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Vaccine Storage and Handling Practices among routine immunization service providers in a metropolitan city of North-Central Nigeria

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KEYWORDS

Routine immunization, knowledge, vaccine handling, Nigeria, practices.

ABSTRACT

Background: The efficacy of vaccines can be compromised by faulty transport, storage, and handling. This study was conducted to assess the knowledge and practice of vaccine storage and handling among Primary Health Care Workers (PHCWs) offering routine immunization (RI) services in static health facilities in Ilorin metropolis, North-central Nigeria.

Methodology: It was a descriptive cross-sectional study carried out among 457 Primary Health Care Workers (PHCWs) in 2 Local Government Authorities in Kwara State, north central Nigeria, using multi stage sampling technique. The research instruments were pretested self-administered questionnaire and observational checklist. The data generated were analyzed using EPI-INFO version 3.5.1 software package. Level of significance was predetermined at p-value of less than 0.05 at 95% confidence interval.

Results: About half of the respondents (52.1%) knew the optimal vaccine storage temperature, 35.4% knew that freezing is harmful to certain vaccines. Although, 67.8% were aware of the 'shake test', only 48.4% of them knew how to conduct it. Up to 367 (80.3%) acknowledged that heat is harmful to vaccines. Even though, 267 (58.4%) knew the vaccine vial monitor (VVM) stages, only 248 (45.3%) could interpret the VVM correctly. About 30% of the health facilities (HFs) had adequate vaccine storage equipments while less than one third (28.6%) refrigerators were used exclusively for vaccine storage. However, functioning thermometers were present in all the refrigerators devoted to vaccine storage.

Conclusions: Vaccine storage and handling practices among PHCWs providing routine immunization (RI) services in the study area was still sub-optimal. There is need for periodic on the job training and supportive supervision of health workers by middle cadre immunization officers in the local government to improve on the vaccine storage and handling practices of RI service providers.

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INTRODUCTION

Vaccine storage and handling is an important component of logistic requirements of vaccination. This is one of the factors that determine whether or not a vaccinated child eventually becomes immunized. Immunization is a proven cost-effective weapon in the prevention, control and elimination of diseases and it is envisaged that it will greatly

contribute to the accelerated attainment of the Millennium Development Goals (MDGs) of halving child mortality rate by the year 2015. Globally, an estimated 3.2 million death is averted and 23 million Disability Adjusted Life Years (DALY) prevented at a cost of 1.4 billion US dollars by immunization annually.1 In Nigeria, VPDs currently account for about 22% of deaths of under-fives, translating to about 200,000 avoidable child deaths annually.[2]

Knowledge and practice of RI service providers regarding vaccine storage and handling have implications on childhood immunization. Studies conducted locally[3,4] and regionally[5-8] have shown varying degree of gaps in vaccine management knowledge of health workers. A WHO report had revealed mortality arising from poor vaccine storage and handling practice from static RI facilities in Yemen, Algeria and Malawi where insulin, selenium and oxytocin respectively had been inadvertently administered as vaccines.[9]

In addition, poor vaccine forecast, poor storage techniques, inefficient vaccine stock control and distribution, coupled with inadequate cold chain maintenance have been found to be important contributors to high vaccine wastage rates in most developing countries.[10-12] This undesirably high level of vaccine wastage rates occurring in most countries in spite of the availability of tools for reducing such wastage still remained a major hindrance to the attainment of substantial progress in immunization activities. All these have direct and indirect impact on immunization programme and control of Vaccine Preventable Diseases (VPDs).

It is increasingly becoming important to prevent loss of vaccine potency during storage and handling as new and more expensive vaccines are being introduced, with some requiring a different approach to storage.[4] Unfortunately, the influence of health workers' knowledge and practice regarding vaccine storage and handling is often neglected.[3] In order to assess health workers' knowledge and practice regarding vaccine storage and handling, Yaun et al[13] conducted a cross sectional study among 135 primary care physicians outside metropolitan Toronto in which only 6% of the participants had adequate knowledge of vaccine storage and handling. Thakker et al[6] in their study involving 50 primary care physicians in central Manchester reported that only 40% of the respondents were aware of the appropriate vaccine storage conditions. In 2004, a study was conducted in south-eastern Nigeria (Enugu) by Uzochukwu et al[3] to assess the PHC workers' knowledge and practice regarding vaccine storage and administration, in which only 24% of the participants were reported to have adequate knowledge of vaccine management.

In Mozambique, following the report of occurrence of epidemics of VPDs in 2003 despite high immunization coverage, Joao et al[11] conducted a survey to assess the knowledge and practice of health care providers regarding cold chain management in Niassa. Fifty-two percent of the respondents knew the optimal temperature for vaccine storage while 61% knew that certain vaccines (DPT and Hep B vaccines) are prone to damage at freezing temperature with only 4% having adequate knowledge of the 'shake test'.

While there are many researches investigating the issue of knowledge, practice and coverage as regards immunization, there is a dearth of local in-depth studies on the knowledge and practices of healthcare givers on vaccine storage and handling. This study was conducted to assess the knowledge and practice of vaccine storage and handling among primary health care workers offering routine immunization (RI) services in static health facilities in Ilorin metropolis, Nigeria.

METHODOLOGY

A descriptive cross-sectional survey of primary

health care workers (PHCWs) in static health facilities offering RI services in Ilorin metropolis, Kwara State was carried from April to June 2010. All the 457 consenting PHCWs in 2 (Ilorin East and west) out of the 3 LGAs were recruited into the study. These comprise of PHCWs in public and private health facilities that were ever involved in RI service delivery and had spent a minimum of one month on the job. On the other hand, PHCWs in public PHC facilities who were not directly involved in RI service delivery including attendants, laboratory technicians and administrative staff were excluded from the study.

The list of names of all the health workers who satisfied the inclusion criteria (those that have spent at least one month at the static routine immunization unit) was obtained from Officers-in-charge of each of the health facility through the Health Department of each LGA while that of health workers in private HFs was obtained from the monthly RI review meeting register in custody of the Local Immunization Officers of the respective LGA. Ethical approval for the study was obtained from Ethical Review Committee of University of Ilorin Teaching Hospital, Ilorin while informed consent was sought from the respondents before been recruited into the study.

The study was carried out at the health facilities during working hours of the week days. The research instruments used were questionnaire and observational checklist. The pre-tested, self-administered, semi-structured questionnaire designed by the researcher was hand-delivered. The questionnaire included questions on socio-demographic variables of the respondents, and their knowledge and practices of vaccine forecasting, vaccine ordering and storage, and vaccine cold chain maintenance. It also included questions related to in-service training in vaccine management and on-the-job supervision.

The observational checklist (OBL) was used to assess the quantity and functionality of available vaccine cold chain maintenance and monitoring equipments in all the 49 public HFs in the study area. The OBL was also used to collect qualitative data through observation of practices such as, maintenance of vaccine record books, documentation of vaccine stock, presence of thermometers in vaccine storage devices, the presence of temperature monitoring charts, the reading of thermometers and the presence of products other than vaccines in the refrigerators/ cold boxes.

RESULTS

A high proportion of the RI service providers 299 (65.5%) were aged 30 to 49 years while 116 (25.4%) were 20 to 29. The mean age of the health workers was 36.60 ± 9.30 years (Table I).

The RI service providers were predominantly females 393 (86.1%) with a majority being CHEWs 227 (49.7%) and Nurses 121 (26.5%). PHCWs with barely 5 years of work experience in RI service delivery constituted the largest group 201 (44.0%) while those with less than one year work experience were 16 (14.2%). The average work experience in RI of the health workers is 8.18 ± 7.6 years. More than half of the RI service providers 295 (64.0%) had attended training on vaccine management prior to the study. Similarly, more than half of them (53.9%) were sponsored by health agencies such as EU-PRIME, UNICEF and WHO (Table II). However, only a minority 99 (21.7%) had supervisory visit within 6 months before the study.

Slightly more than half of the RI service providers 238 (52.1%) knew the optimal vaccine storage temperature range while only 162 (35.4%) knew that freezing is harmful to certain vaccines such as DPT, TT and HBV (Table III). More than two thirds 310

(67.8%) of the health workers were aware of the 'shake test' as a means of detecting whether DPT, TT and HBV had been previously frozen. However, only 150 (48.4%) knew how to conduct the shake test. Up to 367 (80.3%) of the PHCWs acknowledged that heat is harmful to vaccines particularly when it is outside the optimal temperature range of +20C to +80C. More than half of the health workers 240 (52.5%) got the meaning of VVM correctly, 267 (58.4%) knew the VVM stages, and 248 (45.3%) could interpret the VVM stages correctly (TableIII).

Less than 30% of the health facilities (HFs) in the study area had adequate vaccine storage and cold chain monitoring equipments (Table IV). Only 6 (28.6%) refrigerators were used exclusively for vaccine storage as 15 (71.4%) were also used to store food and medications. All the vaccine refrigerators had a functioning thermometer, though the twice daily temperature charting was strictly adhered to in only 19.0% of them.

Vaccines were stored at optimal temperature in 18 (85.7%) of the refrigerators/ cold boxes. Vaccines stored in all the refrigerators and cold boxes had their VVM labels intact. However, in 8 (16.3) of the refrigerators, vaccines with VVM stages III and IV were stored alongside those in stages I & II; and in 2 (9.5%) expired vaccines were stored

Table I: Socio-demographic characteristics of respondents N = 457

Socio-demographic characteristics	**(%)**
Age groups (years)	
< 20	5 (1.1)
20 - 29	116 (25.4)
30 - 39	126 (27.6)
40 - 49	173 (37.9)
50 - 59	34 (7.4)
⩾60	3 (0.6)
Range (years)	18 – 61
Mean (years)	36.60 ± 9.30
Sex Distribution	
Female	393 (86.1)
Male	64 (14.0)
Marital status	
Married	357 (78.1)
Single	80 (17.5)
Widowed	20 (4.4)
Cadre	
CHEW	227 (49.7)
CHO	31 (6.8)
RN/M	121 (26.5)
B.Sc	44 (9.6)
Others (auxiliary health workers)	34 (7.4)

Mean age (SD) = 33.6 (7.3) years

Table II: Respondents' participation in vaccine management training before intervention. N= 457

Variables	(%)
Attended Training	
Yes	295 (64.6)
No	162 (35.4)
Sponsors of Training	N = 295 (%)
LGA	88 (29.8)
SMOH	48 (16.3)
EU-PRIME	68 (23.1)
WHO	44 (14.9)
UNICEF	47 (15.9)
Last supervisory Visit	
<6months ago	99 (21.7)
⩾6 months ago	358 (78.3)
Designate of supervisor	
LGA EPI staff	315 (68.9)
SMOH EPI staff	53 (11.6)
Officers from partner agencies	89 (19.5)

Table III: Correct responses to questions about vaccine storage and handling N= 457

Questions	(%)	
	Yes	**No**
Do you know the optimal temperature range (+2 to +8) for storing vaccines?	238 (52.1)	219 (47.9)
Is freezing harmful to vaccines?	162 (35.4)	295 (64.6)
Are you aware of 'shake test'?	310 (67.8)	147 (32.2)
Do you know how to conduct 'shake test'?	*160 (51.6)	*150 (48.4)
Do you know the full meaning of VVM?	240 (52.5)	217 (47.5)
Do you know all the VVM stages?	267 (58.4)	90 (41.6)
Can you interpret the VVM stages?	248 (54.3)	209 (45.7)

Note: * N= 310

Table IV: Available vaccine cold chain equipments in the health facilities **N= 49**

Cold chain equipment	Frequency (%)
Solar refrigerator	4 (8.2)
Electric refrigerator	3 (6.1)
Ice lined refrigerator	4 (8.2)
Thermometer	6 (12.2)
Cold box	8 (16.3)
Giostyle	56 (1.1)

Table V: Observed practices of vaccine storage and handling **N = 21**

Observation	(%)	
	Yes	No
Designated person looking after fridge/ cold box	0 (0.0)	21 (100.0)
Functional thermometer in fridge / cold box	6 (28.6)	15(71.4)
Temperature monitored at least daily and recorded	4 (19.0)	17 (81.0)
Up to date temperature monitoring chart on fridge / cold box	4 (19.0)	17 (81.0)
Stored vaccine found in optimal temperature range (+2 to $+8^0$C)	7(33.3)	14 (66.7)
Vaccine vials with VVM labels intact	21 (100.0)	0 (0.0)
Unusable vaccines with VVM stages III & IV stored with useable (stages I & II) vaccines	8 (16.3)	41 (83.7)
Expired vaccines found in fridge / cold box	2 (9.5)	19 (90.5)
Food items and drugs stored in fridge /cold box	15 (71.4)	6 (28.6)

Note: N = total number of health facilities observed

together with usable ones. There was no designated officer/ health worker to look after all the 12 refrigerators observed (Table V).

DISCUSSION

The ages of the respondents ranged between 18 to 61 years with a mean age of 36.60 ± 9.30. This showed that majority of the health workers in the study area were within productive age group. In this study, the RI service providers were predominantly female and this corroborated the scenario of most PHC facilities in Nigeria where nursing professions and other nursing related professions like Community Health Officers (CHO) and Community Health Extension Workers (CHEW) are predominantly women.[18]

More than half, 193 (57.4%) of the RI service providers in the study area had 5 years working

experience. This showed that the health workforce at the primary level of care in the study area are made up of young workers who would be more involved in service delivery rather than in administrative role. Up to 295 (64.0%) of the RI service providers had attended training on vaccine management prior to this study, it was, therefore, not surprising that a high proportion of them had good knowledge on aspect of vaccine storage and handling (table III). This might not be unconnected with the fact that vaccine management topics, such as vaccine storage and handling, cold chain management and VVM interpretation were often discussed in seminars and training workshops on immunization service delivery.

In all the 49 health facilities involved in the study, there were on the average 5 giostyles per HF and only 12 HFs had functioning vaccine refrigerators and thermometers dedicated for vaccines. This is a far cry from the standard. This is grossly inadequate for static health facility. The standard practice is to have at least one functioning refrigerator dedicated for vaccine storage. Only 5 of the 12 refrigerators in the study HFs are solar-powered. Considering the erratic power supply in the study area, solar refrigerators would be more suitable than electrically powered refrigerators.

The potency of vaccines depends largely on maintenance of cold chain - a prescribed temperature range of between 2 and 80C during transport and storage. In this study, 80.3% of the respondents had correct knowledge of recommended temperature for vaccine storage. This finding was consistent with the 52% reported by Joao et al[11] in their study of cold chain management knowledge and practices among health workers in Niassa, Mozambique. However, it contrasted sharply with the abysmally low proportion of 5% reported by Munir et al in Lagos, Nigeria.

The sharp contrast to Munir's[4] study might probably be due to the difference in the group of health workers involved in the studies. Whereas only PHCWs in private setting were used in the Lagos study, health workers in both private and public settings were involved in this study. Since health workers in public HFs usually have more opportunities to attend training workshops than their counterparts in private establishments; they, therefore, have ample avenue to acquire new knowledge or update their baseline knowledge. It is, therefore, not surprising that the proportion of respondents with correct knowledge of optimal vaccine storage temperature was abysmally low in Munir's study where only health workers in private HFs were used.

Surprisingly, Malliki et al[14] also reported an alarming gap in knowledge of recommended vaccine storage temperature range among cold chain handlers in Kolkata, India. This portends that poor knowledge of vaccine storage temperature is not limited to RI service providers in peripheral HFs alone but cuts across all cadre of workers involved in cold chain management. Impliedly, most PHCWs are lacking in basic information required for safe vaccine storage and handling necessary for maintaining vaccine potency at all time.

The VVM is an excellent monitoring device to assure that only non-heat damaged vaccines are administered to the prospective recipients. In spite of its laudable property, several studies have revealed gaps in health workers' knowledge of this indispensable vaccine management tool.[7,8] In this study, barely half (52%) of the RI service

providers had correct knowledge of VVM and its interpretation. This finding was consistent with that of Chudasama (48%) et al8 in India but contrasted sharply to the report of Arulogun (85%) et al in Nigeria[17] and Thakur (70%) et al in India, where higher proportions of respondents had good knowledge of VVM.[7] The relatively low level of knowledge of VVM observed in this study has potentially adverse effect on the quality of vaccines, particularly the heat-labile ones such as OPV. Since VVM is present on all vaccine vials, health workers need to have a good grasp of its staging and interpretation to ensure that prospective clients receive potent vaccines in order to stem the current tide of vaccine preventable diseases (VPDs).

As more expensive freeze-sensitive vaccines are being introduced into the immunization schedule, freeze prevention has become critical in order to ensure that the world's children are receiving fully potent vaccines. This possibility of accidental freezing of vaccines in the cold chain has prompted studies throughout the world, to better characterize the risk. In this study, only 35.4% of the RI service providers had adequate knowledge of vaccines prone to damage when exposed to freezing temperature. Contrary to this finding, Joao et al[11] reported 61% in Mozambique, while Ortega et al[19] in Spain reported over 50% of health workers with adequate knowledge of vaccines liable to freezing damage.

The difference in findings may be adduced to the fact that health workers in the latter studies were from temperate regions where knowledge of freeze-prevention is more relevant than knowledge of heat-damage prevention that applies more to the tropical zones. This is because their vaccine storage equipment will have more tendencies to attaining freezing temperatures than high temperature range. Barring other conditions, health workers' knowledge of vaccines prone to freezing and how to prevent vaccines from freezing damage will be at their finger tips.

The observation that sedimentation was faster in a vial which has been frozen than in a vial from the same manufacturer which has not,[20] formed the basis of the 'shake test.' Hence the test is used to confirm whether or not a vaccine vial has been damaged by freezing. In this survey, 67.8% of the respondents were aware of the shake test. Of these, 51.6% had correct knowledge of what the shake test entails. This contrasted sharply with the 32% and 4% reported by Ortega[19] (Madrid, Spain) and Joao's[11] (Niassa, Mozambique) respectively. One reason for this might probably be due to the fact that health workers in the latter studies are more likely to pay more attention to freeze prevention as a way of limiting vaccine wastage by virtue of their temperate environment. On the other hand, health workers in tropical climate, such as Nigeria, would be less conscious of freeze-prevention, and as such, when accidental freezing of a vaccine occurs, conduction of shake test to confirm whether or not it has been damaged becomes imperative. Hence, they are more likely to be conversant with usage of shake test than their counterparts in the temperate zones.

Safe vaccine storage and handling practices entail refrigeration of vaccines in optimal temperature range within the refrigerator; and ensuring that other items aside from vaccines are not kept in the vaccine refrigerators.[21] Unlike findings in studies done in Spain,[19] Atlanta Georgia[22], Taiwan[23], Sri-Lanka[24] Ethiopia[10] and Mozambique[11] where all (100%) HFs; and in Italy (76%)[25] had at least one functioning refrigerator, only 20% of HFs had vaccine refrigerators in this study. This finding agreed with the trend observed in Lagos by Munir et al[4] where only 10% of privately owned HF had

functioning vaccine refrigerators. The abysmally low proportion of HFs with vaccine refrigerators portends the suboptimal vaccine storage and handling practices in the study area and its attendant implication on vaccine efficacy. It also indicates that there is a low level of government commitment and support for routine immunization programme.

This study observed that only 28.6% HFs had functioning thermometers in their vaccine storage equipment. These findings were lower than findings reported in HFs elsewhere - 57% in Sri- Lanka[24], 50% in Spain[19], 100% in Mozambique[11], 97% in Ethiopia[10] and 47% in Taiwan.[23] Report from study done in Lagos revealed that none of the HFs had thermometers in their vaccine refrigerators.[4] This might be because the study was done in privately owned HFs where emphasis is on profit maximization thereby making it rather difficult to conform to standard practice in all aspect of health care service delivery. The lack of thermometers in 70% of HFs in the study area implied that maintenance of vaccines at optimal temperature during storage cannot be guaranteed.

In order to detect variations in vaccine temperature promptly, a twice daily temperature monitoring and recording is advocated.[21] This study observed that only 19% of HFs kept up to date vaccine temperature monitoring charts. This observation also underscored the lack of adequate vaccine management equipment in the study area. This proportion is abysmally low when compared with the 58% reported in Ethiopia[10] and 46% reported in Taiwan.[23] The finding from this study is higher than that of Mozambique[11] where most HFs did not have up to date record of vaccine temperature chart, and that of Italy,[25] where none of the HFs kept any vaccine temperature record. In Sri-Lanka, 40% of HFs monitored vaccine temperature on a daily rather than twice daily basis.[24]

Careful attention to vaccine storage and handling is essential to ensure optimal potency of vaccines. In this study, 71.4% of HFs stored other items in vaccine refrigerator. This finding is consistent with observations in Sri-Lanka[24] (76%), Taiwan[23] (93.7%), Ontario (81.2%)[13] and in Enugu,[3] (71.4%). Similarly high proportion of HFs stored other items with vaccines in Lagos,[4] Italy[25] and Mozambique.[11]

These findings corroborated the pervasiveness of the practice of storing other items with vaccine, especially in developing countries where health resources are usually limited in supply. The frequency of HFs storing other items in vaccine refrigerators also portends that supportive supervision of health workers is not adequate in most parts of the world. A WHO report had revealed that the widespread habit of storing other items in vaccine refrigerators had recently resulted in fatal consequences in Malawi, Algeria and Yemen, as health workers are often liable to mistakenly administering such items as vaccines to prospective immunization recipients.[26]

Storing vaccines or other items on refrigerator door shelves encourages more frequent opening of the refrigerator. This can lead to temperature variation within, which can affect vaccine efficacy. In this study, vaccine or other items were stored on refrigerator door shelves in 13.8% of HFs. Higher trends were observed in Italy[25] and Enugu, Nigeria (61.9%).[3]

Administration of expired vaccines is dangerous as it may evoke adverse drug reactions in addition to lack of sero-conversion in the recipients. This study observed that 9.5% of HFs kept expired vaccine together with usable ones; and 16.3% were in either stage III or IV of VVM. This contrasted with the trend observed by Munir' et al[4] where all the HFs had the vaccine expiry dates

intact, although 80% of the vaccines were in either stage III or IV of VVM.

Continual training and re-training of health workers involved in immunization and vaccine handling is imperative for proper vaccine management. There is need for on the job training and supportive supervision of health workers by middle cadre immunization officers at the local government to improve on the RI service providers' vaccine storage and handling practices.

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