Rainbow (Rapid Access Immunization Now: Better Our World) Record: An Immunization Tool for Nigerian Families

by Valerie Watzlaf, PhD, RHIA, FAHIMA; Sandy Meyers, RHIA; Erh-Hsuan (Reina) Wang, MS; and Kenny Funmilayo

Abstract

Millions of children die every year across the world as a result of not being immunized. Nigeria has made great improvements in childhood immunizations, but it still lacks the effectiveness and efficiency that an immunization tool may be able to provide. The Bill and Melinda Gates Foundation proposed a Records for Life project asking teams to develop innovative immunization records for countries across the world. The authors of this article responded to that project announcement, and although the team did not get selected, the International Federation of Health Information Management Associations (IFHIMA) expressed interest in the proposed record. This article describes the need for and the design of a new immunization record for Nigerian families to use so that immunizations can continue to increase across all geopolitical zones in Nigeria. The immunization tool is called the RAINBOW (Rapid Access Immunization Now: Better Our World) Record and includes a colorful, useable, inexpensive, primarily paper-based record that rewards children with stickers and fun approaches when immunizations are completed. It also incorporates health information technology practices that can be used if the immunization record (built in Excel) is linked to an electronic health record.

Keywords: immunization record, paper-based record, electronic health record, Nigeria

Introduction

Nearly 870,000 children under the age of five die every year in Nigeria. The majority die of diseases that could easily be prevented by immunizations already available or almost available.[1] Although childhood immunizations in Nigeria have increased over the last 30 years, disparities due to socioeconomic and rural-urban differences still exist across the country's six geopolitical zones, even though the same type of immunization record is used across these six zones. In fact, 43 percent of children age 12 to 23 months living in an urban environment receive all basic vaccinations, while only 16 percent of those children that live in a rural environment receive all basic vaccinations.[2] Also, there exists great misunderstanding or misconception regarding the usefulness of vaccinations, as evidenced by the killing of nine polio immunization workers while they were trying to administer the polio vaccine in two clinics in Nigeria.[3,4] In a study by Fatiregun and Okoro,[5] one of the reasons why children in Nigeria do not receive all immunizations is the lack of availability of an immunization card at first contact. An immunization card or child's health record is a record that is used by families and the child's healthcare worker when providing, recording, and retrieving the types of vaccinations that are given or should be given. In some countries, immunization records are stored in the family home and are carried by the family when visiting the healthcare worker. The healthcare worker examines the immunization record to determine what vaccines have already been given and what vaccines the child needs. The healthcare worker then provides the proper vaccine and records it on the immunization record along with the next visit date and gives the record back to the family to keep.

The use of immunization records is widespread across the world and is supported by the World Health Organization, UNICEF, and most national governments.[6] Even though Usman and colleagues[7] have found that use of immunization cards can increase vaccination rates, the prevalence of immunization cards in Nigeria has varied on the basis of geographic location (rural, 21 percent; urban, 39 percent) and wealth (low wealth, 8 percent; high wealth, 52 percent).[8] Also, a recent discussion among our research and design team revealed that a mother who lives in the southern parts of Nigeria with six children did not think there was a problem with immunizations in her region and thought that the immunization card was something everyone used. She is from a higher socioeconomic status and has a master's degree in education. Her husband is a senior healthcare worker. In her part of the country, a system has been developed in which healthcare workers go from house to house to follow up on

immunizations. The healthcare workers wear a distinctive vest that identifies their role. Therefore, Nigeria has varying degrees of use of immunization records (cards) depending on geographic location and socioeconomic status, although the same type of record is available for use across the six geopolitical zones.

The Bill and Melinda Gates Foundation proposed a Records for Life project asking teams to develop innovative immunization records for countries across the world.[9] The authors of this article responded to that project announcement and designed a new immunization record for use in Nigeria. Although the team was not selected by the Gates Foundation, the International Federation of Health Information Management Associations (IFHIMA) expressed interest in the proposed record. This article describes the new immunization record that the team designed for Nigerian families with the aim of increasing immunization rates across the six geopolitical zones in Nigeria.

Existing and Proposed Immunization Records

Figure 1 and Figure 2 provide a sample of both sides of the existing immunization record used in Nigeria. From this immunization record, one can see that a redesign of the record is needed and should address the following issues:

1. Increased usage
2. Improved design
3. Increase in healthcare worker training and mentoring to improve caregivers' understanding of the card
4. Advantages of keeping the card accessible and bringing it to all child care visits
5. Collection of all pertinent information on the card, such as the date, day of the week, and location of the next vaccination visit as well as other health information and instructions that promote child health for the parents and the entire family
6. Increased accuracy in order to support the surveys that are performed for public health purposes and in which immunization coverage of children is monitored
7. Less maternal recall because it is difficult to remember when a child received an immunization as well as which immunization was received
8. Improvements in communication between healthcare workers and parents
9. Streamlining workflow within the health clinics
10. A lifelong record that the child can keep and continue to maintain information on immunizations throughout adulthood

Figure 1: Original Immunization Record for Nigeria, Side 1

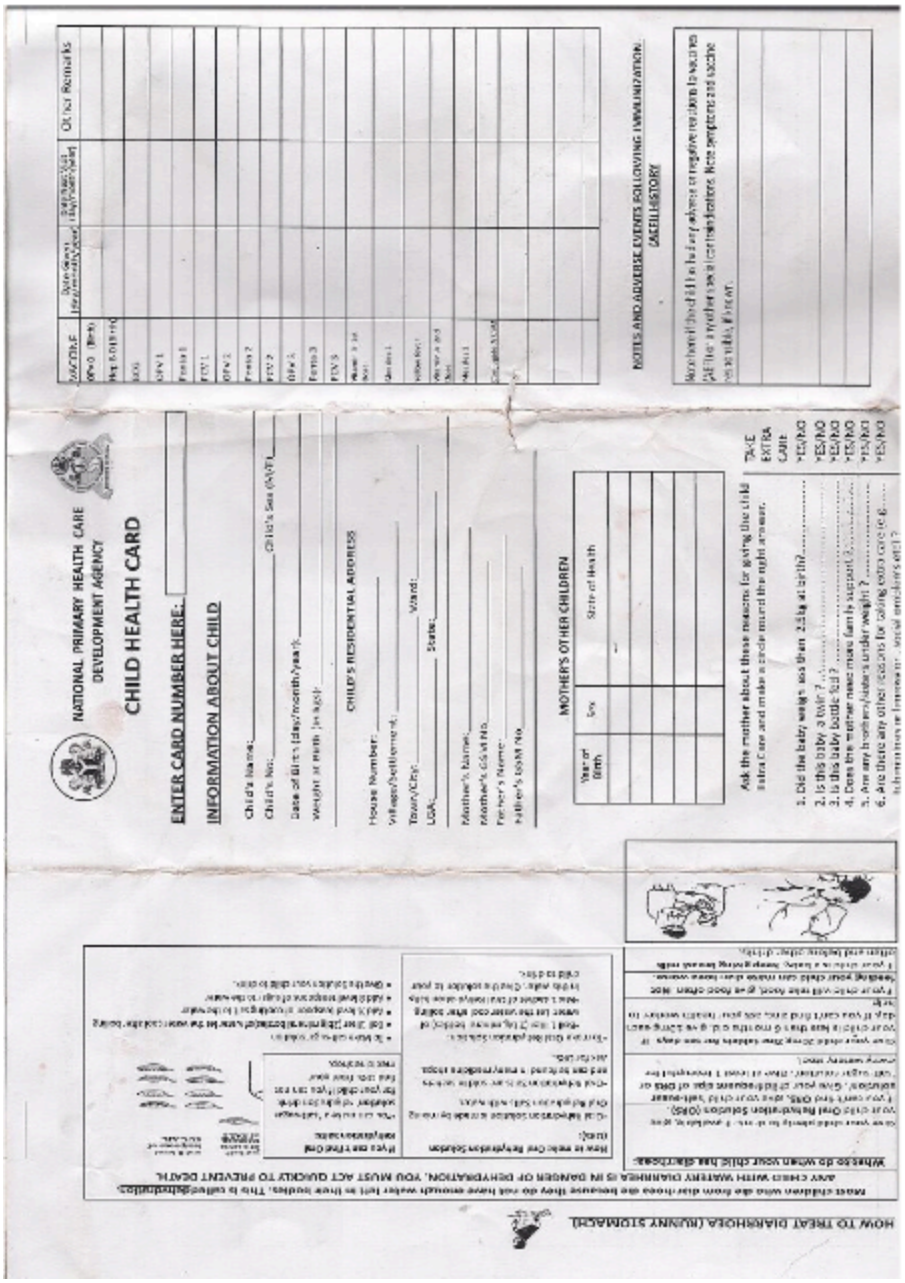
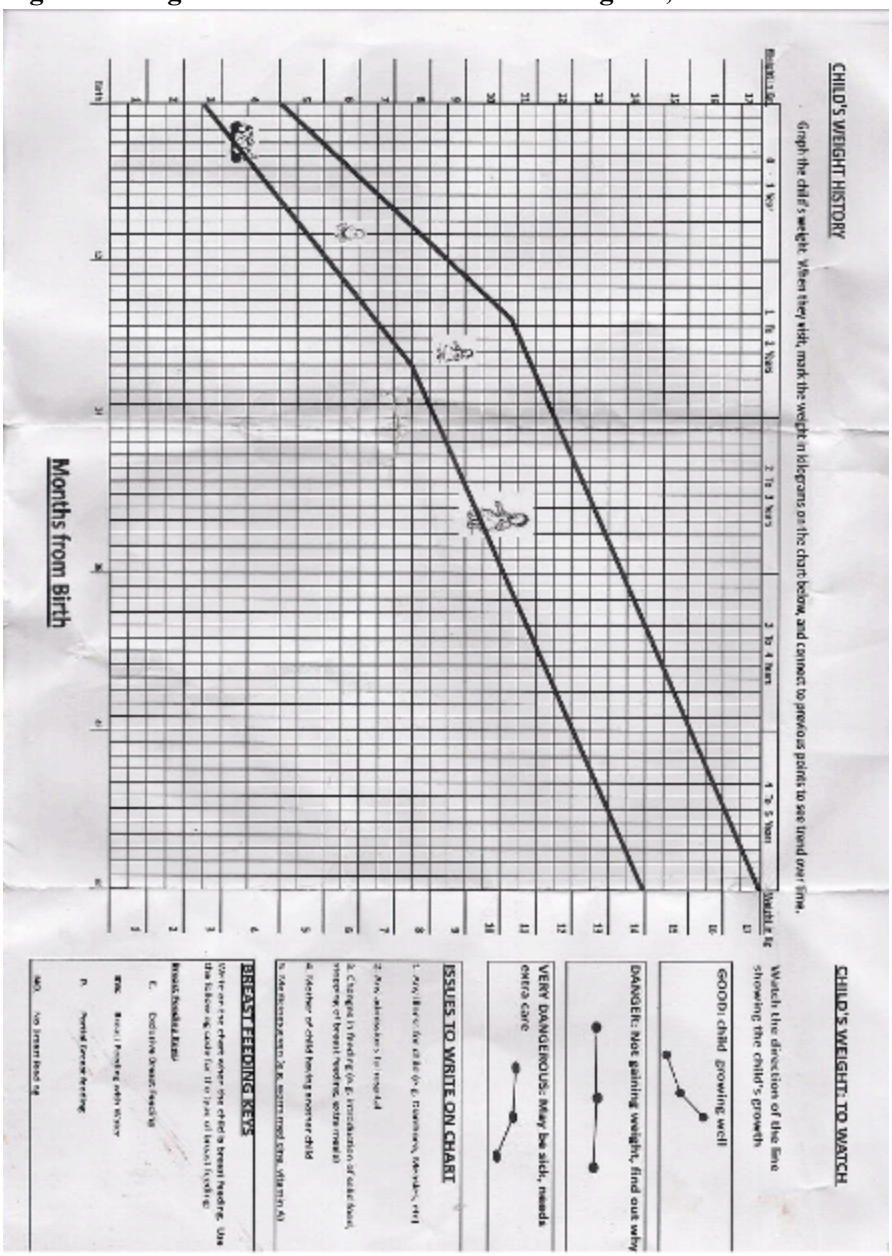


Figure 2: Original Immunization Record for Nigeria, Side 2



A study conducted in Pakistan[10] demonstrated improved follow-up and reduced drop-out rates with the use of redesigned immunization records that include a larger, brighter card with strategic placement of reminder information in large text.

On the basis of the research performed to better understand the immunization cards used in Nigeria and the need for improvements, the authors built a colorful, new immunization record called the RAINBOW (Rapid Access Immunization Now: Better Our World) Record for use in Nigeria. Figure 3 shows the front page of the RAINBOW Record for a girl, and Figure 4 shows the front page of the RAINBOW Record for a boy. Figure 5 shows the back page of the RAINBOW Record for both boys and girls. According to the project background, the Gates Foundation was looking for the new immunization card to serve five functions.[11] These functions are listed below, and the parenthetical notes indicate whether the function was served by the existing immunization record in Nigeria.

Figure 3: RAINBOW Record for Girls: Front

The RAINBOW Record: Rapid Access Immunization Now: Better Our World			
Child's Immunization #:	Mother's Name: Father's Name:	Child's address1:	Child's address2:
Child's Name:	Mother's Cell Phone #: Father's Cell Phone #:	House Number:	House Number:
Child's Date of Birth (d/m/y):	Number of Other Children:	Village/Settlement:	Village/Settlement:
Child's Sex (M/F):	Multiples: Year: Sex(M/F): Health:	Town/City: State:	Town/City: State:
Weight at Birth (kgs):		Ward: LGA:	Ward: LGA:

Age of Child	Vaccines	Date/Clinic Given (d/m/y)	Date Next Visit (d/m/y)	Notes
Birth	Bacillus Calmette-Guerin (BCG)			
Birth	Hepatitis B (HepB or HBV0)			
Birth	Oral Poliovirus vaccine--1st dose (OPV or OPV0 or OPV1)			
6 weeks	Pentavalent Combination-- 1st dose (Penta or Penta1)			
6 weeks	Pneumococcal Conjugate--1st dose (PCV or PCV1)			
6 weeks	Oral Poliovirus vaccine--2nd dose (OPV or OPV2)			
6 weeks	Oral Rotavirus Vaccine--1st dose (RV or RV1 or Rota 1)			
10 weeks	Pentavalent Combination--2nd dose (Penta or Penta2)			
10 weeks	Pneumococcal Conjugate--2nd dose (PCV or PCV2)			
10 weeks	Oral Poliovirus vaccine--3rd dose (OPV or OPV3)			
10 weeks	Oral Rotavirus Vaccine--2nd dose (RV or RV2 or Rota 2)			
14 weeks	Pentavalent Combination--3rd dose (Penta or Penta3)			
14 weeks	Pneumococcal Conjugate--3rd dose (PCV or PCV3)			
14 weeks	Oral Poliovirus vaccine--4th dose (OPV or OPV4)			
6 months	Vitamin A--1st dose (100,000 IU)			
6 months	Influenza (yearly) (TIV, LAIV)			
9-12 months	Measles and Rubella--1st dose (MR or MR1)			
9-12 months with measles vaccine	Yellow Fever			
12 months	Hepatitis A (HepA, HepA-HepB)			
12-15 months	Vitamin A--2nd dose (200,000 IU)			
12-15 months	Varicella (chickenpox)--1st dose (VAR1, MMRV1)			
≥ 1 yr	Tick-borne Encephalitis			As needed per geographic region
15-18 months	Measles and Rubella--2nd dose (MR or MR2)			
2 years	Typhoid			Booster 3-7 years after first immunization
2-5 years	Cholera (Dukoral)--3 doses			Epidemic; booster every 6 mos;
4-6 years	Varicella (chickenpox)--2nd dose (VAR2, MMRV2)			
9-13 years	Quadrivalent Human papillomavirus (HPV)--1st dose 2nd--2 months after 1st; 3rd--6 months after 2nd			
As Required	Rabies--3 doses: 7 days (1), 14-21 days (2)			High Risk Populations; Booster
	Add Off Schedule and Additional Vaccines Here			

Figure 4: RAINBOW Record for Boys: Front

The RAINBOW Record: Rapid Access Immunization Now: Better Our World			
Child's Immunization #:	Mother's Name: Father's Name:	Child's address1:	Child's address2:
Child's Name:	Mother's Cell Phone #: Father's Cell Phone #:	House Number:	House Number:
Child's Date of Birth (d/m/y):	Number of Other Children:	Village/Settlement:	Village/Settlement:
Child's Sex (M/F):	Multiples: Year: Sex(M/F): Health:	Town/City: State:	Town/City: State:
Weight at Birth (kgs):		Ward: LGA:	Ward: LGA:

Age of Child	Vaccines	Date/Clinic Given (d/m/y)	Date Next Visit (d/m/y)	Notes
Birth	Bacillus Calmette-Guerin (BCG)			
Birth	Hepatitis B (HepB or HBV0)			
Birth	Oral Poliovirus vaccine--1st dose (OPV or OPV0 or OPV1)			
6 weeks	Pentavalent Combination-- 1st dose (Penta or Penta1)			
6 weeks	Pneumococcal Conjugate--1st dose (PCV or PCV1)			
6 weeks	Oral Poliovirus vaccine--2nd dose (OPV or OPV2)			
6 weeks	Oral Rotavirus Vaccine--1st dose (RV or RV1 or Rota 1)			
10 weeks	Pentavalent Combination--2nd dose (Penta or Penta2)			
10 weeks	Pneumococcal Conjugate--2nd dose (PCV or PCV2)			
10 weeks	Oral Poliovirus vaccine--3rd dose (OPV or OPV3)			
10 weeks	Oral Rotavirus Vaccine--2nd dose (RV or RV2 or Rota 2)			
14 weeks	Pentavalent Combination--3rd dose (Penta or Penta3)			
14 weeks	Pneumococcal Conjugate--3rd dose (PCV or PCV3)			
14 weeks	Oral Poliovirus vaccine--4th dose (OPV or OPV4)			
6 months	Vitamin A--1st dose (100,000 IU)			
6 months	Influenza (yearly) (TIV, LAIV)			
9-12 months	Measles and Rubella--1st dose (MR or MR1)			
9-12 months with measles vaccine	Yellow Fever			
12 months	Hepatitis A (HepA, HepA-HepB)			
12-15 months	Vitamin A--2nd dose (200,000 IU)			
12-15 months	Varicella (chickenpox)--1st dose (VAR1, MMRV1)			
≥ 1 yr	Tick-borne Encephalitis			As needed per geographic region
15-18 months	Measles and Rubella--2nd dose (MR or MR2)			
2 years	Typhoid			Booster 3-7 years after first immunization
2-5 years	Cholera (Dukoral)--3 doses			Epidemic; booster every 6 mos;
4-6 years	Varicella (chickenpox)--2nd dose (VAR2, MMRV2)			
9-13 years	Quadrivalent Human papillomavirus (HPV)--1st dose 2nd--2 months after 1st; 3rd--6 months after 2nd			
As Required	Rabies--3 doses: 7 days (1), 14-21 days (2)			High Risk Populations; Booster
	Add Off Schedule and Additional Vaccines Here			

Figure 5: RAINBOW Record: Back

1. A unique identifier that is intimately connected to the child (on current record)

In Nigeria, every child is given a number that includes the child's order of birth in Nigeria, birth date, and local government area (LGA) code. Therefore, this number can be used for the child because it will be unique to him or her. This number is also important because Nigeria has a higher than usual number of multiple births.[12] For example, if a child is the first born and is born on March 3, 2013, and the LGA code is 543, then the child's number will be 01-03-03-13-543. The top of the RAINBOW Record has a space where the child's immunization number can be written. This unique identifier will be the child's immunization number and will be used until immunizations are no longer needed. This design would provide an opportunity to expand the use of the number and record beyond the usual childhood immunizations. This number can be adapted for other countries by using birth order number, birth date, and a distinctive family record number. Also, in the future, a personal identification number (PIN) can be embedded into the immunization record at creation; this number can be used to support follow-up and identify no-shows. A PIN can be embedded when the Rainbow Record becomes electronic and easy tracking can be maintained.

2. Source of critical information for health workers about the child's health and vaccination status (new)

A rainbow theme was developed to provide critical information on the RAINBOW Record. With this theme, the age at which the vaccine should be given is color-coded on the left side in different rainbow colors. Vaccines that are required are listed alongside the age. For example, all vaccines that should be given at birth are in red, vaccines given at 6 weeks are in orange, those given at 10 weeks are in yellow, and so forth. A separate column is provided for the healthcare workers to record the date and the clinic in which the vaccine is given. A bright blue column for boys (or bright pink for girls) includes the date of the next visit. Space for notes is provided to record the child's reaction to the vaccine as well as overall health (see Figure 3 and Figure 4). Other health information about the child includes weight and growth charts and demographic information (see Figure 5).

3. Source of critical information for families, such as date of next visit for vaccination (new)

The date of the next visit is provided on the immunization record in a bright blue column for boys and in a bright pink column for girls. When the record is folded (tri-fold), the front of the record will also include a bright rainbow-like sticky note on which the date of the next visit can be written. The record is placed in a plastic bag with a colorful ribbon that can be hung on the wall at home for easy storage and accessibility (see Figure 6). Therefore, the family will have two places in which to see their next visit date:

1. Bright blue column (for boys) or bright pink column (for girls) on the record
2. Outside of the record with the “date of next visit” sticker in rainbow colors

Figure 6: RAINBOW Record Folded, in Plastic Bag with Colorful Ribbon, Stickers, and Date of Next Visit

4. Source of critical information for surveys, which many countries and policy makers rely on to validate coverage levels obtained from administrative data systems (new)

Household surveys are conducted to determine what vaccines have been provided to each child in the family. The surveyor asks the mother questions and reads the record to determine the vaccination status of the child. Polio is one of the vaccines that is desperately needed by children in Nigeria, and many times if the information is not recorded accurately on the record the surveyor gets less than accurate estimates of polio vaccination coverage. This problem is one reason that the immunization record is so important and needs to be maintained accurately. These vaccinations are mandated, and healthcare workers are identified by a unique vest. In the northern states vaccination is more problematic because of the current violence. Residents have a great deal of superstition and deep distrust surrounding immunization in the more northern states where sanitation is very poor and polio is prominent. Therefore, although vaccination is mandated, some families do not want their children immunized, nor do they want to participate in the household surveys. With improvements in the immunization records and the accurate collection of data, the hope is to improve polio vaccination rates among other families.

One of the problems with the immunization record is that because it is stored in the home, it is sometimes lost, torn, or damaged by liquids, foods, and other household items. Thus, a major part of the design of the RAINBOW record was to make sure the record could be durable and easy to store and find. Therefore, the RAINBOW record is stored in a plastic, resealable storage bag, with a colorful ribbon that can be used to hang it on a wall at home so that it will be easily accessible for household surveys. The record should be easy to read in order to determine which vaccines are given when and to which child in the family. Also, because the record is colorful and includes incentives such as stickers, the family is more likely to keep and display it in a prominent place so that it is easy to store and find. (See Figure 6.)

5. An educational tool for families (new)

The back of the record contains educational information related to malnutrition such as breastfeeding, diarrhea treatment, and growth charts. Also, a catch-up immunization schedule is provided for children age 5 to 18 years who were never immunized. It shows which vaccines can be given and at what age for older children. Pictures are provided to make the record colorful and fun (Figure 5).

Categories for Additional Consideration

1. Ease of adding new information (new)

Because the immunization record was built in Excel, in a blank Excel template that can be completed manually, lines with space for new vaccines and dose schedules can be easily added when needed without disrupting the design of the record. New vaccines can be added at the end of the record or under the appropriate age category in the middle of the record, if needed. Data organization and record organization can stay the same as new lines and columns are added. Some of the rainbow pictures on the record may need to be resized as new data elements are added or deleted (e.g., because of vaccines that are no longer recommended), and some of the data elements may need to be adjusted to fit column width and space, but these adjustments can be made without much difficulty.

2. Digital transition: visualization of data (new)

The RAINBOW Record was built in Excel to allow for easy exporting of the data into an electronic health record (EHR) system. Because the RAINBOW Record was built in Excel, the data can continue to be captured manually at home and then be reentered, into Excel, by a healthcare worker using the information provided by the parents. The data elements can be easily coded in numbers so that the information can be transferred into a digital environment. For example, all vaccines that are provided at birth can receive a code of 1, and each individual vaccine can be coded separately. For example, the Bacillus Calmette-Guerin (BCG) vaccine should be given at birth, and the code for BCG could be 2. Therefore, if the code for at birth is 1 and BCG is coded as a 2, the final code for BCG would be 12. This system can continue so that other vaccines are coded, such that the hepatitis B vaccine would be 13 and the oral poliovirus vaccine would be 14, since they are all given at birth. This coding of data is necessary in order to transfer some of the data into SAS or SPSS for additional descriptive analysis of the number of vaccines given per child and household, for example, or for development of an immunization registry. Also, Excel can be linked to most other types of EHRs that are built within a system similar to the Microsoft system, so it should be easy to link the RAINBOW record to those records if needed.

3. Digital transition: retroactive data entry (new)

Tools and technologies that enable records to be easily, inexpensively, and quickly entered into a digital system may include human data entry into a free EHR system such as Practice Fusion. In this system, new templates such as an immunization record can be added, and the system is free. Practice Fusion does contain advertisements and other types of supplemental information, but it is an easy-to-use, inexpensive, efficient way to enter data. We have used the Practice Fusion EHR system in a free clinic environment and have had health information management and health information systems students build the templates and enter the data, and it has worked quite well. This system could be adapted for use with the immunization record fairly easily so that immunization record information can be linked to the child's health record. Also, for records that will have multiple types of handwriting, the record can be scanned and added into the digital environment as a backup or other source of information.

Since Excel is a Microsoft product, linking the RAINBOW record to EHRs that are built in a similar system should be easy. However, if the Excel data in the immunization record will not transfer well into another system, the data can be coded as described above and then exported into SAS or SPSS for further analysis and conversion for entry into an EHR as well as an immunization registry for easy retrieval and analysis.

Evaluation of the RAINBOW Record

We provided the RAINBOW Record to Nigerian student nurses at North Park University in Chicago (who received their undergraduate training in Nigeria in addition to being recipients of immunization) to have them use and evaluate the record

content and design. Changes to the record were made on the basis of their input and that of other student nurses. The changes included the following:

1. Adding more space in the demographic section
2. Adding the clinic in which the vaccine was given
3. Removing color from the vaccine column and only including it in the column for the child's age because when color was used under both the name of the vaccine and the age at which it was given, the nurses found it confusing
4. Adding space at the end for off-schedule vaccines or new vaccines that could be developed, such as for malaria, dengue, or Ebola
5. Adding lifelong vaccines (pneumonia and shingles vaccines for adults) so that the record can be used into adulthood

Further testing and analysis of the feasibility of the use of the RAINBOW Record is needed in Nigeria, and the authors are interested in providing the record to IFHIMA and its regional director for Africa as well as to the president of the Health Information Managers Association of Nigeria.

Conclusion

Nigeria has one of the largest child populations in the world; however, its immunization rates are lagging behind those of other countries. The RAINBOW Record is a redesigned child health record that aims to provide a safe and effective vaccination record for Nigerian families. The improved design for the immunization record contains important medical and educational information, as well as a user-friendly layout for both the child's caregivers and healthcare workers. Also, with an emphasis on durability and simplicity, it will provide great utility and practical application in the rural areas of Nigeria. The authors believe that if the RAINBOW Record were used across Nigeria, immunization rates would improve as was seen in other countries such as Pakistan that incorporated a similar colored design and content into immunization records.[13] However, although a well-designed immunization record is very important for improving the data collection associated with childhood immunizations, it is not the only component necessary to improve childhood immunizations. Communication between the families and healthcare workers is also very important. In the future, the integration of a digital immunization record and EHR is expected to further improve the entire vaccination tracking system in Nigeria.

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Valerie Watzlaf, PhD, RHIA, FAHIMA, is an associate professor in the Department of Health Information Management in the School of Health and Rehabilitation Sciences at the University of Pittsburgh in Pittsburgh, PA.

Sandy Meyers, RHIA, is a research specialist at Care Communications, Inc., in Chicago, IL.

Erh-Hsuan (Reina) Wang, MS, is a doctoral student and graduate student assistant in the Department of Health Information Management in the School of Health and Rehabilitation Sciences at the University of Pittsburgh in Pittsburgh, PA.

Kenny Funmilayo is a healthcare worker in Chicago, IL, and Korodu, Nigeria.

Notes

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