Vaccination of infants aged 0 to 11 months at the Yaounde Gynaeco-obstetric and pediatric hospital in Cameroon: how complete and how timely?

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Abstract

Background: Vaccination is a major, but simple and cost effective public health intervention in the prevention of infectious diseases, especially in children. Nowadays, many children still miss scheduled vaccines in the Extended Program of Immunization (EPI) or are being vaccinated after the recommended ages. This study was aimed at assessing vaccination completeness and timeliness in children aged 0 to 11 months attending the vaccination clinic of the Yaounde Gynaeco-Obstetric and Pediatric Hospital.

Methods: This was an observational cross-sectional study over a period of 3 months (1st February to 30th April 2016). 400 mothers were interviewed and their children’s vaccination booklets analyzed. Information on the children and the parents was collected using a pretested questionnaire. Data analysis was done using SPSS version 20 software. Bivariate and multivariate analysis with logistic regression was done to assess the determinants of completeness and timeliness.

Results: A total of 400 mother-infant pairs were sampled. The vaccination completeness rate was 96.3%. This rate varied between 99.50% for BCG and 94.36% for IPV. Most of the children were born at the Yaounde Gynaeco-Obstetric and Pediatric hospital where they were regularly receiving their vaccines. The proportion of correctly vaccinated infants was 73.3%. The most differed vaccines were BCG, PCV13 and IPV. Factors influencing immunization completeness were the father’s profession and the mother’s level of education.

Conclusions: Despite the high immunization coverage, some children did not complete their EPI vaccines and many of them took at least one vaccine after the recommended age.

Keywords: Immunization timeliness, Immunization completeness, Expanded programme of immunization

Background

Vaccination is considered as one of the biggest achievements of the twentieth century and as one of the most cost effective measures in the prevention of childhood diseases [1]. In 1974, the World Health Organization (WHO) launched a worldwide vaccination program known as the Expanded Program of Immunization (EPI), which has been considered one of the major public health interventions aimed at reducing infant morbidity and mortality [2]. During the launching of the EPI in 1976, only about 5% of infants throughout the world were protected against six diseases (diphtheria, measles, pertussis, poliomyelitis, tetanus, and tuberculosis). By 2013, the number of protected infants was more than 80% in many countries. It is estimated that vaccination helps to prevent 2 to 3 million infant deaths each year [3].

The Expanded Program of Immunization started in Cameroon in 1976 as a pilot project and targeted infants from 0 to 11 months. Initially it targeted 6 diseases (diphtheria, measles, pertussis, poliomyelitis, tetanus, and tuberculosis), and other vaccines were gradually introduced; the
last to be introduced in the EPI was IPV in 2015. Presently, it has vaccines against the following diseases: tuberculosis, diphtheria, tetanus, poliomyelitis, pertussis, viral hepatitis B, type b Hemophilus influenza infections, pneumococcal infections, diarrhoea caused by rotavirus, measles, yellow fever, and rubeola. An infant is completely immunized when he or she has received all the vaccines in the EPI. Ensuring that all the doses are not only administered, but given at the appropriate ages, is of crucial importance in ensuring the efficacy of the vaccine in disease prevention [4]. An infant is correctly vaccinated when he or she has received all the vaccines at the recommended ages. Many infants still do not complete their vaccination schedules or are vaccinated after the recommended ages [5, 6].

Given the importance of vaccination in reducing morbidity and mortality in children, we decided to assess the completeness and timeliness of immunization and its determinants at the Yaounde Gyneco-Obstetric and Pediatric hospital, which is a tertiary mother and child hospital in Cameroon. This will ultimately improve the vaccine coverage and reduce obstacles which might hinder effective implementation.

Methods
A cross-sectional analytical study was conducted; over a period of 3 months (1st February to 30th April 2016) in the vaccination unit of the Yaounde Gyneco-Obstetric and Pediatric Hospital (YGOPH), which is a mother and child referral hospital in Yaounde, the capital city of Cameroon. All mothers of infants aged 0 to 11 months coming for routine EPI were enrolled in the study.

Pre-tested questionnaires were filled for all mother-infant pairs at the vaccination unit, after obtaining consent from the mothers or caretakers of the infants (see Additional file 1). Information collected on the infants included age, sex, place of birth, place of first vaccination, the usual vaccination site, vaccines received, and date of vaccination for each antigen received.

Information concerning the parents included: age, level of education, profession, marital status, religion, region of origin, distance from the house to the vaccination unit, satisfaction from vaccination unit as expressed by the mothers or caretakers. The cut offs of 30 years for the age of children aged 0 to 11 months.

Immunization timeliness was defined as being vaccinated at the recommended ages. A period of 2 weeks was considered above which the vaccine was considered as delayed. Any child with delayed administration of one or more antigens was considered not timely vaccinated.

The independent variables were the different socio-demographic characteristics of our sample population. The outcomes were immunization completeness and timeliness.

Data analysis
Data analysis was done using SPSS version 20.0 for windows. The data input control permitted the minimization of errors. The analysis of factors associated to vaccination completeness was done using the ‘backwards’ model of multivariate logistic regression. Logistic regression was first done to obtain the crude odds ratio for each of these factors with their 95% confidence intervals and their P-values. Thereafter the variables with a p-value <0.2 were all entered in a model of multivariate logistic regression to control the confounding factors and determine which characteristics were independent predictors of the immunization completeness of the child. A p-value <0.05 and an adjusted odds ratio (AOR) with its 95% confidence interval not containing 1.00 was considered significant.

Ethical considerations
Prior to carrying out this study, administrative authorization and ethical clearance was obtained from the Yaounde Gynaeco-Obstetric and Pediatric hospital and the Faculty of Medicine and Biomedical Sciences of the University of Yaounde I respectively. A written consent form was signed by each mother or caretaker who accepted to be enrolled and participate in the study, and for those who could not read and write verbal consent was sought after receiving information on the study. Participants in the study were informed on any missed vaccine and any other information concerning the child’s vaccinations. All infants
with vaccinations not up-to-date were vaccinated as recommended.

Results
Socio-demographic characteristics of the study population.
Overall, there were 415 mothers eligible for the study, and 15 were excluded (10 did not consent to participate and 5 did not have vaccination booklets). A total of 400 mother-infant pairs were sampled, of which 203 (51%) were females and 197 (49%) males; giving a sex ratio of 0.97. The median age for the infants was 98 days (range 1 day to 266 days). Most mothers (56.5%) were less than 30 years, 61.3% had secondary education, 79% were married and 50.3% lived at more than 5 km from the vaccination site (see Table 1). Almost all the fathers (94.8%) had at least secondary school education and 38.8% worked in the informal sector (see Table 2).

Immunization completeness
Of the 400 infants, immunization was complete in 96.3% of them. Amongst the infants who had completed their vaccination, 75.0% were born at the YGOPH, 90.0% of them started their vaccinations there and 87.0% regularly received their vaccines there. The immunization coverage for BCG, DTP3, Polio3 and measles were 99.8%, 93.3%, 93.3% and 100% respectively.

Vaccine coverage for each antigen is presented in Table 3, and the rates are greater than 90% for each antigen. The measles and yellow fever vaccines had the highest coverage of 100%.

Immunization timeliness
We noted that 73.3% of the children were fully vaccinated. The antigen-specific timeliness was 83.2% for BCG, 93.9% for DTP1 and 94.8% for the measles vaccine. The most delayed vaccines were the BCG, IPV and Pneumol133.

Determinants of immunization completeness
The mother’s level of education (secondary or higher level of education) and the father’s profession influenced positively the immunization completeness (Table 4). On bivariate and multivariate analysis, the same determinants: mother’s level of education and the

| Contacts | Age     | Vaccine | Route of administration | Preventable diseases                      |
|----------|---------|---------|-------------------------|-------------------------------------------|
| 1st contact | At birth | BCG     | Intradermal             | Tuberculosis                              |
|          |         | OPV 0   | Oral                    | Poliomyelitis                              |
| 2nd contact | 6 weeks | DTP-HepB-Hib 1 | Intramuscular           | Diptheria, Tetanus, Pertussis, Infection due to Haemophilus Influenzae type b, Hepatitis B |
|          |         | OPV 1   | Oral                    | Poliomyelitis                              |
|          |         | Pneumo 13–1 (PCV) | Intramuscular         | Pneumococcal infections                    |
|          |         | ROTA 1  | Oral                    | Rotavirus Diarrhoea                        |
| 3rd contact | 10 weeks | DTP-HepB-Hib 2 | Intramuscular      | Diptheria, Tetanus, Pertussis, Infection due to Haemophilus Influenzae type b, Hepatitis B |
|          |         | OPV 2   | Oral                    | Poliomyelitis                              |
|          |         | Pneumo 13–2 | Intramuscular     | Pneumococcal infections                    |
|          |         | ROTA 2  | Oral                    | Rotavirus Diarrhoea                        |
| 4th contact | 14 weeks | DTP-HepB-Hib 3 | Intramuscular      | Diptheria, Tetanus, Pertussis, Infection due to Haemophilus Influenzae type b, Hepatitis B |
|          |         | OPV 3   | Oral                    | Poliomyelitis                              |
|          |         | IPV     | Intramuscular            |                                           |
|          |         | Pneumo 13–3 | Intramuscular      | Pneumococcal infections                    |
| 5th contact | 6 to 11 months | Vit A | Oral                    | Measles, Rubella                           |
|          | At 9 months | MR     | Subcutaneous            |                                           |
|          |         | YF      | Subcutaneous            | Yellow fever                               |
father's profession increased the infant's chances of immunization completeness (Table 4).

Determinants of immunization timeliness
Term babies, born at the YGOPH and who were regularly vaccinated there had better chances of being correctly vaccinated. After logistic regression analysis, only term babies had the greatest chance of being correctly vaccinated at the recommended ages (Table 5).

No factor related to the mother or father had a statistically significant relationship with immunization timeliness.
immunization completeness in some studies [6, 14]. It is likely that when a child is born in a hospital, the mother is counseled on maternity and on the care of her baby, and especially on the vaccination schedule.

We observed in our study that 73.3% of the infants were correctly vaccinated. Rates of 88%, 56% and 50%, have been noted respectively in South Africa [7], New Zealand [18], and in the United States [19]. These differences could be explained by the differences in the study sites, sample sizes and study design used. Infants not immunized at the recommended immunization ages have reduced immunity, conducive for development of diseases.

The antigen-specific timeliness was 83.2% for BCG, 93.9% for DTP1 and 94.8% for the measles vaccine. Similar figures have been noted by some authors: BCG (99%), DTP1 (87%) and measles vaccine (85%) [7]; while others had lower figures, 44.59%, 45.38% and 59.25% respectively for BCG, DTP1 and measles vaccine [6].

Children born at term, at the YGOPH, and who were regularly receiving their vaccines there, were more likely to be well vaccinated at the recommended ages. Premature neonates often have to wait until they are medically stable before starting vaccinations, and this could explain the delay in starting vaccination at the recommended postnatal ages. Besides, children born in the YGOPH and who are regularly vaccinated there, receive more counselling than the others. In China, Hu et al.

| Variables                  | Immunization completeness | Unadjusted OR (95% CI) | Unadjusted P value | Adjusted OR (95% CI) | Adjusted P value |
|-----------------------------|---------------------------|------------------------|--------------------|----------------------|-----------------|
| Mother’s age                |                           |                        |                    |                      |                 |
| < 30 years                  | 219(96.9)                 | 7(3.1)                 | 1.51(0.54-4.24)    | 0.43                 |                 |
| ≥ 30 years                  | 166(95.4)                 | 8(4.6)                 |                    |                      |                 |
| Mother schooled to the higher levela |                        |                        |                    |                      |                 |
| Yes                         | 354(97.3)                 | 10(2.7)                | 5.71(1.84-17.76)   | 0.007                | 7.0(2.16-22.68) | 0.001           |
| No                          | 31(86.1)                  | 5(13.9)                |                    |                      |                 |
| Profession                  |                           |                        |                    |                      |                 |
| Employed                    | 251(95.4)                 | 12(4.6)                | 0.47(0.13-1.69)    | 0.24                 |                 |
| Unemployed                  | 134(97.8)                 | 3(2.2)                 |                    |                      |                 |
| Matrimonial status          |                           |                        |                    |                      |                 |
| Single                      | 81(96.4)                  | 3(3.6)                 | 1.07(0.29-3.87)    | 1.00                 |                 |
| Married                     | 304(96.2)                 | 12(3.8)                |                    |                      |                 |
| Religion                    |                           |                        |                    |                      |                 |
| Christian                   | 352(95.9)                 | 15(4.1)                | /                  | 0.62                 |                 |
| Muslim                      | 33(100)                   | 0(0.0)                 |                    |                      |                 |
| Parity                      |                           |                        |                    |                      |                 |
| Primipara                   | 139(96.5)                 | 5(3.5)                 | 1.13(0.38-3.37)    | 0.83                 |                 |
| Multipara                   | 246(96.1)                 | 10(3.9)                |                    |                      |                 |
| Father schooled to the higher levela |                        |                        |                    |                      |                 |
| Yes                         | 365(96.3)                 | 14(3.7)                | 1.34(0.16-10.41)   | 0.56                 |                 |
| No                          | 20(95.2)                  | 1(4.8)                 |                    |                      |                 |
| Father’s profession         |                           |                        |                    |                      |                 |
| Employed                    | 378(96.7)                 | 13(3.3)                | 8.31(1.57-43.95)   | 0.04                 | 12.39(2.21-69.26) | 0.004           |
| Unemployed                  | 7(77.8)                   | 2(22.2)                |                    |                      |                 |

a secondary + university education levels
noted that timeliness of vaccination for specific vaccines
was associated with the mother’s age, maternal education level, immigration status, siblings, birth place and
distance from the house to the immunization clinic [6]. In
South Africa, Fadnes et al. found, the level of education of
the mother and the socio-economic status of the parents
[7], to be determinants of immunization timeliness.

| Table 5 Determinants of immunization timeliness |
|-----------------------------------------------|
| Variables                          | Yes | No   | Unadjusted OR (95% CI) | Unadjusted P value | Adjusted OR (95% CI) | Adjusted P value |
|-------------------------------------|-----|------|------------------------|--------------------|----------------------|------------------|
| **Age**                            |     |      |                        |                    |                      |                  |
| < 30 years                          | 165 (73) | 61 (27) | 0.9 (0.6–1.5)          | 0.9               |                      |                  |
| > 30 years                          | 128 (76.6) | 46 (26.4) |                        |                    |                      |                  |
| **Level of education**             |     |      |                        |                    |                      |                  |
| None/Primary                       | 26 (72.2) | 10 (27.8) | 0.9 (0.4–2)          | 0.9               |                      |                  |
| Secondary/Higher                   | 267 (73.4) | 97 (26.6) |                        |                    |                      |                  |
| **Mother’s profession**            |     |      |                        |                    |                      |                  |
| Employed                           | 192 (73) | 71 (27) | 0.9 (0.6–1.5)          | 0.9               |                      |                  |
| Unemployed                         | 101 (73.7) | 36 (26.3) |                        |                    |                      |                  |
| **Matrimonial status**             |     |      |                        |                    |                      |                  |
| Single                             | 65 (77.4) | 19 (22.6) | 1.3 (0.7–2.3)          | 0.3               |                      |                  |
| Couple                             | 228 (72.2) | 88 (27.8) |                        |                    |                      |                  |
| **Religion**                       |     |      |                        |                    |                      |                  |
| Christian                          | 239 (73.3) | 98 (26.7) | 1 (0.5–2.3)           | 0.9               |                      |                  |
| Muslim                             | 24 (72.7) | 9 (27.3) |                        |                    |                      |                  |
| **Parity**                         |     |      |                        |                    |                      |                  |
| Primipara                          | 105 (72.9) | 39 (27.1) | 0.9 (0.6–1.5)          | 0.9               |                      |                  |
| Multipara                          | 188 (73.4) | 68 (26.6) |                        |                    |                      |                  |
| **Distance from home to vaccination unit** |     |      |                        |                    |                      |                  |
| < 5 Km                             | 149 (74.9) | 50 (25.1) | 1.2 (0.8–1.8)          | 0.5               |                      |                  |
| > 5 Km                             | 144 (71.6) | 57 (28.4) |                        |                    |                      |                  |
| **Father’s profession**            |     |      |                        |                    |                      |                  |
| Employed                           | 287 (73.4) | 104 (26.6) | 1.4 (0.3–5.6)          | 0.7               |                      |                  |
| Unemployed                         | 6 (66.7) | 3 (33.3) |                        |                    |                      |                  |
| **Place of birth**                 |     |      |                        |                    |                      |                  |
| YGOPH                              | 221 (75.9) | 70 (24.1) | 1.6 (1.01–2.6)         | 0.04              | 1.01 (0.9–3.3)      | 1                |
| Others                             | 72 (66.1) | 37 (33.9) |                        |                    |                      |                  |
| **Gestation age**                  |     |      |                        |                    |                      |                  |
| Term                               | 286 (81) | 67 (19) | 24.4 (10.5–56.8)       | < 0.001           | 19.3 (8.1–46.1)     | < 0.001          |
| Premature                          | 7 (14.9) | 40 (85.1) |                        |                    |                      |                  |
| **Place vaccination started**      |     |      |                        |                    |                      |                  |
| YGOPH                              | 261 (74.8) | 88 (25.2) | 1.8 (0.9–3.3)          | 0.07              |                      |                  |
| Others                             | 32 (62.7) | 19 (37.3) |                        |                    |                      |                  |
| **Usual place of vaccination**     |     |      |                        |                    |                      |                  |
| YGOPH                              | 252 (75.2) | 83 (24.8) | 1.8 (1.01–3.1)         | 0.04              | 2.1 (0.9–4.6)      | 0.08             |
| Others                             | 41 (63.1) | 24 (36.9) |                        |                    |                      |                  |

The fact that the study was done in a single site, which was the vaccination unit of a referral hospital, and in an urban setting in which most mothers are well educated constitutes major limitations of this study. The results might not necessarily reflect the vaccination status of the entire Yaounde community or Cameroon at large.
Conclusion
This study shows that immunization completeness was quite high but the number of children correctly vaccinated was relatively low. We suggest that more sensitization campaigns be done so as to enlighten parents on the importance of vaccination and on the importance of vaccinating children at the recommended ages.

Additional file

**Additional file 1:** Data entry form. (DOCX 21 kb)

Abbreviations
AOR: Adjusted Odds Ratio; BCG: Bacille de Calmette et Guérin; DTP: Diphtheria tetanus pertussis; EPI: Expanded program of immunization; HepB: Hepatitis B; Hib: Hemophilus influenzae b; IPV: Inactivated polio vaccine; OPV: Oral polio vaccine; PCV 13: Pneumococcal conjugated vaccine 13; Polio: Poliomyelitis; WHO: World Health Organization; YGOPH: Yaounde Gynaeco-Obstetric and Pediatric Hospital

Acknowledgements
The authors would like to thank the mothers and caretakers of the children enrolled this study, for their consent to participate and for providing all the required information needed in filling the questionnaires.

Availability of data and material
The dataset analyzed during the current study is available from the corresponding author upon request.

Funding
This study was not funded.

Authors’ contributions
AC, FDN conceived the study. FDN, FN, MK, KK conducted the data collection. GN-T, SN, EM did the data analysis. FN, FDN wrote the first draft of the manuscript. AC, FA revised the draft document and the final manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate
The study was approved by the Ethical and Institutional Committee for Research on Human Health of the Yaounde Gynaeco-Obstetric and Pediatric hospital. Reference: No 263/CIERSH/DM/2015 of 8th February 2016. A written consent for publication

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests; but the corresponding author (Andreas Chiabi) is Associate Editor of BMC Pediatrics – Infection

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Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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Received: 7 June 2017 Accepted: 24 November 2017
Published online: 19 December 2017

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