological and geological investigations. A total of 5 vertical electrical soundings (VES) were taken in this study (2 VES at Ozalla, and 3 VES at Ehanlen) using the ABEM SAS 4000 terameter, and adopting the Schlumberger array configuration. The Res1Dinv software was used to carry out the inversion model. This was done to determine the depth to water table at each location of study. In-situ hydraulic conductivity test was conducted by excavating a cylindrical shape hole at each VES point, with each hole cutting into the upper geological layer. Some hydrogeological parameters were measured and input into a mathematical model derived using Darcy's law. The results showed that Ehanlen has high elevation (about 1000ft to 1300ft), low value upper layer hydraulic conductivity (ranging from  $1.55 \times 10^{-3}$  to  $3.3344 \times 10^{-3} \text{cms}^{-1}$ ) and deep water table (about 300m to 400m). Whereas, Ozalla, with very low elevation, has a higher value of upper layer hydraulic conductivity (about  $1.19 \times 10^{-2}$  to  $3.54 \times 10^{-2} \text{cms}^{-1}$ ) and shallow water table (about 30m to 120m). This study has shown that high elevation and low upper layer hydraulic conductivity causes deep water table while low land or low elevation and high upper layer hydraulic conductivity leads to shallow water table.

**Key Word:** Upper layer hydraulic conductivity, elevation, water table, Imo Formation, Bende-Ameki Formation.

### Introduction

The hydraulic conductivity of soil is a measure of the soil's ability to transmit water when subjected to a hydraulic gradient. Hydraulic conductivity is one of the hydraulic properties of soil which determines the ability of the soil fluid to flow through the soil natural system under a specified hydraulic gradient. The Hydraulic Conductivity (k) depends on the soil, grain size, structure of the soil matrix<sup>1</sup>, type of soil fluid, and the relative amount of soil fluid (saturation) that is present in the soil matrix. Several workers have carried out different studies on hydraulic conductivity without relating it to elevation and upper layer of the terrain on water table. Artificial Intelligence and Regression Models have been used to predict saturated hydraulic conductivity<sup>2,3</sup>. Qualitative idea about the hydraulic conductivity of the aquifer can be derived using the presence of geologic structures such as fractures within

geologic materials<sup>1</sup>. It has been shown that the particle size distribution can be used to predict hydraulic conductivity of soil<sup>4,5</sup>. A study on scale effects on hydraulic conductivity has been carried out by researcher who observed that large scale measurement may be biased towards high k values because they are performed in the most permeable zones where pumping rate can be high<sup>6,7</sup>. The centrifugal technique has been used to measure saturated hydraulic conductivity<sup>8</sup>. The result correlated well with results of the constant head method when compared. Both constant head and falling head measurement are known to be practical at forces up to at least 1860 times normal gravity. The hydraulic conductivity of geological materials has been carried out in the laboratory through an experimental work<sup>9</sup>.

Though Ehanlen is a community that is located in Ekpoma, and far from Ozalla, Ehanlen and Ozalla communities source their groundwater from the same aquifer. Nevertheless, previous work has shown that while the water table at Ehanlen is deep and difficult to access, Ozalla has a very shallow water table that is easy to access<sup>10</sup>. Hence in this present work, our focus is to identify the effects of hydraulic conductivity, geology, and elevation on

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groundwater table variations at Ehanlen and Ozalla.

### Local Geology of the Study Area

The study area covers Ozalla and Ehanlen. Ozalla is located within Owan west LGA of Edo state while Ehanlen is a community that is situated in Ekpoma and located within Esan West LGA of Edo State. Ozalla has low land (low

topography) ranging from 500-600ft while Ehanlen is a plateau ranging from 1000-1300ft. Ozalla is underlain by Imo Formation which comprises sequence of unconsolidated sandstone, iron stone and heterolith. while Ehanlen is underlain by Bende-Ameki Formation which comprises lateritic sandstone, lateritic mudstone, and thin layers of kaolin sequence. Below the Bende-Ameki Formation at Ehanlen lies Imo Formation. (Fig. 1).

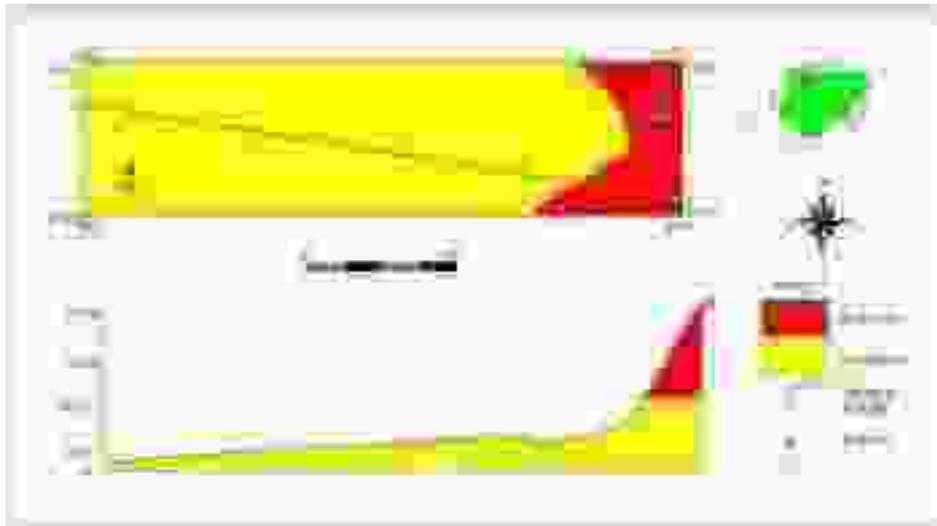


Figure. 1. : The geology map of the study area

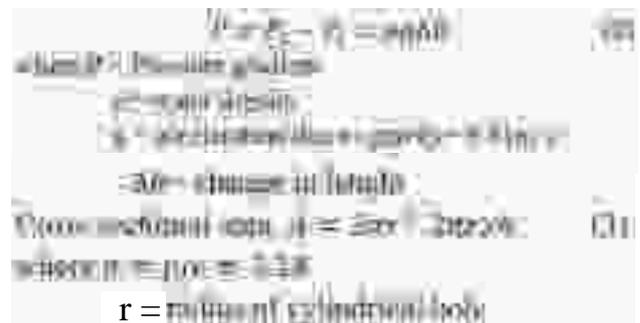
### Materials and Method

Detailed geological investigations were carried out in both areas of study to obtain information on the geological and stratigraphic settings of the area. This was followed by the geomorphology and topographic studies of the area using Global Positioning System (GPS) in acquiring relevant field data in order to determine the effects of elevation on water table. In addition, the depth to water table in each location of study was determined using the geophysical resistivity method.

Hydrogeological study of the areas was done to determine the hydraulic conductivity and the flow rate of the upper layers of the rock units in the two areas by making a cylindrical hole (Fig. 2) into the earth. Measurements of the height of the hole (L) (Fig. 2), the diameter of the hole (D), and the volume of water poured into the hole were obtained. The height of the water retained h in the hole at varying time was determine by subtracting the level of the water in the cylindrical hole H from the height of hole L as

$$L - H = h \tag{1}$$

A stopwatch was used to obtain the time taken for the water that was poured into the cylindrical hole to dry up. This hydraulic conductivity study was repeated twice within both locations. From the acquired data, the hydraulic conductivity in the two areas was computed as follows:



Therefore, the flow rate through the upper layers is given by

$$Q_L = \frac{h}{t} \tag{4}$$

where

- h = height of water retained in the hole
- t = time required for water to dry off

Therefore, applying Darcy's law, hydraulic conductivity is given by:

$$K = \frac{Q_L \mu_L 1000}{A (P_2 - P_1)} \tag{5}$$

where,

- μ = water viscosity (Assumed = 1.005cp)
- L = Length of the cylindrical hole
- A = Cross sectional area of the cylindrical hole
- P<sub>1</sub>-P<sub>2</sub> = Pressure gradient



Figure. 2: A cylindrical hole dug for measuring hydraulic conductivity in the study area

Electrical resistivity method was used to determine earth layer thickness that precedes the water table and the depth to water table in the study area. At the respective VES

points a hole was dug to determine the hydraulic conductivity by using Schlumberger array, Vertical Electrical Sounding (VES), using SAS 4000 terameter. Five VES point were carried out in the study area, two at Ozalla and three at Ehanlen (Fig. 3). The inversion model for resistivity data in the study area was least square method, which is expressed as follows:

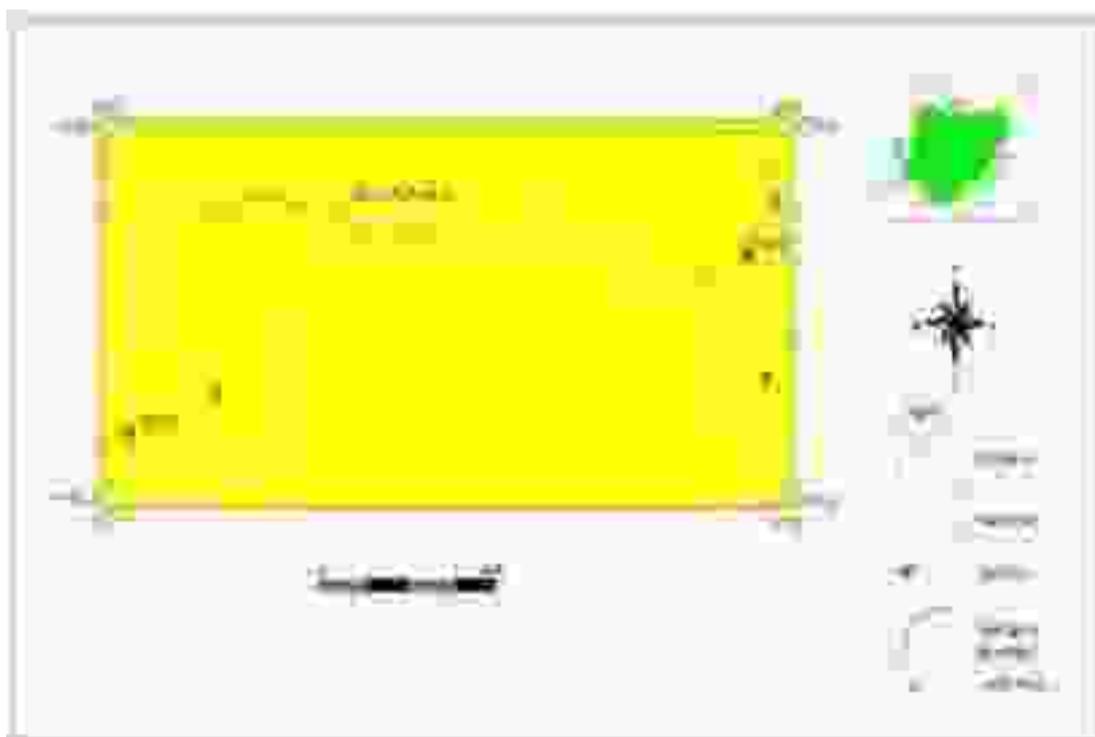


Figure.3: Map of the study area showing VES point and point at which parameter of hydraulic conductivity were acquired

### Results and Discussion

Results of the geological studies show that Ehanlen is underlain by Bende-Ameki Formation. This Formation is further underlain by Imo Formation. In contrast, Ozalla is underlain only by Imo Formation. The VES result for

Ehanlen shows that the water table is very deep, ranging from 300m to 400m (Fig.4 to Fig.6) while the water table at Ozalla is very shallow ranging from 30m to 120m (Fig.7 and Fig.8). The hydraulic study of the area shows that Ehanlen has high elevation ranging from 1000ft to over 1300ft while Ozalla has low elevation ranging from 500ft

to 600ft (Fig.9) the rock units that constitutes the upper layer of the geology of Ehanlen has partially permeable geological unit that is not only clayey but poorly sorted. This hinders the free flow of rainwater into the aquifer, thus slowing down the rate of groundwater recharge. While at Ozalla, the upper geological layer is highly porous, consisting of fine to moderately clayey sandstone that is moderately sorted. This promotes the rate of groundwater recharge.

The result of the upper layer hydraulic conductivity computed for the hydrogeological field data obtained at Ehanlen ranges from  $1.55 \times 10^{-3}$  to  $3.33441 \times 10^{-3} \text{cms}^{-1}$  (Table1) while that of Ozalla ranges from  $1.19 \times 10^{-2}$  to  $3.54 \times 10^{-2} \text{cms}^{-1}$  (Table 1). These suggest that the rate of aquifer recharge at Ehanlen is very slow as a result of the

geological nature and properties of the upper geologic unit of the area. This explain why flooding is often experienced at Ehanlen whenever it rains, with 90% of the rain water lost as run-off to other locations, while the remaining 10% that is expected to recharge the aquifer get attenuated within Bende-Ameki Formation due to high elevation effect. However, at Ozalla, the upper hydraulic conductivity is higher than that of Ehanlen (Table 1), the geological nature and property of the upper geological unit at Ozalla leads to the existence of shallow water table. More so, the low land elevation observed in the area does not allow attenuation during recharge. The hydrogeological and geological property of the upper geologic units at Ozalla localizes its aquifer recharge while the aquifer at Ehanlen does not recharge locally but elsewhere, probably at Ozalla.



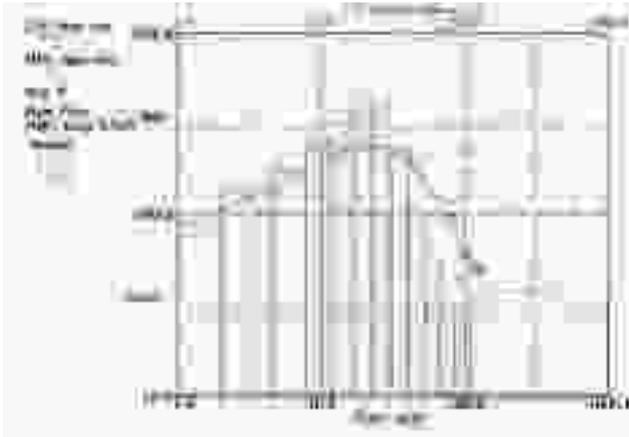


Figure. 8: VES 5 inversion model resistivity result acquired at Ozalla.

Table 1: Summary of hydrogeological results and corresponding elevation of the study area

Location	Radius R (m)	Height of hole L (m)	t (s)	Volume of water (lit)	Height of Water in hole H (m)	Height of water retained in hole h (m)	Change in height $\Delta h$ (m)	Flow rate QL (m/s)	Area (m <sup>2</sup> )	Pressure Gradient (Kgm <sup>-1</sup> s <sup>-2</sup> )	Hydraulic Conductivity K (cms <sup>-1</sup> )	Elevation (ft)
Ehanlen	0.37	0.34	180.29	5	0.18	0.16	0.02	$8.32 \times 10^{-4}$	0.29	$2.94 \times 10^2$	$3.33441 \times 10^{-3}$	1000
Ehanlen	0.37	0.34	240.15	5	0.18	0.16	0.02	$6.25 \times 10^{-4}$	0.29	$2.94 \times 10^2$	$2.50483 \times 10^{-3}$	1150
Ehanlen	0.37	0.34	240.11	5	0.19	0.15	0.04	$6.25 \times 10^{-4}$	0.28	$4.90 \times 10^2$	$1.55657 \times 10^{-3}$	1300
Ozalla	0.37	0.34	180.15	5	0.21	0.13	0.08	$2.22 \times 10^{-3}$	0.27	$8.82 \times 10^2$	$3.54341 \times 10^{-2}$	500
Ozalla	0.39	0.37	180.15	5	0.19	0.18	0.01	$1.05 \times 10^{-3}$	0.45	196	$1.19 \times 10^{-2}$	600

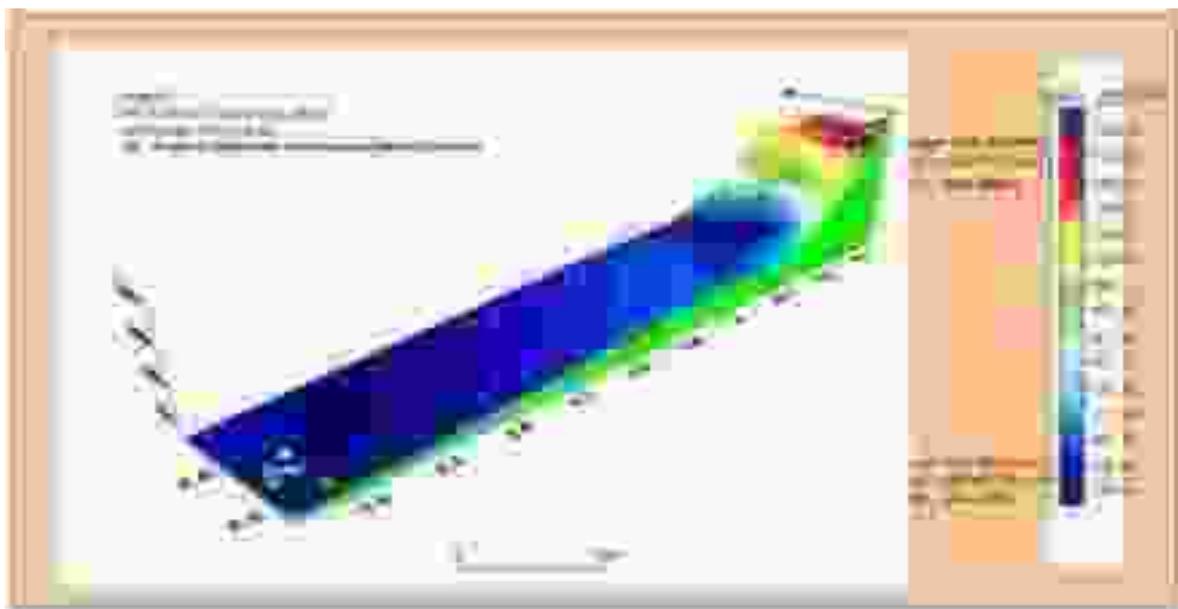


Figure. 9: 3D model of hydraulic conductivity layer, elevation, and water table of Ozalla and Ehanlen, Edo State, Nigeria.

## Conclusion

Using Ehanlen and Ozalla as study communities, we have been able to demonstrate that top layer hydraulic conductivity and elevation effect affects the depth of water table occurrence of a particular place. The deep water table observed in Ehanlen is attributed to its high elevation and low hydraulic conductivity, whereas Ozalla, which is characterized by a high top layer hydraulic conductivity and low elevation, has a shallow water table.

Therefore, an area with high hydraulic conductivity associated with low elevation will have shallow water table, while high elevation and first layer having low hydraulic conductivity will result to deep water table.

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## An Assessment of Factors Responsible for Gully Development in Ambrose Alli University, Ekpoma, Nigeria.

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### Abstract

An assessment of factors responsible for gully development in Ambrose Alli University was carried out by combining two-dimensional induced polarization (2D-IP), 2D electrical resistivity tomography (2D-ERT), physico-chemical, and topographic studies of an existing gully site. The study was aimed at using the combined methods to identify factors responsible for gully development. Over 157 data points were collected for both the 2D-IP and 2D-ERT. The acquired field data was inverted using RES2Dinv software. Soil samples were collected from the gully and analyzed using standard methods, while global positioning system (GPS) was used to acquire topographical data. The data obtained from 2D-ERT, 2D-IP, physico-chemical, and topography were integrated to delineate the geology, identify the soil type, and ascertain the geomorphological factors that predisposed a site to gully. The 2D-IP and 2D-ERT results showed that the gully site contains large deposits of montmorillonite clay overlain by clayey sandstone unit. The montmorillonite clay caused diapiric movement which resulted to faulting of the underlying rock strata. The physico-chemical properties showed that the site had sandy loam texture (high sand 93.2%, low clay 5% and silt 1.98%) which allowed much of the rainfall to seep into the soil due to good infiltration and drainage. Bulk density was 0.99-2.00g/cm<sup>3</sup>, the permeability; 5, slope angle high 5<sup>0</sup>, with high slope length. The development of the gully is attributed to the movement of swollen clay underlying the friable unconsolidated sandstone.

**Keywords:** Erodibility factor, 2D-IP, 2D-ERT, Gully, Fault, Physico-chemical.

### Introduction

Gully is described as a constantly eroding channel formed very close to the head of a depression side or floor<sup>1</sup>. Gully is also a displacement of soil or soft rock particles by a flow of water that forms narrow incisions that are larger and deeper than rills, and that usually carry water only during and immediately after heavy storm. Gullying is governed by concentrated flow characteristic and is frequently focused as a threshold process<sup>2</sup>. Several hydraulic indicators have been used to express and quantify the intensity of the process such as total discharge, unitary discharge, flow shear stress and stream power. The threshold for gully initiation and gully development can be extrinsic, for example, climatic and anthropogenic factors or intrinsic to the channel as a consequence of geomorphologic and

sedimentological natural processes within the gully<sup>2</sup>.

Whenever failure occurs along a well-defined shear plane shallow landslides are formed in the rapid down movement of slope material<sup>3</sup>. They<sup>3</sup> further asserted that movements are commonly triggered when intense rainfall results in high pore water pressure at the contact between the soil mantle and an underlying impermeable layer, which result in the saturation of the soil and a reduction in the factor of safety, may subsequently lead to gully. Shallow landslides commonly evolve into debris flows due to water infiltration<sup>4</sup>.

Gully erosion has attained a larger and devastating dimension in Edo State that it has attracted the World-Bank and other International interventions<sup>5</sup>. All the senatorial districts in the State have their share of environmental problems. In Edo South for instance, the main gully erosion sites are located at Queen Ede, West Moat, University of

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Benin (Ugbowo Campus) and Costain. In Edo North, the main gully sites are located in Auchi, Ikabigbo and Oshibugie while the main gully sites in Edo Central are Emu and Ibore<sup>5</sup>.

An integrated approach has been used to investigate the factors responsible for the formation of gully at post-coal mine in Agali, Istanbul, Turkey<sup>6</sup>. The geological and geophysical data of the area were integrated with the ecological, geomorphologic and metrological data of the area to ascertain the trigger factors. Vertical electrical sounding was used to ascertain the geological information of rock units that underlie the area. The findings showed that areas with unconsolidated sandstone are prone to landslide by infiltration of excessive rainfall which later modified it to gully while areas with consolidated well cemented sandstone are not prone to gully. The study also indicated that areas that later experience afforestation are synonymous with reclamation surfaces while areas with deforestation continue to experience active gully.

Climate and geomorphologic data have been integrated to gully formation<sup>7,8,9</sup>. Aerial photographs have been used to investigate factors that trigger gully<sup>10,11</sup>. However, the present study adopted the integrated approach to scientifically identify the factors that triggered Ambrose Alli University gully and provide mitigation measures or

recommendations that are scientifically based in order to curtail its menace to life and properties.

## Materials and Method

The study area is located in Ambrose Alli University Ekpoma (AAUE), Edo State, Nigeria (Fig. 1). The gully trends from the main road that passes through the entrance of Faculty of Environmental and Management Sciences (Fig. 1), and gully meanders from the North West to the South West of the campus. The widest and deepest portion of the gully occurs in the North West of the trend while it becomes shallower and narrower south westward (Fig. 1).

The geology sections along the gully show that the upper portion of the gully (Fig. 2) comprises friable sandstones while the lower portion of the sections is indurated and clayey. The topography of the area attests to these observations. The shallow and narrow portions are restricted to low elevation; deeper depth (below 300m) while the portion that experienced the highest erodibility is restricted to the area with higher topography; shallow depth (330-360m). The gully stretches up to 0.5 Km (Fig. 1). The sediments that underlie the study area belong to Bende-Ameki Formation and Imo Formation within Edo State arm of Anambra Basin. Bende-Ameki Formation covers 99% of the total area of study while the remaining 1% is underlain by Imo Formation (Fig. 3).

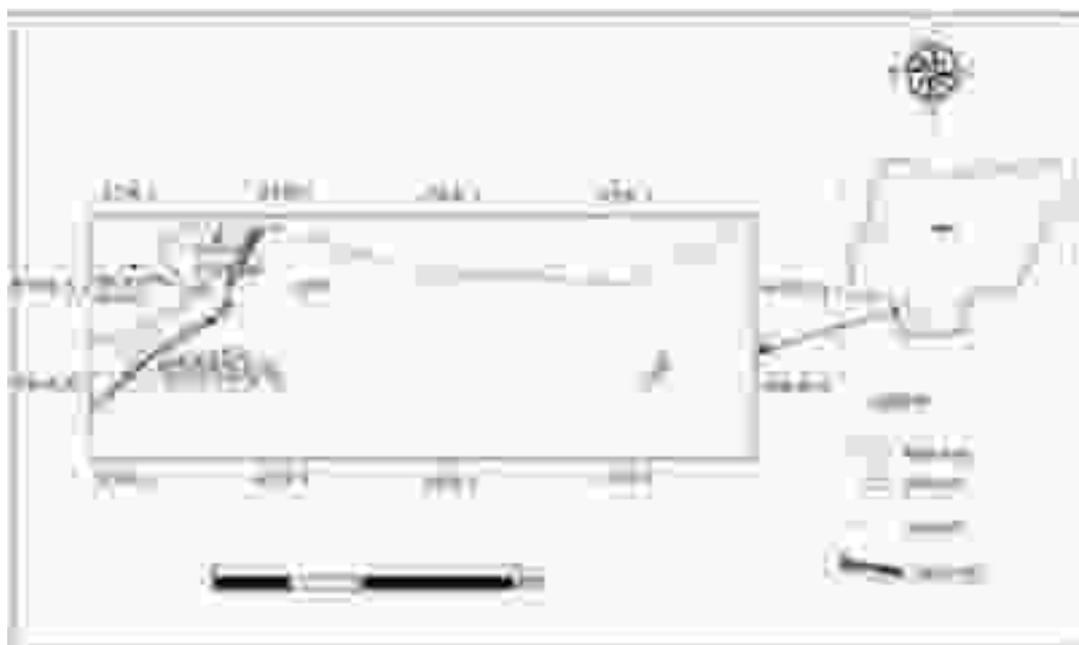


Figure. 1: Map of the study area indicating the gully and the topography of the area



Figure. 2: Gully Site Exposure at AAUE



Figure 3 : Geologic map of the study area indicating the cross section of the area.

### Soil sampling and measurement of morphological properties.

Surface soil samples were collected from each eroded site at depths of 0 – 15 cm and from 15 – 30 cm for the morphological studies. Profile pit was dug in the eroded site and soil samples collected based on standard method<sup>12</sup>. Soil morphological properties were also determined based on standard<sup>13</sup> (Table 2). The geological mapping of the area was carried out to delineate geology section of the area. Samples of geological materials, at selected horizons were collected along the gully channel for geochemical and textural analyses. Two transverses, T1 and T2 (Fig. 4) were taken for this study. The first, T1 was taken parallel to the

gully channel while the second (T2) cut perpendicularly across the gully channel (Fig. 4). Moreso along the transverses, 2D Induced Polarization (IP) and Electrical Resistivity Tomography (ERT) were conducted to delineate the susceptibility of the soil to erosion, identify clay mineral content and porosity of the soil. The positions of data acquisition and gully site were duly geo-referenced using Global Positioning System (GPS). The geological, geophysical, physio-chemical and topographical data of the area were integrated, with inferences made to ascertain the cause(s) of the gully. Thereafter, remediation strategies were proposed to address the environmental problem in AAU gully.

The geophysical data acquisition for both resistivity and

induced polarization were carried out using ABEM SAS 4000. During the period about 150 and 100 data points were sampled along transverse T1 and T2 respectively. Afterwards, the data was processed using RES2Dinv. The inversion model for both resistivity and IP was based on the least square method, expressed in Equations (1) and (2) below:

$$V = IR \tag{1}$$

where

$$V = \text{measured voltage (V)}$$

$$I = \text{measured current (A)}$$

$$R = \text{resistivity (ohm m)}$$

$$L = \text{spacing (m)}$$

$$T = \text{depth (m)}$$

$$\rho = \text{resistivity of the rock}$$

$$\rho = \text{chargeability}$$

$$T = \text{time constant}$$

The resistivity meter was used to simultaneously measure the resistivity (2D-ERT) and chargeability (2D IP) of subsurface rock units around the gully channel. The IP measurement was taken to discriminate clay mineral from sandstone in the area. The IP method measures the transient

decay of the voltage when the transmitted current is turned off. The voltage with length of the different time intervals is expressed in Equation (3)

$$V = IR \tag{3}$$

$$V = IR \tag{4}$$

$$V = IR \tag{5}$$

Equation (4) can be further expressed as Equation (5) in order to have IP unit in form of mV/v as:

$$V = IR \tag{5}$$

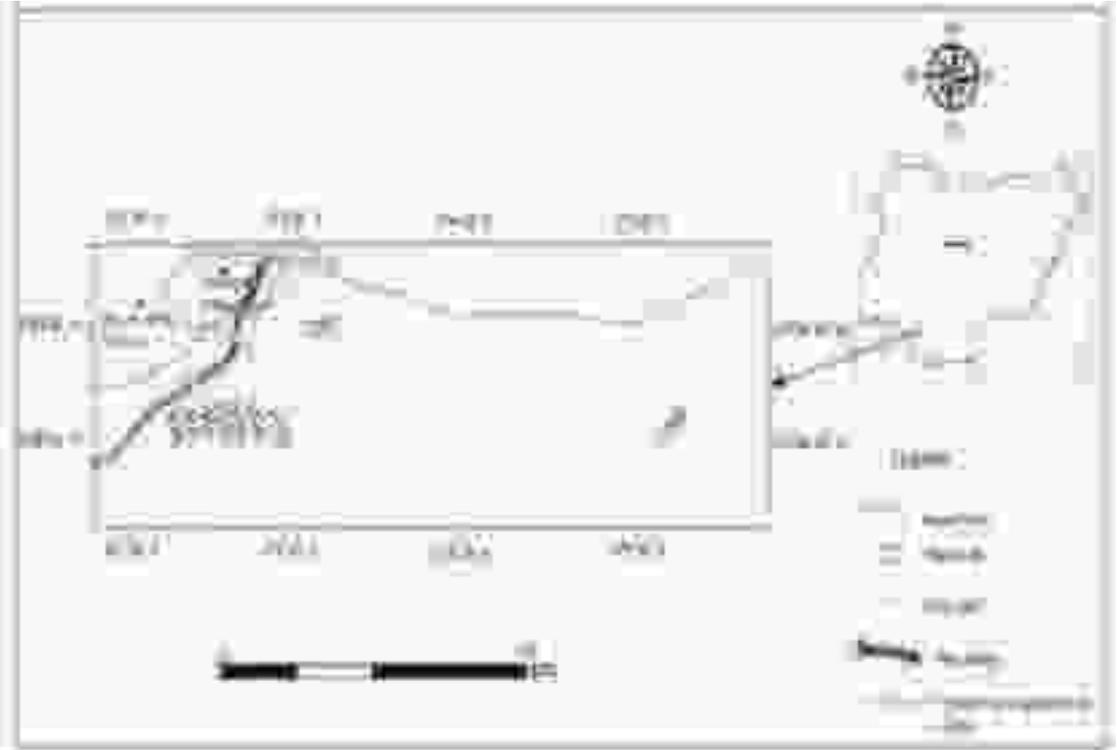


Figure. 4: Transverse map indicating area of geophysical data acquisition.

## Laboratory analysis of samples

Soil pH was measured in a 1:1 soil-water suspension using glass electrode pH meter<sup>14</sup>, while organic carbon was determined by wet dichromate acid oxidation method<sup>15</sup>. Particle size distribution was determined by the hydrometer method<sup>16</sup>. The soils were dispersed with sodium hexamethaphosphate solution and also by distilled water for dispersion determination. The core method<sup>17</sup> was used to determine the soil bulk density and porosity.

## Quantification and estimation of soil erodibility (K-factor)

To evaluate the effectiveness of Universal Soil Loss Equation – erodibility factor model (USLE-K model), comparison between the measured William<sup>18</sup> erodibility data with the Wischmeier<sup>19</sup> and nomograph data was done. According to Goldman<sup>20</sup>, the preferred method for determining K-factors is the nomograph method based on studies<sup>19</sup> and is mathematically represented as shown in Equations (6) and (7)

$$K_{\text{fact}} = (1.92) [2.1 \times 10^{-6} f_p^{1.14} (12 - P_{\text{om}}) + 0.0325 (S_{\text{struc}} - 2) + 0.025 (f_{\text{perm}} - 3)] \quad (6)$$

$$f_p = P_{\text{sil}} (100 - P_{\text{clay}}) \quad (7)$$

There are various methods available for determining soil erodibility factors. In this study, the methodology developed by Wischmeier<sup>19</sup> was implemented.

where

$f_p$  is the particle size parameter

$P_{\text{om}}$  is the percent organic matter

$S_{\text{struc}}$  is the soil structure index

$f_{\text{perm}}$  is the profile-permeability class factor

$P_{\text{clay}}$  is the percent clay

In Equation 6 the factor (1.292) is needed to convert  $K_{\text{fact}}$  from the English units used in Goldman<sup>20</sup> to the metric units used in this study. The soil structure index,  $S_{\text{struc}}$ , is equal to: 1 for very fine granular soil; 2 for fine granular soil; 3 for medium or coarse granular soil and 4 for blocky, platy, or massive soil. The profile-permeability class factor,  $f_{\text{perm}}$ , is equal to: 1 for very slow infiltration; 2 for slow infiltration; 3 for slow to moderate infiltration; 4 for moderate infiltration; 5 for moderate to rapid infiltration; 6 for rapid infiltration.

**Statistical analysis:** The standard deviation and percent coefficient of variability was carried out according to Frank<sup>21</sup>.

## Results and Discussion

### Physico-chemical and Morphological Properties

The soil texture in the gully site ranged from sandy to loamy sand. Based on the texture, these soils are readily exposed to erosion. Sand fraction has macro-pores capable of water movement into the deep layers of the pedon. Sand particles are usually of low transportability<sup>22</sup>. However, the deep gully developed is mainly attributed to the volume of run-off water that enters the site. A dispersion ratio of more than 15% recorded for the sites further accounted for the erodible nature of the site. The surface soil structure is medium or coarse granular as presented in Table 2. The weak structure is evidenced by the very low organic matter. The sand particles are easily detached and therefore prone to erosion since they form poor soil structure. Aggregates are aided by organic matter, clays, iron oxides and aluminum oxides. Aggregate breakdown and soil dispersion may affect soil porosity, decrease water infiltration and hydraulic conductivity and increase surface sealing and susceptibility to erosion<sup>23,24</sup>.

In the gully site, bulk density ranged from 0.99 to 2.00 g/cm<sup>3</sup>, with density increasing with depth as depicted in Table 1. Porosity (41%) is directly proportional to the bulk density and was almost similar in value with mean porosity (43.2%). As soil particles are eroded, soil materials become loose, thereby reducing the bulk density and increasing the porosity<sup>25</sup>. Soil density increases with compaction at depth<sup>26</sup> and very compact subsoils or strongly indurated horizons may exceed 2.0 g/cm<sup>3</sup>. At higher depths, higher bulk density is attributed to high clay content and thus makes it less vulnerable to erosion as in the case of AAU site. However, in the gully site the sandy texture of the profile even at higher depth further increases the vulnerability to erosion<sup>27</sup>.

As measured, the permeability of the site was 5 (moderate to rapid) (Table 2). Slope angle of the site was 5° high with high slope length. No other variable affects the stability of slopes with regard to surficial erosion and mass wasting as does topography or slope morphology i.e. inclination and degree of slope<sup>28</sup>. In spite of slope angle of 10%, runoff will not only carry fine particles but can also attack the soil, digging out stratified channels for which speed quality build up, and thus becoming linear erosion (grooves, rills and gullies).

Table 1: Physico-chemical properties for the AAUE gully site.

Depth (cm)	pH	OC	Omg/kg	Sand	Silt %	Clay	Silt/Clay	Bulk density g/cm <sup>3</sup>	Porosity	Dispersion %
0 – 10	4.6	6.66	11.48	93.02	1.98	5.00	0.40	0.99	63	64
10 – 25	4.6	5.70	9.82	92.30	1.69	6.01	0.32	1.23	54	60
25 – 55	4.4	5.69	9.81	91.67	1.00	7.33	0.14	1.56	41	42
55 – 74	4.5	5.30	9.13	88.17	2.88	8.95	0.32	1.67	37	56
74 – 122	4.4	4.98	8.59	85.67	2.10	12.23	0.17	1.70	36	57
122 – 157	4.6	4.66	8.03	82.67	4.00	13.33	0.30	1.87	29	55
157 – 200	4.9	4.30	7.41	80.19	1.61	18.20	0.09	2.00	25	45
X	4.57	5.33	9.18	87.67	2.18	10.22	0.25	1.57	41	54
SD	0.17	0.78	1.34	5.02	0.98	4.84	0.11	0.35	13.49	7.90
%CV	4	15	15	6	45	47	46	23	33	15

Table 2: Some surface physical and morphological characteristics of the soil<sup>13</sup>.

Parameter	Gully Site
Soil structure	3 - medium or coarse granular
Aggregate stability	0.17%
Permeability Class	5 – moderate to rapid
Slope Length	5%

Based on the computations from equation 1 and 2, the K-factor value of 0.14 was obtained for the gully under review. The erodibility indices for the samples of soils from the gully when compared with standard erodibility indices (Table 3) showed that it falls into group II. However, it is difficult to reduce erodibility once soil has become degraded and lost its organic matter, clay, structure and permeability. Erodibility (k) factor can rise from 0.1 to 0.2 or 0.35 with the degradation of cropped soils<sup>29</sup>.

Table 3: Standard erodibility indices<sup>27</sup>.

Group	K-Value	Nature of soil
I	0.0 – 0.1	Permeable out wash well drained soil, slowly permeable substrata
II	0.11 – 0.17	Well drained soils in sandy gravel free material
III	0.18 – 0.28	Graded loams and silt loams
IV	0.29 – 0.48	Poorly graded moderately fine texture soil
V	0.49 – 0.64	Poorly graded silt, very fine sandy soil, well and moderately graded

The ERT transverse taken perpendicular to the mouth of the gully showed that the upper layer of the gully is friable sandstone bed (from the surface to 6m). Below it is a clay bed that occurs at a depth of about 6.5m. The clay bed is clearly noticed from the ERT (Fig.5) and IP (Fig.6) results. However, the clay is probably a montmorillonite because from the ERT at around 50m along the transverse showed evidence of upward movement that pierced into the overlying beds thus, deforming the beds and resulting in fault (Fig. 5). The structure could not be seen in IP due to masking by the lithology that is pierced.

Moreso, the clay type has been identified as montmorillonite. This was revealed at a distance of about 50m along the transverse from the 2D-ERT inversion model (Fig. 5) which showed evidence of upward movement that pierced into the overlying beds, thus deforming the beds and resulting in a fault (Fig. 5). The structure could not be seen in the 2D-IP result (Fig. 6) as a result of masking effect by the pierced lithology.

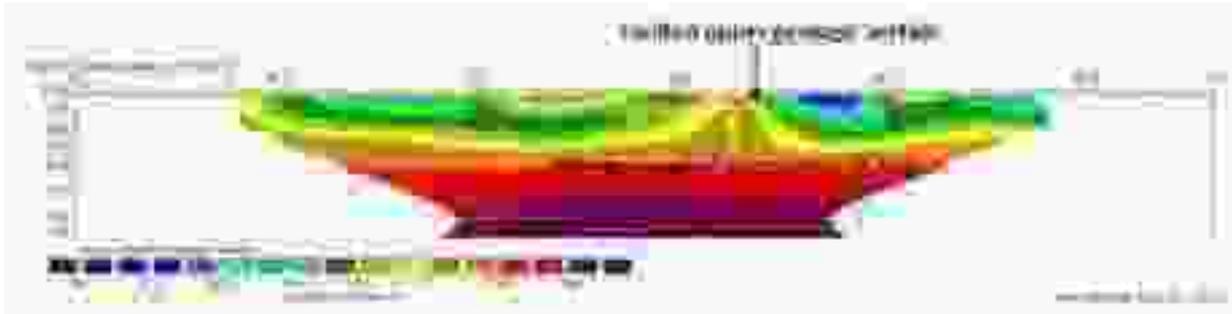


Figure.5: 2D-ERT inversion model taken perpendicular to the mouth the gully site (Transverse T2)

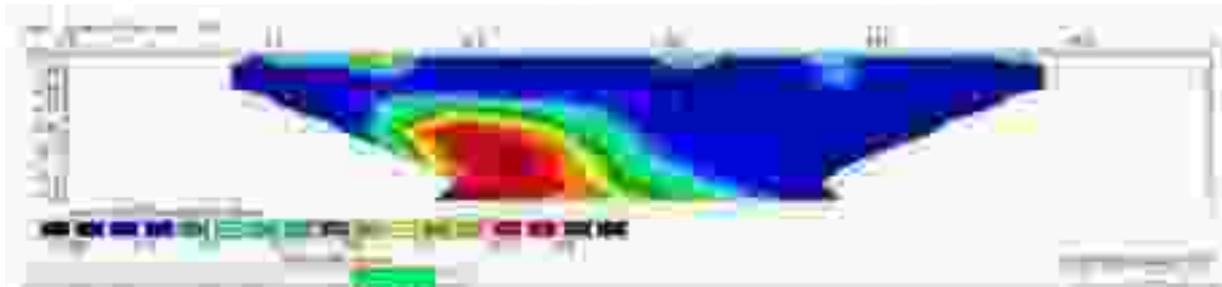


Figure.6: 2D-IP inversion model taken perpendicular to the mouth of the gully site (Transverse T2)

Transverse 1, taken parallel to the gully channel showed an anticlinal structure (Fig. 7). The IP taken parallel to the gully showed that the chargeability is negative from surface to a depth of about 5m and 12m (Fig.8). This very low value indicates that the area is underlain by unconsolidated sandstone that can easily be eroded by run-off coming from the adjacent slope. This observation is in conformity with the observation made during geological mapping of the study area.

The lower portion of the gully showed high resistivity and high chargeability values (Fig.5 to 8). These values show that the lower part of the gully is well consolidated, highly clayey, and cemented. It also showed that the portion could not easily be eroded by the run-off.

The AAUE gully was structurally formed as a result of a faulted subsurface rock which is located adjacent to the flow direction of run-offs. This runoffs usually flows from a high gradient surface with high turbulence into the faulted friable sandstone bed.

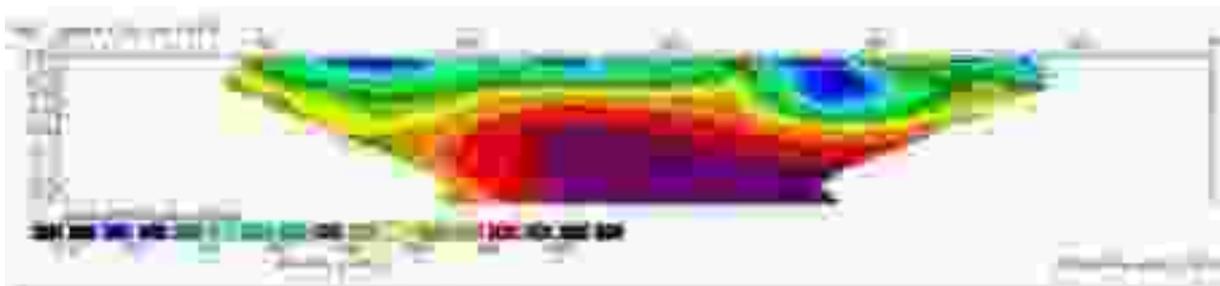


Figure. 7: ERT inversion model taken parallel the gully's orientation (Transverse T1)



Figure 8: 2D IP inversion model taken parallel to the gully's orientation (Transverse T1)

## The Origin and Factors that Triggered the Gully

The development of the gully was initiated gradually over time by the movement of swollen clay that underlay friable sandstone units within the earth subsurface. As time lapses, the swollen clay continue to exert an upward force on the sandstone bed which subsequently became folded, pierced, fractured (due to exceeding elastic limit), and finally develop into a fault (due to the action of opposing forces) (Fig. 5 to 8). Thereafter, two drainages from adjacent slope which gathers rainwater within the University community (Fig. 4) channeled its run-off at high pressure, thereby causing the rainwater to percolate through the fault into the formation. This action weakens of the formation. The friable nature of the sandstone paved way for the action of the run-off to gradually erode its material to form gully. Hence, the, geologic structure (fault), the geomorphology of the area, and the rainwater channel pattern, are the causal factors that triggered the gully.

## Conclusion

The AAUE gully was formed by internal and external factors which are still active. The internal factors occurred through geologic time by geological activities from the time of basin creation through transportation, deposition, diagenesis and lithification of sediments that underlie gully site. After lithification, overlaying weight of the upper beds and gravity force constitute overpressure that made the underlying clay material suspected to be montmorillonite to expand at the retention of water and push upward into the overlying beds. The movement led to failure of the overlying bed which resulted into a fault.

The external factors are human activities that modified the landscape of the gully site such as constructing drainage channel that drains rainwater perpendicularly into the faulted beds. The fault plane creates conduit through which rainwater runoff easily infiltrates the underlying clay. The swelling of the clay minerals resulted into an upward movement of the overlying strata with a gradual extensive force that made the strata to be faulted and become loosen due to their friableness (highly unconsolidated sandstone), with the particles of the loosen rock gradually been eroded away through the developed gully channel with time. The other external factors include rainfall and high gradient topography.

If unusual increase in rainfall occurs in future, such that the channel becomes flooded and over flows, the outcome will be catastrophic and impact adversely on building around the

gully site, nearby structures, and human life. Finally, we propose re-channeling of rainwater run-off within the location under study, in such a way that the flowing pressure and the carriage capacity of the run-off will be reduced to minimize the erodibility action of run-off along the gully channel. In addition, planting of gully prevention plants should commence along the gully channel as a preventive control on erosion of soil materials and further widening of the gully.

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## Typical Presentation of Organophosphate Poisoning In Bisha, Saudi Arabia: Illustrative Case Series

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### Abstract

Organophosphates and carbamates are the most frequently used insecticides worldwide. They are also among the common causes of childhood poisoning. The aim of this report is to illustrate 3 cases of organophosphate poisonings and highlight the presentation and circumstances surrounding their occurrences. The three patients were females with ages between 3-5years. Two of them were admitted on the same day. They had no pre-morbid mental sub-normality. They all got poisoned through a socially acceptable but harmful practice within the community, and the third got exposed without physical contact. They were all managed and discharged within 48 hours of admission. Continuous community engagement and probably some form of enforcement are needed to correct the socially acceptable but harmful practices inimical to the well-being of the community.

Keyword: Organophosphates, carbamates, insecticides, patients, Bisha

### Introduction

Organophosphates were first discovered more than 150 years ago–; however, their widespread use began in Germany in the 1920s, when these compounds were first synthesized as insecticides and chemical warfare agents. Interest in their effects on humans has increased in recent years due to their potential use as weapons of mass destruction. Organophosphates and carbamates are the most frequently used insecticides worldwide.

These compounds (Organophosphates and carbamates) cause 80% of the reported toxic exposures to insecticides. Organophosphates produce a clinical syndrome that can be effectively treated if recognized early. Most paediatric poisonings occur as the result of accidental or arguably non-accidental exposure to insecticides in and around the home or farm.

Worldwide, pesticide poisonings cause an estimated 20,000 deaths and cause more than one million serious

poisonings annually. No known racial differences in mortality or morbidity are reported. No differences in clinical effects between the sexes are known. In King Abdullah Hospital, Bisha, Saudi Arabia, hospital records in the last 15 years showed that over 100 cases were managed (6-10 cases per year on average) with one death recorded.

Organophosphates and carbamates bind to cholinesterase enzymes, preventing the degradation of acetylcholine, resulting in its accumulation at nerve synapses. Enzymes affected include acetylcholinesterase or red blood cell cholinesterase, pseudocholinesterase (found in plasma), and neurotoxic esterase (found in the nervous system). If left untreated, organophosphates form a permanent bond to these enzymes, inactivating them. The organophosphate-cholinesterase bond can spontaneously degrade, reactivating the enzyme, or can undergo a process called aging. The process of aging results in irreversible enzyme inactivation and occurs over 2-3 days after exposure. It takes weeks to months for the body to regenerate inactivated enzymes. In contrast, carbamates form a temporary bond to the enzymes, allowing regeneration of the enzymes over some hours.

Cholinesterases rapidly hydrolyze the neurotransmitter acetylcholine into inactive fragments. Acetylcholine is found in sympathetic and parasympathetic ganglia and in

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the terminal nerve endings of postganglionic parasympathetic nerves at the motor endplates of nerves in the skeletal muscle. Inactivation of the enzyme allows acetylcholine to accumulate at the synapse, leading to overstimulation and disruption of nerve impulses. Skeletal-muscle depolarization and fasciculations occur secondary to nicotinic stimulation at the motor endplate.

Muscarinic effects occur at the postganglionic parasympathetic synapses, causing smooth-muscle contractions in various organs including the GI tract, bladder, and secretory glands. Conduction can be delayed in the sinus and atrioventricular (AV) nodes. Dysarrhythmias are frequently reported; these typically include bradycardia, though tachycardia can also occur.

Our intent is to highlight the circumstances of the poisoning, the manifestation, the early presentation and the outcome with the apparent awareness of the care givers of the possibility of the poisonous nature of the offending agents.

## Case Series

### Case 1

A three year old girl was referred to King Abdullah Hospital, Bisha on account of dizziness, nausea and vomiting following exposure to a chemical suspected to be organophosphate about 7 hours prior to presentation. There was no history of pre-morbid mental sub-normality in the child. Parents were aware of the poisonous potential of the chemical used in washing the hair of the child. At presentation, she was conscious, not pale, anicteric, afebrile, not cyanosed, not dehydrated. Central nervous examination was essentially normal except for pin-point pupils. Cardiovascular examination revealed bradycardia (heart rate of 82 beat/minutes), other parameters were normal. She was admitted and treated with atropine, pralidoxime, intravenous fluid and hydrocortisone. She made significant improvement and was discharged home about 48 hours after admission.

### Case 2

A five year old girl referred to the hospital on account of dizziness, drooling of saliva, poor vision and vomiting of about 7 hours prior to presentation. She developed these symptoms as she was being prepared for hair cleansing with a chemical containing organophosphate. There was no history of ingestion of the chemical, no pre-morbid mental sub-normality in the child. Parents were aware of the

poisonous potential of substance prior to the child's exposure. At presentation, she was conscious, not pale, anicteric, afebrile, not cyanosed, not dehydrated. Central nervous examination revealed a conscious but weak child, with pin-point pupils, normal muscle bulk, tone and power of 4/5 in both upper and lower limbs. Cardiovascular examination revealed pulse rate of 76/minute, blood pressure of 92/58mmHg, normal precordium and normal heart sounds. Respiratory and abdominal examinations were essentially normal. She was admitted and placed on atropine, pralidoxime and intravenous fluid. She made significant improvement and was discharged home 48 hours after admission.

### Case 3

A five year old girl referred to our hospital on account of vomiting, hearing abnormal sounds and unsteady gait of nine hours prior to presentation. She was said to have developed symptoms following the use of a chemical containing organophosphate on her hair by her elder sibling (who was about 15years old), Parents and the household were aware of the poisonous potential of the chemical prior to their child's exposure. Other aspects of the history were not contributory. At presentation, she was drowsy, not pale, anicteric, afebrile, not cyanosed, not dehydrated. Central nervous examination revealed pin-point pupils, normal cranial nerves and unsteady gait. Respiratory examination was essentially normal and cardiovascular examination revealed pulse rate of 80 beats per minute. She was admitted and placed on atropine, pralidoxime, intravenous fluid and oxygen. She made significant improvement but was discharged against medical advice about 48 hours after admission.

## Discussion

Organophosphates are generally highly lipid soluble and are well absorbed from the skin, mucous membranes, conjunctiva, GI system, and respiratory system thus the toxicity follows the use of substance when used topically on the skin or hair. Exposure can occur by means of ingestion, dermal exposure, or inhalation. This probably explains the reason why the children presented with signs of toxicity despite the absence of oral ingestion of the chemicals.

Most symptoms appear within 12-24 hours of exposure however, symptoms occurred earlier in these children and their presentation earlier as well. This may be attributable to good health financing nature of the environment. Parents are often encouraged to present when the earliest sign of any illness is noticed in their children or wards.

Children are at a significantly increased risk of exposure to organophosphates worldwide, particularly in developing regions, where the widespread availability and use of organophosphates and the lack of regulation and safety packaging are high risk factors for exposure. They often ingest home pesticides they find in unmarked or poorly stored containers. They can also be exposed when playing in areas recently treated with organophosphate compounds. A history of possible exposure combined with physical signs and symptoms consistent with exposure often lead to diagnosis. Many organophosphates can irritate the skin and mucous membranes. Some have a characteristic odour, such as a garlic-like smell. In the highlighted cases, this substance was not ingested however effected the poisoning through exposure to the skin or inhalational route.

Physical findings relate to the accumulation of acetylcholine at peripheral nicotinic and muscarinic synapses and in the CNS. Muscarinic signs and symptoms include diaphoresis, emesis, urinary and fecal incontinence, tearing, drooling, bronchorrhea and bronchospasm, miosis, and hypotension and bradycardia. These were well demonstrated in the children highlighted. However, muscle weakness, ataxia, malaise are mainly nicotinic signs and symptoms and these were present in some of the children. Other nicotinic manifestations include fasciculations, tremors, hypoventilation, hypertension, tachycardia, and dysarrhythmias.

Possible cardiac manifestations include myocardial ischaemia, arrhythmias including heart block, QTc prolongation and ventricular dysarrhythmias. Metabolic abnormalities include metabolic acidosis, pancreatitis and hyperglycaemia. –

Neurologic manifestations include intermediate (neurologic) syndrome and delayed/long term neuropathy. Intermediate (neurologic) syndrome manifests between 24-96 hours after exposure. It may consist of neck flexion weakness, proximal muscle weakness, cranial nerves deficit, attenuated deep tendon reflexes and respiratory insufficiency. Recovery begins 5-15 days after onset. Delayed and long term neuropathology include organophosphate induced delayed neuropathy (OPIDN) and neuro-behavioural deficit. OPIDN occurs 1-3 weeks after exposure and is peculiar to specific agents such as Chlorpyrifos. Affected patients present with transient, painful “stocking-glove” paresthesia followed by an ascending symmetrical polyneuropathy resulting in flaccid weakness of the extremities. These were not observed

probably because the presentation was quite early in all the cases and appropriate medical care were rendered immediately.

Indications for admission include intentional ingestion or exposure, patients with severe cholinergic (Muscarinic, Nicotinic or CNS) manifestation requiring admission into ICU, suspected abuse and unfavorable social condition. These patients were admitted on account of presence of social environment that perpetuate the use of organophosphate for hair care in addition to need for early medical intervention. Thus, it is probably not surprising that none of the cases needed admission into intensive care unit. Investigations done included Complete Blood Count to rule out infectious causes, chemistry tests which may be useful in ruling out electrolyte disturbances. ECG done in them revealed sinus bradycardia and no arrhythmias, chest radiography was essentially normal. These can be attributed to early presentation and early and appropriate treatment. Treatment involves resuscitation, decontamination, stabilization and giving antidotes. Resuscitation involves ensuring airway patency, ventilation, and giving circulatory support when necessary. Decontamination involves removing all of the patient's clothing and washing him or her with water and soap preferably before entering the emergency room. It is of utmost importance in minimizing continued exposure and to protect providers and other patients from contamination. Gastric decontamination with activated charcoal is recommended to be administered if ingestion if patient is seen within one hour thereafter, this was not necessary as the children presented well after one hour and through inhalational and skin contact route.

Atropine and pralidoxime are the two key medications used in the treatment of organophosphate poisoning. Both were administered to all the children. Atropine antagonizes the central and muscarinic effects by blocking the muscarinic receptors. It is given at 0.03-0.05 mg/kg IV/IM/IO/ET q10-20min PRN to effect; then q1-4hr for at least 24 hours. Pralidoxime is a cholinesterase reactivator and the antidote for organophosphate poisoning. It is administered to patients with organophosphate exposure and signs of muscle and respiratory muscle weakness. It primarily affects the nicotinic receptors and does not reverse the CNS effects. It is given as an IV infusion after a loading dose until signs of weakness improve.

It is important to avoid the use of morphine, caffeine, loop diuretics, theophylline, and succinylcholine in patients with organophosphate poisoning because these drugs can

increase the toxicity of the exposure. We had no cause to administer any of these to any of our patients.

Patients with minor or no symptoms of toxicity after organophosphate exposure may be discharged from the emergency department after 6 hours of observation. Discharged patients usually do not require outpatient medications. All our patients in this series were discharged after 48 hours to be sure that the symptoms have resolved.

Prevention of organophosphate poisoning in children involves use of safety lids on accessible containers of pesticides, keeping chemicals out of reach of children, avoidance of storing in a familiar container, desisting from socially acceptable but harmful practice like use of organophosphate in the care of the hair and educating the public of the danger of exposure to organophosphates must be widely announced and enforced within the community.

Prognosis of organophosphate poisoning is excellent when patients present early. Most patients fully recover in 7-10 days. Patients with toxicity untreated for more than 24 hours may have a prolonged and severe course with lasting neurologic complications. This probably explains the very good prognosis associated with organophosphate poisoning in the centre. Early presentation is the norm.

## Conclusion

Organophosphates are common causes of childhood poisoning. Early presentation and institution of appropriate therapy improve the outcome in patients. Continuous health education of the populace and training of health care workers will reduce the occurrence and attendant morbidity and mortality of the condition. Also, enforcement of adherence to the desist from the use of organophosphates as hair cleansing agent should be vigorously pursued in the community of the study.

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## Challenges and Prospects of Contemporary Environmental Issues

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### Abstract

Man's interest in the environment is largely connected with its provision of habitat and resources for survival. Consequently, the overall objective of this paper is to analytically examine how man's increasing technological sophistry, careless use of environmental resources, omnipotence stance has created myriad of disharmonies in environmental systems resulting in feedbacks that threatens his existence on planet earth. Specifically, the paper discusses general contemporary man-environment challenges and the prospects for the future with references to the situation in Nigeria. The paper adopts basically content review and analysis of documented evidences, together with field observations and dialogues in addressing issues raised. The findings showed that the urgent sectors presenting severe environmental challenges are agriculture; deforestation and biodiversity depletion; aridity, drought and desertification; environmental degradation from oil exploitation; climate change and global warming; environmental pollution; waste generation and management; flooding as well as soil and gully erosion. The prospects now and in the future are highlighted to include the adoption of environmentally intensive agricultural system such as precision farming; proactive conservation and regeneration measure in addressing problems of deforestation, biodiversity loss, aridity, drought and desertification; environmental friendly oil exploitation measure including zero gas flaring and proactive remediation of blighted areas; adaptive climate change measure particularly in agriculture, water exploitation and land use activities; and comprehensive waste management approach, including waste minimization, recycling and reuse policies, particularly with respect to plastic wastes. Moving forward, the paper recommends investments in researches and development of environmentally friendly and affordable energy sources from solar, wind, and biomass; sustainable human use of land to obtain good and services; and above all, an inclusive environmental education in order to address issues of environmental challenges now and in the future.

**Keywords:** Environment, resources, degradation, technology, challenges, management

### Introduction

The environment comprises of the land, water and air, including all layers of the atmosphere and the biosphere, together with all organic and inorganic matters and living organisms on, in and below the earth's crust. However, the environment in the concept of man is not complete without bringing in the human factor in terms of its effects in the modification and determination of life and character. As espoused by the Federal Environmental Protection Agency Act, the environment include water, air, land and all plants and human beings or animals living therein and the interrelationship which exist among these or any of them<sup>1</sup>.

Consequently the environment of man which is the built environment embodies all the land uses, associated infrastructure and recreational space which enhance the people's standard of living. In essence the environment includes the ways in which the environmental media interacts with one another and the ways in which they interact with manmade environment and the fauna and flora which inhabit them<sup>2</sup>: The environment should therefore be seen to cover the natural environment given by God for man's usage and the built environment designed and developed by man.

Man is perhaps the most important organism in the environment. Indeed our interest in the environment is largely connected with its provision of habitat for man. Man is material-using organism: Everything he uses from the food needed to keep him alive to the objects he fabricates, whether tools or sculptures, comes from the substances of the planet (environment) on which he lives<sup>3</sup>. Wastes are then returned to the biological and abiotic

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systems of the earth.

Man's levels and rates of interaction with his environment have undergone tremendous transformation from his presence on planet earth to contemporary times. This has been largely dictated by his needs, modes of meeting the needs as well as technological knowhow. The emergent issues from man's interaction with the environment maybe chronicled into three phases, namely *Palaeolithic era*, *Neolithic era* and *Modern era*<sup>4,5</sup>.

During the Palaeolithic period, man's needs depended basically on whatever the environment offered: This was the era of *environmental determinism* when man essentially met his needs for food, water and shelter through gathering of fruits, hunting for animals using sticks, stones and clubs as hunting tools; taking shelters in caves, under trees and covering themselves with leaves and hides and skins. The interaction between man and his environment during this era was a one-way affair as he had no option but to yield to whatever is obtainable from the environment. Moreover, human population was relatively low. Consequently, man's actions on the environment could not really provoke serious disruptions in environmental systems

The Neolithic era which is also referred to as the *middle age* or *Iron Age*, witnessed massive improvements in technological developments such that man could take advantage of the possibilities offered by the environment using technology, to enhance his wellbeing. Man thus had the ability to decide what he desires from the environment. This era which is aptly termed *environmental possibilism* was marked with revolutionary technological developments, and growing population that largely transformed environmental systems resulting in unprecedented massive disturbances and the emergence of a myriad of environmental problems.

Increasing sophistication in human wants resulting in increased technological sophistry brought about the era termed *the modern phase* or *the modern age*. The unique feature of the modern era is that man has the capability to reject possibilities offered by the environment and modify them to his taste using technology. Thus, the phase is characterised by the desire for various needs by man and many steps have been devised to meet these various needs from the environment, with the concomitant repercussions of environmental upheavals. This situation is exacerbated by burgeoning global population, Suffices to note that increased technological sophistication and population explosion, coupled with man uncaring attitude on the

environment, threatens man's survival and well-being both in the presence and future too.

Indeed the twentieth-century man is drifting; cut off from the earth by the advent of urbanism and industrialisation. This has been labelled *alienation*. Urban population and sophisticated virtual urbanism is growing at an alarming rate. Man no longer belongs in any natural setting and his externalities (including the environment) are alien and almost certainly hostile. Consequently, man's wants and desires have become more novel and perhaps bizarre resulting in monumental disruptions in the balance of environmental systems. This era of *alienation* perhaps may be described as the fourth phase of man-environment relationship.

## Man's Impact on the Environment

At some stage in the last million or two years, the environmental systems were unaffected by man: they were pristine or virgin. Suffices to note that only very few such places remain: this is because much tracts of the terrestrial surface has been altered in some way by man. In the primeval era when human population was small and his technological ability limited his activities inflicted little damage on the environment and such damages were repaired by the regenerative powers of nature. However, with explosion in population and increasing technological knowhow man's dominance of nature is on the increase, albeit at a huge cost to his survival and well-being<sup>6</sup>. Consequently environmental problems are manifestation of disharmony between human activities and the environment. All over the world, environmental problems of various types and intensities have emerged to threaten man's well-being, and the natural environment which serves as his life-support system.

All biological life depends on a wholesome and well-functioning environmental systems and it must be noted that the earth has no limitless supply of resources which must be proportionately shared by all living<sup>7</sup>. It must also be noted that human beings disobey the law of nature at their risk while human success results from co-operation with nature, fitting into the web of life<sup>8</sup>. One effect seems to have been the heightening of confusion about man's place in nature. Omnipotence seemed to be manifest, yet the lot of many was so obviously unimproved.

The inventiveness and applicability of nineteenth century technology meant that the resources of the world appeared

to be infinite, for new means of making them accessible and new markets for material products went together. It has however become very clear that man's activities in the environment cannot be sustained if unchecked. This is because there are ecological limits which set boundaries on the pattern and manner of utilisation of the environment and its resources. This calls for the entrenchment of environmental management. Environmental management is the process of putting together those items of environmental (nature) where man exists so that man's penetration and exploitation do not have adverse effect on the environment<sup>9</sup>: This is aimed at ensuring that the environment is free from abuse, and misuse that may result in pollution and degradation. It is aimed to promote development compatibility, balance urban land use value and upgrade the environment for present and future generations. Consequently, sustainable development and environmental protection and management are now the major issues facing mankind.

## Conceptual Issues

The primordial aim of development in the environment is to improve the quality of life and enable people to realize their potentials and lead lives of dignity and fulfilment<sup>6</sup>: Development is real only if it makes human lives better in all these respects. A development pattern that pays little or no regards to environmental issues is essentially a disaster right from outset. Five core paradigms to explain the nexus between development and environmental management have been identified<sup>10</sup>. The paradigms are: *Frontier Economics, Deep Ecology, Environmental Management, Resource Protection and Eco-Development*.

The notion of the Frontier of Economics is that nature is blessed with infinite supply of physical resources such as raw materials, energy, water, soil, vegetation and air among others, which are available to satisfy human needs, and likewise provide an infinite sink for the by-products generated therein in the form of pollution and degradation. Deep ecology seeks to synergise the scientific aspects of ecology with a *biocentric* (non-anthropocentric) or harmonious conception of the links between man and nature. It advocates for equity, control/reduction in human population, bioregional autonomy, bio-cultural diversity, decentralized planning, non-government run simple economies, simple and indigenous technology among others.

Environmental protection emphasized rational means for assessing the costs and benefits of development activities.

The essence simply is to guide and control man's use and interaction with the natural environment in order to impose some order on the use of space and land resources and ensure that these are in tune with the natural qualities and capabilities of that environment. It is also to see that man's use of the environment does not adversely affect its intrinsic quality. This led to the institutionalization of *environmental impact statements*. Adequate environment protection entails inventory (measurement), mapping, monitoring and modelling of environmental parameters. Resource management aim at the incorporation of all types of capital and resources- biophysical, human, infrastructural and monetary into calculations of natural accounts, productivity, and policies for development and investment planning. Resource management necessarily involves inventory of the resource base, careful development and management of the resources, education, training and acquisition of requisite skills (for human resource) employment of right technology in exploitation and exploration, employment of qualified personnel, environmental impact assessment, monitoring, replacement of resources against loss where necessary or use of alternatives among others.

Eco-development is geared towards restructuring the nexus between society and nature into what has been termed a *positive sum-game* by re-organising human activities in tune with ecosystem processes and services. Eco-development emphasizes biophysical economics model of a thermodynamically open economy embedded within the ecosystem: biophysical resources (energy, materials and ecological processing cycles) flow from the ecosystem into the economy, and degraded (non-useful) energy and other by-products (pollution) flow through to the ecosystem<sup>11,12,6</sup>.

Resource management is key for the conceptualisation of eco-development. This begins with simply looking carefully for ways to do more with less (making it possible for resources to become useful for more people), and follows with conservation of resources through recycling<sup>12</sup>. This becomes more imperative in view of the fact that many natural resources (particularly non-renewable) have been overexploited and as a consequence the quantity and quality of the remaining reserves have become been greatly reduced.

Energy being the most critical resource of industrialized society need to be conserved particularly fossil fuels. Suffices to note that any measures which conserve energy

are advantageous to the user and to society in general. Deliberate and sustained efforts should be taken towards financing the development and/or manufacture of more energy-efficient equipment as well as the purchase and use of such equipment after being developed, manufactured and certified.

While energy conservation is critical to an efficient, well-managed economy, nonetheless energy conservation does not produce any energy per se. In order to function, the *wheels of commerce* still require sources of energy. Even if emphasis is shifted towards financing energy generation from renewable resources leveraging is critical, important and possible: "In effect, when we use the energy in a barrel of oil to produce electricity for fabricating a renewable energy device, such as a wind generator or a solar panel, in essence we are converting that barrel of oil into many barrels of oil, because over the useful life of that equipment it will generate several times more electrical energy than the barrel of oil "invested" in the equipment: The oil-producing nations which "invest" their oil in renewable energy equipment can effectively sell several times more oil than the nations which sell oil simply for combustion, consumed once and gone forever in a puff of smoke"<sup>12</sup>.

While each of the paradigm address issues of development and the environment, it is becoming increasingly lucid that what is required is a synergy of ideas and strategies in ensuring that a harmonious balance is struck between development and environmental sustainability.

## Contemporary Environmental Challenges

Whereas 'primitive' people seem to have enjoyed a close association with nature (probably too close for our present ideas of comfort), literate man has erected a dualism, in which 'progress' has been linked with control over nature<sup>3</sup>. The result is myriad of environmental challenges. Some of the most critical of the current and future environmental challenges are examined in the following discussion.

**Agricultural Practices:** In attempt to meet his basic need for nutrition man has highly manipulated the resources of the environment in the name of agriculture. From the practice of shifting cultivation where after the plot has been abandoned the system is expected to revert to its original condition, which often is never totally achieved to the most highly manipulated (intensively cultivated) sedentary agriculture, the natural environmental balance of flora, fauna, soil and water balances are altered, paving way for adverse environmental challenges such as deforestation,

soil erosion and loss of biodiversity. Pastoralism may also produce a high degree of manipulation. Traditional pastoralism moved over a very large area and so aimed at a minor degree of alteration of the ecosystem, but the growth of herds and the relative confinement of pastoralists (e.g. by political boundaries, the provision of constant water from tube wells, veterinary centres, and the presence of government-provided markets) have brought about strongly changed ecological systems which in many dry places have been at the point of breakdown and erosion. The aforementioned scenario is exacerbated by issues of climate change<sup>13</sup>. Another dimension of agricultural practice and concurrent food security issue is the depletion of fish populations globally due to overfishing. Consequently, the task of feeding an ever-increasing world population is huge now and in the future. Food demand will rise in response to population growth, growth of per capita income, and attempts to reduce the under-nutrition of the very poor<sup>14</sup> and this has grave implications for the environment.

**Deforestation and Biodiversity Depletion:** A significant current environmental challenge (particularly in Tropical Developing Countries), and that is likely to stay with us for a long time to come is deforestation. This phenomena is the result of several factors including; population explosion, urbanization, unsustainable agricultural practices, and industrialization and construction activities among others, all of which have increasingly assumed greater magnitude in the world over the years: Consequently huge tracts of forest land are depleted annually both in the forest and grassland regions of the developing countries. It is instructive to note that as deforestation is occurring, flora and fauna species are adversely affected in terms of survival, diversity and complexity: Indeed many rare species of plants and animals particularly in the Tropical Rain Forest have become extinct. It is also imperative to note that a large part of the population thrives on nature and the products obtainable therein, leading to the loss of a large number of animals and plants living in the forests as well as adversely affecting our climate.

The welfare of species and ecosystems in a rapidly developing world is of critical importance in meeting the normative goals of a sustainability transition. Biodiversity resources provide many of the goods and services needed to sustain human life; goods such as timber, forage, fuels, pharmaceuticals, precursors to industrial products, and services such as recycling of water and chemicals, mitigation of floods, pollination of crops, and cleansing of the atmosphere<sup>15</sup>.

Sadly however is that with continued growth in human population land conversion for agriculture, extractive uses, and urban settlements will continue to exert tremendous influence on biological diversity and on the ability of ecosystems to act as biogeochemical buffers and water suppliers. Increased use of biofuels could place even more pressure on land use. Atmospheric and water pollution due to industrial and agricultural activities can have effects on species and ecosystems as significant as they have on human health, and the resulting alterations in the functioning of ecosystems can also feedback to affect human well-being<sup>15</sup>.

***Aridity Drought and Desertification:*** It is often difficult, but very important to differentiate between aridity, drought and desertification. These terms have no widely accepted definitions. However, aridity is usually considered to be the result of low average rainfall, and is a permanent feature of the climatology of a region<sup>16</sup>. It is a period of water shortage that range from a few days or weeks for some crops to a few years for large reservoirs or ground water aquifers at a given location. In contrast, drought is a temporary feature, occurring when precipitation falls below normal or when normal rainfall is made less effective by other weather condition such as high temperature, low humidity, and strong winds<sup>16</sup>. It is instructive to note that aridity is not a prerequisite although a catalyst for drought: This is because even areas normally considered humid may suffer drought from time to time. However severe drought often occur only in areas with some degree of aridity in their climatological make-up.

Desertification is defined in Chapter 12 of Agenda 21 and in the International Convention on Desertification as the degradation of the land in arid, semi-arid and sub-humid dry areas caused by climate change and human activities. Although desert condition is caused largely by natural factor of inadequate rainfall: it is aggravated and extended by human factors of unsustainable crop farming and animal grazing. It suffices to note that millions of people live in such ecologically fragile zone and eke out a living in the environment and consequently extending the frontiers of desertification. Desertification leads to degradation of land in arid regions constituting a significant threat to the environment. The process turns productive land into non-productive land as a result of poor management conditions. Desertification which is a major problem in many countries including Nigeria, is made worse by massive water impoundment and irrigation schemes. The northern fringes of Nigeria bordering the Sahara desert is characteristically a

semi-arid region. Uncontrolled grazing and livestock migration put tremendous pressure on the environment in some areas. However quite worrisome is that the prevailing desert-like conditions is rapidly spreading into the interiors at alarming rate. This menace remains a major environmental challenge today and in the future in many parts of the world including Nigeria.

***Environmental Degradation from Oil Exploration and Exploitation:*** Since the discovery of crude oil, there has been massive and aggressive drive for exploration and exploitation of the resource worldwide. No doubt oil has become a leading resource in international economy and politics. From the Middle East, through Europe and America to Africa crude oil is exploited from the environment causing grave environmental upheavals. Indeed oil remains a major revenue earner for most of the producing countries albeit at the expense of the environment. A typical case scenario is Nigeria: since the early 1960s oil has been the major revenue earner in Nigeria, contributing over 90% for several years. Of recent however, governments at various levels have embarked on measure to diversify the economy. Although substantial developmental milestones have been achieved from revenue derived from oil, the exploration and exploitation activities have become an albatross to environmental sustainability in the Niger Delta. Significant harm to the Niger Delta is caused by activities of oil companies. The region has become one of the most polluted and dirtiest places on the earth surface since every year a huge amount of oil products are deposited there, destroying the air, water and land component and associated resources, particularly the flora (the rich mangrove forest) and fauna. Consequently the local people (peasant farmers and fishermen) who live in this coastal territory and rely on the natural resources as their means of livelihood have barely be existing in the precarious condition they found themselves. Apart from the issue of degradation in the environment, disruption of economic activities of farming and fishing, the host communities have as well been faced with sever health challenges from polluted air and water. The people suffer from chronic diseases all their lives.

Another critical challenge of oil exploitation in the Niger Delta is gas flaring. It is generally speculated that Nigeria flares more natural gas associated with oil extraction than any other country currently. The harmful effects of gas flaring on the environment, ecosystems, human health and global warming are legendary to say the least.

**Climate Change and Global Warming:** Changes in atmospheric chemical composition and chemistry also reflect the activities of multiple human endeavors, as well as natural processes<sup>14</sup>: The cumulative and interactive consequences of gas emissions associated with industry, fossil fuel consumption, and agriculture are linked via atmospheric circulation and chemistry, and the influence of those chemical and physical interactions is felt from regional to global scales. The consequences are that atmospheric changes that were hitherto characterized as local to regional in scale have now assume global dimensions.

Various human activities relating to agriculture, transportation, urbanization, industrialization among others release harmful elements into the atmosphere. For instance burning associated with land use changes such as deforestation or agriculture, alone or in combination with industrial air pollution, can have tremendous impacts on the health of people and ecosystems. Consequently, high-ozone episodes and acid rain are experienced by people and ecosystems even in areas far removed from urban activity<sup>17</sup>. Furthermore the deposition of compounds of nitrogen, a regional change produced by intensive agricultural and combustion processes may interact with elevated atmospheric CO<sub>2</sub> concentrations, a global-scale change, to affect the ecological and biological responses of terrestrial and marine ecosystems<sup>18</sup>. Again long-term nitrogen deposition resulting from human activities is likely to damage vegetation, thereby decreasing its carbon uptake. Moreover, nitrogen deposition may also increase the emissions of other greenhouse gases<sup>19</sup>.

Global warming leads to rising temperatures of the oceans and the earth' surface causing melting of polar ice caps, rise in sea levels and also unnatural patterns of precipitation such as flash floods, excessive snow or desertification. This has fundamental implications for development and economic activity, as more frequent and severe extreme weather condition in the face of population explosion will expose coastal areas and floodplains to massive economic losses. The consequences of climate change could be very displeasing and bring on things like drought, desertification (already discussed) flood, erosion or hurricane, now and in the future. The change in precipitation level will affect agriculture, as harvests will decrease. In addition, there may be soil problems in coastal areas, as a result of which mass migration, civil unrest and mass conflicts may occur. Lack of food fuels people's anger and militancy; when this is experienced amongst a rapidly growing population, the

problem becomes even more serious. Significant efforts are required to save food and clean water suitable for drinking for the teeming human population. Similarly, migrations in search for pastures and water in the face of climate change-induced drought and desertification is already increasingly resulting in violent clashes between herders and farmers as evidenced in Nigeria, further exacerbating food security issue; All these prospects make us think about how to feed and protect ourselves.

**Environmental Pollution:** Environmental pollution could be in form of land, water or air pollution. Land pollution entails the release of harmful elements such as toxics from agricultural, mining, automotive and industrial activities, municipal solid and commercial wastes, effluents and wastes from households among others on the land: Water pollution is caused by the discharge into water bodies of harmful elements such as oil and grease, heavy metals, chemical sludges, dyes, acid, bases, hospital wastes, wastes chemicals, human/household wastes among others: Air pollution is caused by the emission of harmful gaseous pollutants such as sulphur dioxide, sulphur trioxide, nitrogen dioxide, nitrous oxide, hydrocarbon vapours, photochemical oxidants, particulates, hydrogen sulphide, asbestos dust, herbicides, pesticides, ammonia, carbon monoxide, radioactive substances and combustion products of fossil fuel into the atmosphere<sup>4, 5, 6</sup>. Essentially these pollutants contaminates land, water and air components of the environment, reducing quality, fertility, productivity and general utility value, as well causing harm to flora, fauna and humans.

The challenge of environmental pollution is envisaged to remain with us due to the massive developmental strides taking place across the globe, partly in the Developing World including Nigeria. The Niger Delta region of Nigeria is persistently polluted. Gas flaring and oil spills are the major causes of water, air and land pollution.

**Waste Generation and Management:** Wastes are natural by-products of human consumption or use of environmental resources. Every day, man generates wastes from his body metabolism, household chores, business and commercial activities as well as mining and industrial activities<sup>3, 4, 5</sup>. Wastes when not properly handled could become hazardous to the environment and human life. Essentially wastes pollute the environment with respect to the land, water and air components. The various sources of waste pollutants have been highlighted under environmental pollution. Waste could be in form of liquid or solid; it could be

biodegradable or non-biodegradable or not degradable at all<sup>5,6,16</sup>. Various factors such as population growth, urbanization, industrialization, general economic growth, consumption patterns among others influence the rate and modes of wastes generation. With increasing population (particularly in the Developing World), increasing magnitude of urbanisation and industrialisation, the challenge of waste generation and management will subsist and must be addressed compressively.

Of particular concern in Nigeria is the current menace of massive generation of non-biodegradable waste in form of plastic materials used for packaging. It suffices to note that virtually every type of commodity is now packed with plastic material, the waste of which is disposed of indiscriminately. Indeed this remains a fundamental challenge to the environment in Nigeria now and the future if not properly managed.

**Flooding:** Flooding is an environmental hazard that is common in areas of low relief. It entails the covering of land by water which may occur when rainwater fills depressions on the ground or when rivers overflow their banks after rainfall. Natural factors such as topography, particularly slope, altitude, depth of water table, the nature of the underlying rocks, and the infiltration capacity of the soil play crucial role in flooding; Anthropogenic factors like land use pattern, lack of or inadequate channelization, blockage of drainage system, dredging or blockage of river channels and deforestation also play important roles in flooding<sup>20</sup>. Recently, however the impact of climate change and global warming have been causing widespread and devastating flooding incidences the world over.

Flooding has far-reaching implications on the environment because of its destructive tendencies on physical structures, loss of lives, damages to food, water and supplies, disruption of wildlife habitat, transportation systems among others.

**Soil and Gully Erosion:** Soil erosion is the detachment, transportation and deposition of soil materials by such erosive agents like water, wind and ice<sup>20</sup>. Soil erosion is a fundamental earth phenomena that has both theoretical and practical significance in our daily activities, particularly with respect to land use activities. Soil erosion could be *normal* (geologic) or *accelerated* (man-induced), Normal geologic erosion refers to the slow removal of soils and other particles by the natural processes of denudation, while accelerated soil erosion is man-

induced: it occurs as a result of man's various activities on the earth surface. The former is common in most parts of the world, particularly in areas where there is slow movement of energy in form of water, wind and glacier. The latter is more rapid and begins with development of agriculture on the earth by man. It is a more devastating and destructive processes and remains a challenge now and in the future as man is often unconscious of environmental feedbacks from misuse of earth resources. Particularly more devastating is the development of gullies which leads to gully erosion; a menace that has been causing widespread destruction and degradation in the environment and socioeconomic activities in many parts of Nigeria.

## Prospects for Addressing Environmental Challenges

To squarely address issues of global environmental challenges now and in the future some vital sectors of the economy need to be reorganised. Development in the agricultural sector to ensure food security is pivotal. Prospects exist to develop new and appropriate approaches to improve food production to feed the teeming world population especially in the Developing World. Biotechnology (genetically modified food) holds substantial hope for improving crop production and efficiency of resource use, although debate is still ongoing on the desirability and safety of consuming products of biotechnology. Furthermore, appropriate strategies for optimal use of soil, water, and biological resources offered by precision farming can increase and sustain food production while decreasing environmental consequences. Precision farming is an information and technology-based agricultural management system that identifies, analyses, and manages site-soil spatial and temporal variability within paddocks (farm fields) for optimum yield or productivity, profitability, sustainability, and protection of the environment.<sup>21,22,23,24,25</sup>

Energy is another very critical factor to be tackled. Energy is required in virtually all we do; from growing our food, raising livestock, cooking our meals, moving ourselves and goods from one place to another, running our homes, transforming resources to finished products etc. The energy sources must grow at sufficient rates to maintain other energy-dependent activities, yet at the same time must impose few if any environmental costs in the form of local air pollution, carbon dioxide, toxic residuals, and despoiled land<sup>15</sup>. Environmentally friendly sources of

energy that allows the world population enjoys requisite lifestyle at the same time protects and sustains human health and the health of the biosphere from local to global scales must be developed. Consumption of fossil fuels must be deemphasized: Apart from its associated environmental hazard, fossil fuel is also an exhaustible resource. Non-fossil energy sources such as hydroelectric power have already be overexploited in some areas, and as well have associated environmental consequences when not properly managed. Furthermore, the growth of nuclear power in many parts of the world is retarded by high costs and associated toxic wastes as well debates regarding safety, security issues and philosophical concerns. Emphasis should therefore be on the development of alternative sources of renewable energy such as wind, sunlight, and biomass fuels. Adequate funds should be invested in developing appropriate technology from the aforementioned sources to harness their potential benefits in the face of abundant and low-cost fossil fuel. Another viable area is the development of photovoltaic technology that enables the production of electric vehicles (motorcycle, cars etc.) envisaged to have far fewer adverse local, regional, and global environmental impacts. Another way forward is to develop strategies to sustainably manage human use of land to obtain goods and services which is one of the most significant alterations of the global system. Approaches must be evolved to sustainably manage both the resources societies use directly and the benefits that accrue indirectly from the world's living capital<sup>26</sup>: for example appropriate measures and strategies must be put in place to check deforestation and the depletion of biodiversity, soils among others. More environmentally friendly approaches such as zero flaring and gas re-injection should be adopted in mining oil particularly in the Niger Delta of Nigeria.

Furthermore, broad approaches to tackling environmental issues are required. This is because such issues are usually all-inclusive and pervasive across broad sectors of our lives. Indeed emphasis should be on interrelationships and interactions within and between facets of the environment and human activities and environmental problems: For example, no longer can we ask about the consequences of climate change on agricultural ecosystems; instead, we must ask about the combined effects of climate change, increased climate variability, elevated carbon dioxide, soil quality changes, crop management changes, and tropospheric and stratospheric ozone changes on crop productivity<sup>15,17,18</sup>.

The challenge of waste generation and management must be adequately addressed. Efforts must be made to encourage waste minimization policies through broad environmental education drives. Waste minimization is the reduction of waste at source through technological innovation and behavioural change. Waste minimization should be complimented with effective town planning with master plans that includes adequate provision of central waste management schemes for handling of liquid, solid and gaseous effluents from the various human activities. The central waste handling facilities should be part of the plans for housing estates, markets, shopping complexes, industrial areas and designated sections of the towns and cities<sup>6</sup>. Above all policies for minimization of use of plastic materials for packaging should be formulated and implemented. People should be educated and encouraged for instance to have shopping bags, adopt more environmentally friendly ways of packaging various items rather than using plastic materials. Production and use of plastic packing materials should be taxed and the proceeds plunged into management of waste generated therein. Waste recycling of glass, paper, cardboard, plastic, metals and other materials should be well integrated in the waste management scheme which will further create jobs, earn income for individuals and revenue for government. Recycling should be practiced at household, commercial and industrial levels. Reuse of materials should also be encouraged as a strategy to minimize waste generation, for instance plastic bags, bottles among others can be reused for a variety of purposes. Regulations on indiscriminate disposal and dumping of waste should be strict, fined, properly monitored and enforced. Offenders must not be spared. Existing environmental regulations should be reviewed to reflect the exigencies of the moment and strictly enforced.

Funding is crucial in addressing environmental issues. Adequate, regular, and timely funds are required to tackle the challenges as they occur. Consequently sources of finding must be expanded and proactively exploited. Some of the viable sources for funds for managing environmental issues are: federal, state and local government budgetary allocations, environmental taxes, emission fees, pollution abatement fees from mining, oil exploration, forestry, urban industry and transportation among others, funds from corporate organizations (such as the oil companies), funds from commercial (e.g. banks) and industrial sectors (e.g. oil revenue), funds from forestry rent taxes and royalty, funds from eco-tourism, non-governmental and volunteer organizations,

Finally environmental education through public awareness creation, formal (from pre-primary to tertiary) and informal (across all facets of communities' lives) is key to achieving environmental, socioeconomic and developmental harmony. This will provide the necessary knowledge, understanding, values and skills required by the general public and many occupational groups for their participation in devising solutions to environmental questions.

The Tbilisi 1977 Declaration defined environmental education as process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivation, commitments and skills to work individually and collectively toward solutions of current problems and the prevention of new ones<sup>16</sup>: It is further noted that in general, a good definition of environmental education should encompass: raising awareness, acquiring new perspectives, values, knowledge and skills, and formal and informal processes leading to changed behaviour in support of a sustainable environment. Environmental education is not a passive process because it involves constant generation of new ideas especially in raising the levels of awareness, knowledge and skills. It is also aimed at changing behaviour, whether one's own or part of a larger community changes

## Recommendations and Conclusion

Absolutely, man's place in nature, of his subjugation of other components of the planet and his modification of its systems, cannot be overemphasised. While not advocating for the primitive man's style of man-environment relationship, modern man's idea of progress hinged on control and subjugation of nature is clearly no longer sustainable. It is therefore recommended that we begin to reconsider our philosophical view of environment and development to focus more on ecological and moral perspectives, knowing that every facet of nature is very vital for a harmonious functioning of the system and that generations to come have the right to enjoy resources as we do today. It is as well recommended that researches into the development and use of environmentally-friendly technologies in agriculture, transportation, industrial productivity and waste generation and management sectors among others must be intensified globally. Environmentally and human health-friendly technologies should as well be extended to the provision of energy with a focus on renewable sources such as solar, wind and biomass. It is further recommended that innovative sources of funding to prosecute environmental issues be exploited, while an inclusive environmental education campaign with

requisite policies and enforcement strategies be vigorously pursued.

Conclusively, it suffices to note that man's indifference to the environment which provides him with all the necessities of life is clearly unsustainable and perilous. As Simon<sup>3</sup> puts it: in managing the earth for our survival there is no way in which technology can be abandoned: what appears to be essential is a deeper knowledge of the relations between man-made machine-dominated systems and the bioenvironmental system, and ways in which a stable co-existence can be procured.

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## A Review of Informed Consent in Neurosurgical Practice- any change at Irrua, Nigeria?

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### Abstract

Neurosurgery is one of the highly specialized area in surgery, the treatment instituted may lead to poor outcome with possibility of litigation in the face of an expected good prognosis. The need to allow an encompassing far reaching patient participation in decision making led to the concept of informed consent. Regrettably, the neurosurgical informed consent in our rural environment has been debased, devalued and left at the caprices of family influence, religious and ethnic manipulation that are not geared towards protecting the neurosurgeon in the event of legal liability that may arise from errors as result of negligence or otherwise. Medical trainees and specialists in training are rarely trained and if when trained, the training are done poorly in both communicative and clinical skills that are needed for the process of administering informed consent. Irrua Specialist Teaching Hospital being located in rural settings is fraught with challenges as majority of patients presenting are poorly uneducated, caught in a web of strong ethnoreligious belief that affect consent to neurosurgical services and procedures. We have discussed briefly, the phenomenon of informed consent, the difficulties to patient autonomy and consent in neurosurgery, the pros and cons of obtaining neurosurgical consent, and the planning of an optimal process for neurosurgical informed consent.

**Keywords:** Informed consent, Neurosurgery, Rural, Nigeria

### Introduction

Consenting is the process by which a physician obtains permission to perform an act or a procedure on the patient for either diagnostic or therapeutic purposes.<sup>1</sup>The concept of informed consent was conceived to facilitate patient autonomy or independence by ensuring that they participate in the decision-making process as regards their management. Consenting in surgical practice has evolved and effort has been made to improve the process.<sup>2,3</sup>The process is not without its problem and setbacks as it has been noted to be debased, undervalued and reduced to a documentary academic exercise to protect surgeons from all legal encumbrances rather than giving the ultimate power to the patient to ensure the best is chosen and the best is done for him under a sound moral context and judgment. Regrettably, undergraduate and postgraduate medical

curricula in Nigeria have not done much to address this subject as trainees rarely get instructed on this process. The few trained ones have poor clinical and communicative skills required for consenting in neurosurgery procedure.<sup>4,5</sup> Nevertheless, the National Health Bill legislation recently enacted by the Nigerian legislative house, has made it a more significant process in patient care by empowering patients on decision making. This is likely to serve as check and balance to egocentric physician power. This process of informed consent is of utmost importance to the neurosurgeons, because of the sensitive nature of neurological surgeries, and the dearth of high-tech facilities in our environment and the recent increased rate of medical litigation, probably the affirmation of the new legislation. This process of consenting for neurosurgical procedure may play a significant role in reducing the risk associated with neurosurgical interventions and providing a basis for physicians and patients to developed a strong patient-physician relationship during the course of management<sup>6</sup>.

### Historical Perspective of Informed Consent in Surgical Practice

Consenting in surgical practice has evolved in tandem with surgical evolution. This evolution can be traced to the law

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of Fieda, a royal system which justifies killing someone who kills. Subsequently in 1252, the Anglo-Norman Law initiated the concept of blood money-provision for ascertaining equivalence for life.<sup>7,8</sup> The Roman in 1268, introduced a major change by advocating “Cum volenti at scienti non fiat injuria”, meaning with consent and knowledge, no injury alone is done and this was the first step in introducing consenting to medical practice. From the archive, the Slater vs. Baker and Stapleton<sup>9</sup> 1767 was noted as the first reported case for the need for obtaining informed consent prior to the commencement of treatment. In this case the physician was sued for experimenting with an external fixating mechanism without informing the patient of the procedure and failure, to obtain consent prior to the surgical procedure. The main component in the current concept of surgical informed consent (SIC) began to evolve in the early part of the 20<sup>th</sup> century. For instance, in 1905, in the case between Mohr vs. Williams, a surgeon was made to face litigation for carrying out surgery in both ears instead of the right ear for which consent was given. In one of the famous cases in history which brought surgical informed consent to the front burner, the case of Schloendorff vs. Society of New York Hospital in 1914, a patient named Mary Scholendorff who was admitted to the above hospital, she consented to an examination under anaesthesia to determine if intra-abdominal tumour was malignant or not, but yet refused consenting for operative removal of the tumour. Unfortunately, the surgeon out of emotion removed the tumour after observing it to be malignant during the same procedure. The honourable judge, Justice Benjamin Cardozo in his ruling stated that: “Every human being of adult years and sound mind has a right to determine what shall be done with his own body; and a surgeon who performs an operation without his patient's consent commits an assault for which he is liable in damages. This is true except in cases of emergency where the patient is unconscious and where it is necessary to operate before consent can be obtained.”<sup>8</sup> Previously, the method for conveying information about surgical benefits and risks were based on a doctor-centered approach, with less regard to the patient. This was observed in a UK case of Bolam versus Friern. The Hospital Management Committee established the well known Bolam principle which states that: any surgeon should tell their patients what other surgeons also tell theirs. (Bolam v Friern hospital management committee [1957] 1 WLR 582). A more patient-oriented point of view was subsequently instituted by Canterbury vs. Spence in 1972 464 F.2d 772, 782 D.C Cir. 1972, which determined that all risks and alternatives of a procedure must be explained to a patient. Furthermore,

Truman vs. Thomas in 1980 (27 Cal. 3d 285[S,F. No. 24054. Supreme court of California]) determined that the information provided in a SIC process must include the possible risks of “not acting or postponing.”

## Component of a Neurosurgical Informed Consent

The tripod in the legal doctrine of SIC has the following components or elements: the preconditions, information, and consent.<sup>6,10,11</sup> The preconditions include the competence and voluntariness of the patient and in few cases parents or guardians to give consent without any coercion, meaning that a patient or his/her parents or guardians should be capable of making decisions about their body without outside influence. In most cases, a patient's competence is presumed if their communication is clear, succinct and defined to be normal.<sup>11</sup> But, it must be noted that, for valid informed consent to be effective, a patient should not be cognitively impaired by any condition or medication, as this would not satisfy the precondition of voluntariness.<sup>12</sup> The element of information covers the full disclosure of information by the surgeon and verification of the patient's knowledge and understanding of this information as given by the surgeon. For informed consent to be legally valid, it should include the instructions to the patient such as: the diagnosis and natural history of the disease; the recommended procedure along with its benefit and risks/complications; possible alternatives to the proposed procedure with their attendant benefit and risks; and the consequences or prognosis if no procedure is attempted.<sup>13</sup>

The administration of informed consent should preferably be conducted by the neurosurgeon (the attending surgeon is most appropriate) who is directly involved in the proposed treatment/procedure and who has a sufficient understanding of the pros and cons of the procedure and treatment modalities. This is because, resident doctors or other trainees most often provide inaccurate and inappropriate information as regards the diagnosis, proposed procedure and alternatives.<sup>4,5</sup> All competent cognitive intact patients should receive all information, except when the patient is a minor, or patient's life or wellbeing is seriously threatened (as in emergency situation), if the treatment is delayed, or in cases when disclosure of the information itself could cause serious physical or psychological harm.

Lastly, the third component of the tripod is the informed consent and it covers the final decision of the patient and

authority or permission to proceed with treatment/procedure.<sup>14</sup> Here, the requirements vary by country, as written consent in the form of the patient's signature is needed in the US just as it is in Nigeria unlike in the UK where a note in the patient's medical chart is a sufficient means of given final authority. Nevertheless, it should be noted that the medical consent form is a mere evidence that the process of consent occurred, while the dialogue between the patient and the physician- doctor-patient interface is the core of the SIC process<sup>12</sup>.

## Informed Consent in Neurosurgical Emergencies and Hurdles to Patient Autonomy in Informed Consent

Consenting in emergency situation constitutes something of a dilemma because, it involves doing what is right versus avoiding catastrophe and mortality. The time it would take to make disclosure and obtain the patient's consent could constitute a disadvantage to the compelling interest of the patient.<sup>13</sup> In the light of this, it is important to note that saving a patient's life supersedes morality, Certain emergency conditions can be an exception to the rule of obtaining consent before instituting treatment<sup>15</sup> and in practice, a treatment/procedure can proceed without informed consent in cases or situations such as:

- when there is an obvious catastrophic, serious, and immediate threat to the patient's life such as significant extradural haematomas;
- the time required to gain informed consent would seriously jeopardize the patient's recovery or increase mortality and morbidity;
- the patient presents with conditions that can undermine competence (conditions such as hypoxia or shock); and
- when, in certain emergency situations, the patient's competence to understand the information provided, can be called into question due to severity and scenario of the emergency.

Research in patients with a subarachnoid hemorrhage, less than 20% of those who consented to treatment could remember the process afterwards<sup>13</sup>. When in an emergency where exception applies, the physician/surgeon presumes consent and must provide the treatment that most medical practitioners or board would deem appropriate or standard for the patient.<sup>16</sup>

Several hurdles to patient's autonomy and optimal SIC have been identified<sup>17</sup>. Amongst these are: physician's poor communication skills, surgeon expectation, patients level

of education, sociocultural and ethnoreligious belief,<sup>18,19</sup> and the short time allotted to consenting, and discrepancies between the patient's understanding and retention of the information provided for SIC.<sup>20, 21</sup> The average patient has been observed to remember less than 50% of the major risks linked to their proposed treatment within 2 hours of information being provided.

## Benefits of Informed Consent in Neurosurgery

Despite the several daunting hurdles to an autonomous and optimal consenting process, several benefits have been identified with this process. The process provides numerous benefits to both the patient and the physician. Amongst these benefit are: the knowledge the patient acquire during consenting is vital to their autonomy and allows them to achieve the will-power and thus maintain a sense of control during the treatment process. Informed consent helps to alleviate anxiety, panic and fear and provides hope, higher satisfaction and treatment co-operation as regards their diagnosis and treatment modalities. Anxiety, a sense of helplessness and hopelessness are eliminated. It establishes a psychological defense mechanism for the patient and helps patients to cope with or adapt to stressful surgical circumstances. It helps to improve the quality of health-care services by keeping the patients abreast of the pre-operative, intraoperative and postoperative processes.<sup>22</sup> it makes the patient to realise that complications do arise and are the consequences of a joint-decision between the patient and the physician, and not simply the physician alone.<sup>23</sup>

Its unfounded fears, confusion, nostalgia, belief or misconception that may impede treatment process are averted and rectified as soon as possible. The therapeutic alliance between the physician and the patient helps to build trust, cooperation and confidence militating against medico-legal issues that may arise<sup>24</sup>.

## Drawback of Informed Consent in Neurosurgery

The main drawback of consenting is the "nocebo" or negative placebo effect in which side effects or risks are over-emphasized or overtly explained to a patient, creating a bias of unexpected complications thus aiming to give the physician advantage of security.<sup>13, 25</sup> This makes the patient to nurse what they expect to feel causing withdrawal from treatment, dissatisfaction and this impedes the process of

treatment or neurosurgical intervention. Psychologically, the burden of fear and stress can diminish confidence and competence giving the patients an opportunity to be irrational and make harmful choices after being given the prerequisite information. In instances where patient refuses consent to an appropriate treatment due to mistrust, lack of confidence and fear the physician owes the patient the duty to respect this decision, even if it endangers the patient's life with the attendant risk of morbidity and mortality. The consenting process may make the patients feel they come to the hospital for education rather than treatment and may result in unco-operative patients becoming hostile, violent and fail to receive the information provided by the physician. Only few patients are likely to read the informed consent form as meticulously as they should in presence of this bias.<sup>26</sup>

### Ways of achieving Optimal Sic Process

The following, are some of the ways which have been identified to achieve optimal SIC process. They are:

- i the neurosurgical consenting process should include both the patient and their family. It is an idea to involve the patient's family in the original decision making process based on the understanding of the treatment and attendant risk which is especially important in the case of post operative complications when the patient becomes unconscious or suffer severe disability;
- ii several ways should be employed to effectively communicate with patient. While verbal communication is the most effective, other educational intervention material such as pamphlets and videos, can also be used to reinforce the SIC process<sup>2,12, 27, 28, 29,30,31</sup>. These materials are more useful when used in advance of the physician-patient interview. In particular, the appearance of the physician in a video or audio recording can boost patient trust and confidence on the ability of the neurosurgeon to carry out the treatment plan. Patients' knowledge of their disease and related treatment modalities can be ascertained using a questionnaire. The questionnaire results can then be used as data for research purposes after obtaining patient consent and seeking an institution ethical clearance as may be needed<sup>27,30,31</sup>;
- iii all clinical and therapeutic uncertainties, possibilities and probabilities should be explained to the patient or relatives as the case may be, and this will help to facilitate the therapeutic alliance between the physician and the patient;
- iv the information in consenting must include the patient's diagnosis, treatment plan/modalities, prognosis if no intervention is attempted, the recommended intervention with the attendant benefits and risks, and any significant alternative modalities with their attendant risks and benefits in the advent the initial therapeutic plan is abandoned;
- v the patient should receive a full and detailed explanation of the operative procedures such as site and extent of surgery, need to create additional incision for bone or nerve graft harvest, choice of anaesthesia and associated risks<sup>1</sup>, and management to be initiated, In addition the clinical events that will be experienced during the preoperative, intra-operative, and postoperative periods, These can help the patient to develop psychological defenses to cope with the stressful circumstances of surgery;
- vi the neurosurgeon should encourage the patient to ask questions regarding information in the consenting process and verify that the patient understands this information<sup>16</sup>;
- vii the communication of this information needs to be initiated well in advance of the surgical procedure, days-weeks-months as the situation allows, giving the patient time to take a decision;
- viii the patient interviews should be coordinated with hospital visits for diagnostic or pre-surgical management for the covert or overt uncooperative patient;
- ix other team members such as anaesthetist, oncologist, radiotherapist and haematologist should be involved from the beginning explaining their roles in the care, benefits of their procedure(s) and associated risks. The need for blood transfusion, benefit and risk should be explained to the patient or relatives; and
- x the need for additional devices such as drain, implants, use of post-operative ventilator and possible duration of use, should be clearly stated.

### Special Issues in Surgical Informed Case

We have also highlighted the following as some of the relevant special issues in surgical informed cases. They are:

- i Consent in Paediatric: parents or guardians are expected to give informed consent for children less than 12 years, but restricted consent for age 12-18 years, However for neurosurgical cases, consent from both parents are encouraged and obtained<sup>1</sup>;
- ii Cancelled/postponed cases: This does occur in neurosurgical practice due to varied factors. The

validity of signed consent is controversial but known to be valid within 72 hours and could remain valid for a longer period except the patient requested for additional clarification<sup>1</sup>;

- iii Time for obtaining consent: Consent is obtained for emergency cases immediately a procedure is contemplated. For elective cases, it should start at the point of first review in clinic<sup>1</sup>; and
- iv other controversial issues have remained with neurosurgical practices. Issues such as clinical pictures or radiological images for publications or research, video recording in pre-operative and intra-operative periods have remained at the forefront of consenting and currently, it is being said to be included in the consent documents<sup>1</sup>.

## Neurosurgical Informed Consent at Irrua

Neurosurgical service is one of the latest addition to the expansion in the health services in Irrua Specialist Teaching Hospital (ISTH). Proudly, several neurosurgical procedures (elective and emergency) are carried out for all age groups of patients. Prior to commencement of these procedures, informed consent are administered in line with standard practice as described above in this article. However, the peculiar nature of our environment allows the unit to integrate the relatives of patients as an integral part of this process. Another core component of consenting in our environment is the cultural upbringing where a woman transfers the right to sign consent to the husband, thus affecting most women individual right to voluntary consent to interventions.

## Conclusion

Neurosurgical consenting is an integral part of care and neurosurgeons who most often are faced with high-risk patients needing intervention must understand the rationale, the elements, and obstacles to consenting in neurosurgical practices. Strong family values, sociocultural and religious influences remain a major barrier to obtaining informed consent in our environment. An informed consent process must satisfy the criteria for being ideal if it provide patients with a detailed comprehension of the diagnosis, and treatment and other modalities, benefit and risk of treatment and the natural history of the disease if left unattended to, thus providing a strong therapeutic bond between the doctor and the patient.

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## A Review of the Current Management of Lumbar Degenerative Disc Diseases

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### Abstract

Lumbar Degenerative Disc Disease (LDDD) otherwise referred to as lumbar spondylosis commonly result in low back pain (LBP) with the chronic type having the potential to present with debilitating consequences for patients and their families. LBP at some point in an adult life will invariably occur, a large population of adults. In addition to LBP, they could present with other neurological symptoms which often define the stage of the disease. Making a diagnosis may be challenging, but clinical evaluation with imaging modalities are helpful. Treatment approaches of LBP depend on the timing, mode and stage of presentation. It mainly involves non-operative and operative approach with a clear-cut indication aiming to decompress neural tissue with or without stabilization. Our review aimed to highlight the current management approach of lumbar degenerative disc disease. Literature search was done through PubMed and MEDLINE.

**Keyword:** Degenerative, Low back pain, Pathogenesis, fusion

### Introduction

Lumbar Degenerative Disc Disease (LDDD) is a disease of adulthood that commonly present with low back pain (LBP), though can result in leg pain (sciatica) secondary to disc herniation, canal stenosis and rarely spinal deformity. LBP affects about 60–90% of adults during some point in their lives and peak at about 40 years with equal sex involvement.<sup>1,2</sup> Luckily, majority present with symptoms which are mild, transient and short-lived, with about 90% subsiding within 4–6 weeks with or without medication.<sup>3</sup> Chronic LBP, a type of LBP is defined as pain persisting more than 12 weeks, and it does affects about 20–50% of the general population<sup>5</sup>. Classically, few that this represent has intractable debilitating symptoms with poor quality of life (QOL) and it is of significant economic implications to the individual and family.<sup>5,6</sup> Prevalence of this diseases increases with age, but not all degenerated disc does present with LBP and cases has been identified in young people without history of spine loading.<sup>7</sup> Marshalling out a therapeutic approach remain a daunting task with the associated high cost and variable management approaches.<sup>5</sup>

### Anatomic-pathophysiology of disc degeneration

This avascular intervertebral disc (IVD) is designed to sustain, distribute, transmit and withstand pressure between vertebrae, while allowing for relative joint mobility but resisting excessive motion. It is made up of the nucleus pulposus (NP) centrally, the annulus fibrosus (AF) peripherally and the cartilaginous endplates rostrally and caudally at the junction to the vertebral bodies.<sup>8</sup> The IVD are innervated by branches of the sinuvertebral nerve, the spinal nerves and gray rami communicantes,<sup>9</sup> thus believed to be part of the neurologic basis for discogenic back pain. Risk factors that have been identified to be implicated in the pathological process are as follows:

i. Genetic: There is a place for genetic causation in degenerative disease of the spine. A genetic component to this becomes evident from twin study findings which involved mice with a knockout for genes which was suspected to have play a role in the spine disc degeneration.<sup>10</sup> Genes noticed to be involved in the degenerative process are genes that code for interleukin 1 (IL-1), collagens I, IX and XI, aggrecan, Taq 1 and Fok 1 of the vitamin D receptor gene, and matrix metalloproteinase 3 (MMP-3).<sup>11</sup>

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ii. Ageing: The process of degeneration correlates with the process of human ageing in several ways. However, DDD often occurs at a faster rate, making the process of degeneration common in patients of working age. With increasing age, the water content of the disc decreases and pressures develop in the NP, potentially extending into the AF, and the start of this process, termed chondrosisintervertebralis, can mark the beginning of degenerative destruction of the disc, the endplates and the vertebral bodies.<sup>12</sup>

iii. Environmental Factors: An association between smoking and disc degeneration has been shown to exist in literatures. Twin<sup>10</sup> as well as animal studies<sup>13</sup> have postulated an involvement of nicotine in disc degeneration, which might be due to impaired blood flow to the disc.<sup>14</sup> Furthermore, an association of atherosclerotic lesions in the aorta and LBP reflecting a possible link between atherosclerosis and DDD have been reported.<sup>15</sup>

iv. Activity and occupation: DDD has long been associated with certain activities. Studies citing body mass index (BMI), incident back trauma, daily spine loading (twisting, lifting, bending and sustained non-neutral postures) and whole body vibration (such as vehicular driving) to be factors which increase both the likelihood and severity of spondylosis.<sup>16</sup> As this association do exist, a study following progressive radiographic changes in LDDD did not find significant associations with the extent of physical activity, noting only age, back pain and associated hip osteoarthritis to be predictive of DDD and osteophyte changes.<sup>17</sup>

### Clinical evaluation

Pain within the axial spine are nociceptive and tend to arise from either the myofascial structure, disc, facet joints, nerve root dura and sacroiliac point<sup>18</sup> and this form the basis for the evaluating the origin of LBP in patients with LDDD. it may radiate to the buttock, groin, thigh or foot and it worsen with factors that increase intradiscal pressure such as forward flexion, coughing, straining and lifting from a position of lumbar flexion with weight in front of the body. Pain is reduced with extension and lying down. Pain and stiffness related to sitting or standing for prolonged periods is common. Pain becoming worse with extension, however, is more likely to be due to facet arthropathy, which may be primary or secondary to disc degeneration. The natural history of discogenic back pain is that up to 90% of patients will experience improvement of their symptoms within 6 weeks and resolution by 3 months with or without

treatment<sup>19</sup> and approximately 20% experience recurrence of pain within 6 months.<sup>20</sup> A common pattern in patients with lumbar canal stenosis is neurogenic claudication (NC). It is characterized by LBP with associated leg pain, paraesthesia, and numbness that worsen with upright stance and walking, and improve with sitting and supine positioning and motor weakness to lower extremities.<sup>21</sup> Radiculopathy may emanate from herniated disc which may affect transversing rootlets of the cauda equina, nerve roots exiting at the next lower intervertebral canal, or the spinal nerve within its ventral ramus, if protruding centrally, posterolaterally, or laterally.<sup>22</sup> Common differential diagnosis causing LBP include bacterial spondylitis (history of fever with night time chills, high suspicion of intravenous drug user), lumbar spine trauma (history of fall, assault or collision) and spine tumour (known history of cancer mainly from paired organs, new onset weight loss).<sup>23</sup>

### Investigation

A plain lumbosacral X-ray in two planes (anteroposterior and lateral views) are the initial imaging study of choice. It is useful in ruling out pathologies such as deformity, fractures, or metastatic cancer as underlying causes of LBP and, often supplemented by other imaging modalities. Findings in degenerative discs include disc space narrowing, endplate sclerosis, “vacuum” phenomenon within the disc, foraminal stenosis and osteophytes. Flexion and extension studies are helpful if instability is suspected.<sup>24,25</sup>



Figure 1: showing a lateral view lumbosacral X-ray of a 56-year old man with chronic low back pain, showing end plate sclerosis, disc space narrowing and osteophytic spurs. Magnetic resonance imaging(MRI) is the investigation of choice in evaluating LDDD and it is more sensitive when

compared to other imaging modalities. Features seen include disc herniation with disc space narrowing, thecal sac compression and end-plate changes.<sup>24,25</sup> It also assist in assessing other cause of lumbar back pain such as infection (tuberculous spondylitis) and spine tumour. Modic et al. were among the first to radiologically characterize endplate changes that are associated with DDD<sup>26</sup> and this classification system showed three grades of changes involving the marrow. In Type I, there is increased signal on the T2 sequence and decreased signal intensity on the T1 sequences indicative of marrow edema. Type II is characterized by fatty infiltration of the marrow as demonstrated by hyperintense T1 and T2 images. Finally, Type III demonstrates hypointense signals on T1 and T2 sequences, which corresponds to endplate sclerosis.<sup>26</sup>



Figure 2: showing a sagittal T2-weighted MRI with L3/L4, L4/5 disc herniation with canal stenosis in a 45-year old woman who presented with back-related leg pain

The use of discography has attempted to identify specific degenerated discs as pain generators.<sup>27</sup> Provocative discography involves the injection of contrast dye into the nucleus. Computed tomography (CT) scan is used to assess canal diameter, evaluate for extravasation of dye indicating annular tears and assess bone quality for instrumentation.<sup>25</sup>

## Treatment

Treatment involves non-operative or operative approach, each with clear-cut indications. Non-operative treatment can be classified into the following subheads:

**i. Exercise-based and behavioral therapy:** This is tailored to include aerobic exercise, muscle strengthening and stretching exercises.<sup>28</sup> The optimal approach to exercise therapy in chronic LBP patients appears to be those regimens involving an individually-designed exercise program emphasizing stretching and muscle strengthening,

administered under supervision, with high frequency and close adherence.<sup>28</sup>

**ii. Lumbar supports:** Lumbar back supports may be of great benefit to patients suffering LBP. These supports are designed to limit spine motion, reduce mechanical force, stabilize the spine and aid in correcting deformity. They may further have effects by massaging painful areas and applying beneficial heat; however, they may also function as a placebo.<sup>29</sup>

**iii. Traction:** Lumbar traction applies a longitudinal force to the axial spine through use of a harness attached to the iliac crest and lower rib cage to relieve chronic LBP. The forces, which open intervertebral space and decrease spine lordosis, are adjusted both with regard to level and duration and may closely be measured in motorized and bed rest devices. Temporary spine realignments are theorized to improve symptoms related to LDDD by relieving mechanical stress, nerve compression, and adhesions of the facet and annulus, as well as through disruption of nociceptive pain signals.<sup>29</sup>

**iv. Massage therapy:** Massage therapy for chronic LBP appears to provide some beneficial relief. Weighed against other interventions, it proved less efficacious than TENS and manipulation. It is comparable with lumbar corsets and exercise program and superior to acupuncture and other relaxation therapies, when followed over a 1-year course.<sup>30</sup>

**v. Spine manipulation:** Spine manipulation is a manual therapy approach involving low-velocity, long lever manipulation of a joint beyond the accustomed, but not anatomical range of motion. The precise mechanism for improvement in LBP patients remains unclear. However spinal manipulation as non-operative therapy may function through: (a) release for the entrapped synovial folds, (b) relaxation of hypertonic paraspinal muscle, (c) reduction of muscle spasm (d) unbuckling of motion segments that have undergone disproportionate displacement, (e) reduction of disc bulge, (f) repositioning of miniscule structures within the articular surface, (g) disruption of articular or periarticular adhesion, (h) mechanical stimulation of nociceptive joint fibers, (i) change in neurophysiological function.<sup>31</sup> Comparing this to other conservative treatment approaches such as pharmacotherapy, and exercise therapy, spinal manipulation appears comparable in its effectiveness both in short- and long-term benefits.<sup>29</sup>

## Pharmacotherapy

This is one of the conservative treatment approaches which involves the use of the following:

- i. **Non-steroidal anti-inflammatory drugs (NSAIDs);** NSAIDs are widely regarded as an appropriate first step in management of LBP, providing dual benefit of analgesic and anti-inflammatory effects but limited by gastrointestinal (GI) side effect of gastric erosion. COX-2 inhibitors give a modest relief in chronic LBP improving functional status, QOL and less GI irritation;<sup>29</sup>
- ii. **Opioid:** They are readily available and may be considered as an alternative or augment NSAIDs due to GI effects or poor pain control but limited by high rate of tolerance and abuse associated with long-term narcotic use;<sup>32</sup>
- iii. **Antidepressants:** The use of antidepressants such as amitriptylline for treatment of LBP has gained momentum due to proposed analgesic value at low doses, and dual role in treatment of commonly comorbid depression that accompanies LBP but may negatively impact both sleep and pain tolerance with resultant dependence from prolong usage;<sup>29</sup>
- iv. **Anticonvulsant:** anticonvulsant such as carbamazepine and pregabalin have a useful place in sufferers with LBP with varying results most often in combination with analgesic, effect on functional status is insignificant;<sup>32,33</sup>
- v. **Muscle relaxants:** Muscle relaxants (anti-spasmodic or anti-spasticity) may provide benefit in chronic LBP attributed to DDD. Moderate-strong evidence does exist from several trials comparing either a benzodiazepine or non- benzodiazepine with placebo that muscle relaxants provide benefit with regard to short-term pain relief and overall improving functional status and QOL;<sup>29,34</sup>
- vi. **Epidural steroid injections (ESI):** ESI have been popularized as a treatment strategy in patients with chronic LBP. These injections are either done via interforaminal, interlaminar, or caudal approaches under fluoroscopy, then local anaesthetic (LA) and steroid are infused into the epidural space. LA provide rapid diagnostic confirmation, and therapeutically may

short circuit the "pain spasm cycle" and block pain signal transmission.<sup>34,35</sup> Steroids reduces inflammation through inhibition of pro-inflammatory mediators; and

- vii. **Facet injections:** Facet (zygapophysial) joints are paired diarthrodial joint between adjacent vertebrae. These joints receive innervation from the medial branches of the dorsal rami possessing free encapsulated nerve endings, mechanoreceptors and nociceptors. Inflammation to the joint causes pain signals in 15–45% of patients with LBP.<sup>35</sup> Diagnostic blocks of the joint involve the injection of LA directly into the joint space or associated medial branch (MBB);<sup>35</sup>

## Operative treatment

Operative interventions are indicated for patients who have failed conservative options, progressive neurological deterioration and spinal deformity. Candidate for surgery take into account the patient age, socioeconomic status, anticipated activity level post-operatively and as well as comorbid medical conditions.<sup>36</sup>

The work done by the Swedish Lumbar Spine Study Group (SLSSG) provided the first systematic evidence that fusion for LDDD showed a superior outcome when compared to non-surgical treatment options.<sup>37</sup> Surgical approaches have evolved to achieve the goal of surgery namely-spinal decompression with or without fusion.

## Fusion for LDDD

The rationale behind fusion of a selected lumbar spinal segment is to reduce the nociceptive load by wide removal of the disrupted disc material and the stabilization of the affected motion segment(s) that are thought to be causing pain. Three main techniques are currently employed, namely posterolateral fusion, interbody fusion and a combination of the two (360° spinal or circumferential fusion).<sup>38</sup>

### i. Posterolateral fusion

This approach targets only the posterior spinal elements. It is through a midline skin incision with either a posterior approach or bilateral muscle splitting fascial incisions, with resultant decortication of the facets joints and transverse processes bilaterally. Local or autologous bone graft from the iliac crest are packed into the posterolateral gutters to promote fusion. It was initially done without

instrumentation, but pedicle screws instrumentation has become standard addition due to high rate of non-fusion<sup>39</sup> with limited effect on function status. Fusion rates have been reported as ranging from 46 to 100% and the pseudoarthrosis rate have been reported as high as 32% for non-instrumented fusion.<sup>40</sup>

## ii. Interbody fusion

This can be performed either through an anterior or posterior approach providing several biologic and biomechanical advantages over posterolateral fusion: (1) They address the disc as the pain generator (2) The anterior column of the spine supports 80% of the body load and consequently interbody devices are subjected to compressive load. Together with a large surface area, this biomechanical advantage facilitates fusion. (3) Insertion of interbody devices allows restoration of intervertebral height, correction of lumbar lordosis and restoration of sagittal balance depending on design and final positioning on the endplates, with potential for indirect decompression of the neural elements.<sup>40</sup> The approaches utilized include the following:

i Posterior lumbar interbody fusion (PLIF) which give access to both columns (anterior and posterior) through a single posterior approach. It involves an extensive laminectomy, with partial or complete facetectomy, subtotal discectomy, endplate preparation and insertion of interbody device (bone graft or cage) with or without pedicle screw fixation. Advantage of this approach include an excellent canal decompression useful for concomitant central canal stenosis. The wider resection, allow a lesser neural retraction providing a means to approach the diseased disc.<sup>40</sup>

ii Transforaminal lumbar interbody fusion (TLIF). This is a further modification of the PLIF technique where the disc is exposed unilaterally through a transforaminal approach with subtotal facetectomy with bilateral pedicle screw instrumentation to restore stability. Nerve root are retracted to access the disc with attendant risk of nerve injury and radiculitis. Contralateral posterolateral fusion can be added to increase fusion rates.<sup>41</sup>

iii The anterior approach for lumbar interbody fusion (ALIF). This is performed through either a trans-peritoneal or retroperitoneal approach. This approach allows access to the discs from L2 to the sacrum. Diaphragm and renal vessels do limit extending exposure proximally. The pubic symphysis occasionally also obscure proper vision and

instrumentation of the L5–S1 disc space in patients with a deep-seated L5–S1 level in relation to the pelvis.<sup>40,41</sup>

## iv Minimal invasive surgery (MIS) fusion

This technique has been developed which allow access while limiting soft tissue dissection and muscle damage. It is a modifications of pre-existing open techniques.<sup>41,42</sup>. MIS adaptation of TLIF make use of the Wiltseparaspinal approach<sup>43</sup> through multifidus and longissimus intermuscular plane for unilateral facetectomy and pedicle screw instrumentation. it reduces muscle stripping and damage, preserves blood supply with minimal blood loss and preserve muscular attachment and thereby reduces erector muscle dysfunction and fibrosis.<sup>43</sup> Neural monitoring is necessary to identify the lumbosacral plexus.

## v. Interbody and graft options

The tricortical autologous iliac crest bone graft were initially used in surgery with significant technical issues ranging from determining the size of the grafts, its stability once impacted into the disc space, the issue of subsequent collapse and subsidence.<sup>38</sup> it has long been considered the gold standard for fusion, but it has several drawbacks compared to currently available alternatives. These include prolong operative time, more blood loss, donor site morbidity, prolonged hospital stays and often limited graft volume in older patients. Interbody cages made of carbon fibre and the non-absorbable, biocompatible material polyetheretherketone (PEEK) are radiolucent and are thought to have a modulus of elasticity closer to bone. They may have lower subsidence rates and in addition, their usage allows easier assessment of fusion rates on X-rays. The enhancement by titanium implants for bone incorporation into the implant as opposed to PEEK, which is thought to stimulate fibrous, non-mineralised tissue is still a debatable venture.<sup>38</sup> Allograft yields comparable fusion rates to autograft without donor site morbidity,<sup>44</sup> but with an increased cost and a potential for infectious disease transmission.

## vi. Lumbar disc arthroplasty (LDA)

LDA usually is performed through an anterior approach at lower lumbar levels (L4/5 and L5/S1) in younger and active individuals with limited adjacent segment disease(ASD), adequate bone stock, absence of spondylolisthesis and normal facet joints. The major driver for development of this technique has been the motion preservation as an alternative to fusion with theoretically lower risk for ASD.<sup>45</sup> Many of the complications noted such as implant extrusion and vascular injury can be linked to inadequate training,

improper sizing and lack of confirmation of satisfactory placement on imaging with implant impingement linked to the aforementioned factors.<sup>46</sup>

vii. Intradiscal surgical procedures: Intradiscal surgical procedure,<sup>36</sup> such as the use chemonucleolysis which uses the chymopapain injected intradiscally have been used in LDDD. This procedure though promising based on report are inferior to other decompressive techniques. Others also described in literature are the minimally invasive options such as the Intradisc electrothermal therapy (IDET) and Radiofrequency posterior annuloplasty (RPA) which involve the placement of electrode into the disc as varying result not comparable to surgery.<sup>35,36</sup>

viii. Novel Approaches  
stem cell therapy in combination with tissue engineering approaches as a minimally invasive alternative to manage LBP with human trials ongoing but inconclusive.<sup>47</sup>

## Conclusion

From this review, it has been established that LDDD and its attendant disabling, debilitating chronic LBP has huge impact on the socioeconomic status of the patient and the health care system. Therefore, diagnosis and treatment approaches varies and are evolving. Researches are ongoing on this subject aiming to reverse the degenerative disc cascade.

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