International Journal of Gynecology and Obstetrics 130 (2015) S63–S69

Contents lists available at ScienceDirect

International Journal of Gynecology and Obstetrics

journal homepage: www.elsevier.com/locate/ijgo

RESEARCH

Estimating the uptake of maternal syphilis screening and other antenatal interventions before and after national rollout of syphilis point-of-care testing in Ghana

Edward T. Dassah [a,b,*], Yaw Adu-Sarkodie [a,c], Philippe Mayaud [d]

[a] Department of Obstetrics and Gynecology, Komfo Anokye Teaching Hospital, Kumasi, Ghana
[b] School of Public Health, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[c] School of Medical Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[d] Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, London, UK

ARTICLE INFO

Keywords:
Antenatal syphilis testing
Ghana
Point-of-care tests
Uptake
Validation

ABSTRACT

Objective: To compare the uptake of maternal syphilis and HIV screening, intermittent preventive treatment for malaria, and tetanus toxoid administration in three regions of Ghana, before and after the rollout of syphilis point-of-care tests (POCTs). *Methods:* Antenatal register records were reviewed in 15 selected health facilities over an eight-month period, 16 months apart. Register records had been evaluated using the maternal record booklets as a gold standard in a separate prior survey. *Results:* In the evaluation study, the sensitivity of register data was low, ranging from 33.3% for tetanus toxoid administration to 53.8% for syphilis serology. In total, 8282 antenatal client records (4141 in each period) were reviewed. Less than a third of pregnant women received any single intervention at either period (ranging from 17.8% for tetanus toxoid to 29.8% for HIV testing). Overall, HIV screening had a marginal absolute increase of about 2% while the remaining interventions experienced non-significant absolute decreases of 4.1 to11.1%. When adjusting for under-recording, syphilis screening uptake was 50% before and 33.6% after the introduction of POCTs. *Conclusion:* Use of POCTs for syphilis did not result in increased uptake. Routine monitoring of antenatal interventions using the antenatal register may result in underestimation of their uptake.

1. Background

Syphilis in pregnancy accounts for over half a million entirely preventable perinatal deaths annually [1]. Yet, only less than 40% of women receiving antenatal care (ANC) in Sub-Saharan Africa are screened for syphilis [2]. Control of congenital syphilis is a global priority; the World Health Organization initiative for the Global Elimination of Congenital Syphilis stipulates that at least 90% of pregnant women should be tested for syphilis and that no less than 90% of those found to be seropositive should receive adequate treatment by 2015 [1]. To achieve these targets, antenatal syphilis testing (AST) with rapid point-of-care tests (POCTs) and same-day benzathine penicillin treatment (usually at the first antenatal visit) for seropositive women is currently recommended [1,3,4].

Given the poor implementation of syphilis screening for pregnant women and the reported dramatic increases in antenatal syphilis seroprevalence in Ghana [5–7], a national rollout of rapid syphilis POCTs for pregnant women was undertaken in 2009, offering an unprecedented opportunity to increase the uptake of screening and treatment. However, estimating such an uptake, especially in low- and middle-income countries such as Ghana, remains a major challenge [8]. While routinely collected data, such as ANC register records, are valuable and remain the only accessible resource, their completeness and accuracy are often doubted [9,10]. Therefore, an assessment of the accuracy of ANC register data was required to provide useful estimates of the uptake of interventions delivered in the antenatal setting in Ghana.

The aims of the present study were to compare the uptake of AST and treatment in three regions of Ghana, before and after the rollout of syphilis POCTs, and to assess the accuracy of ANC registers regarding documentation of AST results and treatment. Uptake of AST was also compared with three other recommended antenatal interventions, namely prevention of mother-to-child transmission of HIV, intermittent preventive treatment for malaria in pregnancy (IPT_p), and prevention of maternal and neonatal tetanus (tetanus toxoid), as tracer control interventions. We hypothesized that the rollout of syphilis POCTs in Ghana would increase AST and treatment uptake; however, uptake of the tracer control interventions was not expected to change over time.

* Corresponding author at: Department of Obstetrics and Gynecology, Komfo Anokye Teaching Hospital, P.O. Box KS 1934, Kumasi, Ghana. Tel.: +23 324 462 3287.
E-mail address: edidassah@yahoo.com (E.T. Dassah).

http://dx.doi.org/10.1016/j.ijgo.2015.04.013

2. Material and methods

2.1. Study context and settings

A revamping of routine AST was performed by the Ghana Health Service through the National AIDS/STI Control Programme in 2009 [11]. Contrary to previous practice, where AST was carried out by trained laboratory personnel using non-treponemal tests, these POCTs were to be used by trained midwives at the antenatal clinic in all facilities. Details of the implementation, including training, supply chain management, and testing and treatment guidelines are the subject of a related study (unpublished data).

Based on reported treponemal seroprevalence from the 2004–2009 national HIV/syphilis sentinel surveys [6,7], we categorized the 10 administrative regions of Ghana into three strata: regions with seroprevalence of greater than 10%, 5% — 10%, and less than 5%. One region was selected from each category and according to one of three geographical locations, namely southern, middle, and northern sectors of the country, often used as "representative" regions in other Ghanaian health surveys [12]; the Central, Ashanti, and Northern regions were thus selected. Within each region, two districts were randomly selected, except in the Central region, where one district, which had the highest seroprevalence of treponemal infections in the country, was purposively selected.

In each region, the teaching, regional, and district hospitals (of selected districts) were included. One smaller health unit with at least 20 antenatal registrants per month was also randomly selected from each district to represent all levels of implementation of the ANC intervention. The teaching and regional hospitals in the Ashanti region were not included owing to a known lack of documentation of AST results in the ANC register and the relatively low antenatal clinic attendance, respectively. A total of 15 health facilities were selected: three district hospitals, one private hospital, and one health center in the Ashanti region; one regional hospital, two district hospitals, and two health centers in the Central region; and one teaching hospital, two district hospitals, and two health centers in the Northern region.

2.2. Estimating uptake of key antenatal interventions

Retrospective register record reviews covering four months in each of two phases were conducted to measure uptake of AST before (January to April 2009) and after (September to December 2010) the national rollout of syphilis POCTs. A period of 16 months (May 2009 to August 2010) was chosen to allow enough time for the national rollout to elapse before review and ensure the same duration of observation in both periods. Register records were selected from each facility by systematic random sampling using the ANC register as the sampling frame.

For purposes of confidentiality, in some facilities, syphilis or HIV test results were recorded in special books for the two interventions without documentation in the ANC register. We searched for the test results of selected clients from these special books up to three months post-registration (as documented in the ANC register). If the test results for a given client were not found in the books, we assumed the test was not performed for this particular case. Three hospitals, one in each region, also had similar IPT_p and tetanus toxoid administration books and recording practices during both periods. However, due to time constraints, we could not review these during our assessment.

2.3. Validation sub-study

There are two main sources of ANC data in Ghana: the maternal record booklet (MRB [or ANC card]) and the ANC register. The former is the primary record of all clinical evaluations, including history, physical examination, laboratory investigations, and interventions/treatments given, while the latter is a summary of key assessments and interventions [13], commonly extracted from the MRB before the attendee leaves the clinic. The MRB is kept by the attendee, who presents it at each ANC visit, while the ANC register is retained at the health facility. Hence, ANC register recording of the four interventions was validated against those in the MRB as the gold standard. IPT_p was given after the first trimester, while the remaining three interventions were to be administered at the first ANC visit regardless of the trimester [13]. Results of tests performed in the laboratory (e.g. syphilis testing) were recorded in the MRB or ANC register at the subsequent visit. Therefore, antenatal clinic attendees who had had at least one prior antenatal visit and in the second trimester of their pregnancy in each of the 15 selected healthcare facilities were systematically selected during the second phase using the ANC register (records for the day) as the sampling frame. The sampling fraction varied from one in two to one in four attendees depending on the number of eligible women, with the first being randomly selected. Selected attendees were approached individually after their antenatal evaluations and invited to participate in the study if found eligible according to their MRB. Consenting clients were then interviewed using a structured questionnaire and documentation of each of the four interventions in the MRB and ANC register was reviewed and compared.

Sensitivity was defined as the proportion of women whose test results or treatments were recorded in the ANC register among those who had test results or treatments recorded in the MRB. Specificity was the proportion of women who did not have any test results or treatments recorded in the ANC register among those who had no test results or treatments recorded in the MRB [10,14,15]. Positive predictive value (PPV) was defined as the proportion of women whose test results or treatments were recorded in the MRB among those whose test results or treatments were recorded in the ANC register. Negative

Table 1
Sociodemographic characteristics of women attending antenatal clinics in selected healthcare facilities in Ghana.[a]

Characteristic	Number of women (n = 390)
Age group, y	
18–19	29 (7.4)
20–24	103 (26.4)
25–29	116 (29.7)
30–34	86 (22.1)
35–46	56 (14.4)
Mean (standard deviation)	27.4 (5.8)
Marital status	
Single	15 (3.8)
Married/cohabiting	375 (96.2)
Education	
No formal education	117 (30.0)
Basic education	210 (53.8)
Secondary or higher education	63 (16.2)
Occupation (woman)	
Professional	24 (6.2)
Vocational	85 (21.8)
Trading/business	144 (36.9)
Manual/farmer	94 (24.1)
Unemployed	43 (11.0)
Occupation (spouse)	
Professional	75 (19.2)
Vocational	128 (32.8)
Trading/business	60 (15.4)
Manual/farmer	124 (31.8)
Unemployed	3 (0.8)
Parity [b]	
0	98 (25.8)
1–2	168 (44.2)
3–10	114 (30.0)
Median (Interquartile range)	2 (0–3)
Trimester at booking [c]	
First trimester	178 (48.1)
Second trimester	180 (48.7)
Third trimester	12 (3.2)

[a] Values are given as number (percentage) unless otherwise indicated.
[b] Parity, 10 missing values.
[c] Trimester at booking, 20 missing values.

predictive value (NPV) was the proportion of women who did not have test results or treatments recorded in the MRB among those who did not have any test results or treatments recorded in the ANC register [10,14,15]. The Kappa statistic was the agreement between MRB and ANC register records beyond chance [10,14,15]; Kappa values greater than 0.75, 0.4 − 0.75, and less than 0.4 indicate excellent, good, and poor agreement, respectively [10,14,15].

2.4. Sample size calculations

For the register validation study, a sample size of 360 women (24 women per clinic) was required to estimate a measure of PPV or NPV of 30% and 90% (95% confidence intervals [CIs] 22%–39% and 83%–95%, respectively). An average of 420 and 120 ANC register records in each phase gave at least 80% power to detect minimum absolute differences of 10% and 20% in AST uptake in the larger hospitals and smaller health facilities, respectively, following the rollout.

2.5. Statistical analyses

All analyses were performed using Stata version 11.0 software (Stata Corp, College Station, TX, USA). Sensitivity, specificity, PPV, and NPV with exact binomial 95% CIs to correctly identify testing status and treatment by MRB as the gold standard were calculated. Agreement between the two recording methods (MRB and ANC register) was assessed by the percentage overall agreement (p) = (a + d)/N, where a is the number recorded by both methods, d is the number not recorded by either method, and N is the total sample; the percentage negative agreement = d/[0.5*(N–a + d)]; the percentage positive agreement = a/[0.5*(N + a–d)]; and the prevalence-adjusted bias-adjusted Kappa = 2p–1 [16].

To compare coverage of the four interventions before and after the rollout of syphilis POCTs, differences in uptake with 95% CIs were calculated using the survey "*svy*" command in Stata to take account of clustering and number of records reviewed in each facility.

The study was approved by the institutional review boards of the Ghana Health Service and Kwame Nkrumah University of Science and Technology, Ghana, and the London School of Hygiene and Tropical Medicine, UK.

3. Results

3.1. Validation sub-study

A total of 390 women (26 from each facility) were recruited for the validation study. The sociodemographic characteristics of the women are shown in Table 1. About a quarter of the women were primigravidas and nearly all (97%) had had a first antenatal visit before the third trimester.

Generally, all four interventions appeared under-recorded in the ANC register with low and variable sensitivities of 11.9% to 67.8% and relatively higher specificities of 76.8% to 100% (Table 2). Overall, sensitivity of AST recording was the highest compared with the other three interventions (53.8% vs <50%). Except for one facility, all PPVs were over 80% while NPVs were generally lower, ranging from 33.3% to 70.2%. Validation measures varied across regions. Except for sensitivity, specificity, PPV, and NPV were generally higher for hospitals compared with the smaller health facilities.

Overall, the Kappa scores for syphilis and HIV testing were poor to good, and poor for IPT_p and tetanus toxoid administration; Kappa ratings varied across regions. Except for AST, scores were generally

Table 2
Comparing documentation of syphilis and HIV testing, intermittent preventive treatment for malaria in pregnancy, and tetanus toxoid administration, by region and type of health facility, in the antenatal care register and maternal record booklet.

Intervention by region and level of health facility	Result/treatment recorded in												
	MRB	ANC register	Both	Neither	Total (n)	PA (%)	NA (%)	OA (%)	Kappa	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95% CI)	NPV % (95% CI)
Syphilis screening													
Ashanti region	56	26	25	73	130	61.0	82.0	75.4	0.51	44.6 (31.3, 58.5)	98.6 (92.7, 100)	96.2 (80.4, 99.9)	70.2 (60.4, 78.8)
Central region	87	66	59	36	130	77.1	67.3	73.1	0.46	67.8 (56.9, 77.4)	83.7 (69.3, 93.2)	89.4 (79.4, 95.6)	56.3 (43.3, 68.6)
Northern region [a]	43	17	16	34	78	53.3	70.8	64.1	0.28	37.2 (23.0, 53.3)	97.1 (85.1, 99.9)	94.1 (71.3, 99.9)	55.7 (42.4, 68.5)
Private Hosp./Health Centre	62	38	34	38	104	68.0	70.4	69.2	0.38	54.8 (41.7, 67.5)	95.7 (89.5, 98.8)	89.5 (75.2, 97.1)	57.6 (44.8, 69.7)
Teaching/Reg./Dist. Hosp.	124	71	66	105	234	67.7	76.9	73.1	0.46	53.2 (44.1, 62.2)	95.5 (89.7, 98.5)	93.0 (84.3, 97.7)	64.4 (56.6, 71.7)
Total (all facilities)	*186*	*109*	*100*	*143*	*338*	*67.8*	*75.1*	*71.9*	*0.44*	*53.8 (46.3, 61.1)*	*94.1 (89.1, 97.3)*	*91.7 (84.9, 96.2)*	*62.4 (55.8, 68.7)*
HIV screening													
Ashanti region	78	30	28	50	130	51.9	65.8	60.0	0.20	35.9 (25.3, 47.6)	96.2 (86.8, 99.5)	93.3 (77.9, 99.2)	50.0 (39.8, 60.2)
Central region	98	49	44	27	130	59.9	47.8	54.6	0.09	44.9 (34.8, 55.3)	84.4 (67.2, 94.7)	89.8 (77.8, 96.6)	33.3 (23.2, 44.7)
Northern region [b]	79	38	38	51	104	83.5	87.2	85.6	0.71	48.1 (36.7, 59.6)	100 (86.3, 100)	100 (90.7, 100)	37.9 (26.2, 50.7)
Private Hosp./Health Centre	88	47	43	64	130	78.9	84.8	82.3	0.65	48.9 (38.1, 59.8)	90.5 (77.4, 97.3)	91.5 (79.6, 97.6)	45.8 (34.8, 57.1)
Teaching/Reg./Dist. Hosp.	167	70	67	64	234	56.5	55.4	56.0	0.12	40.1 (32.6, 48.0)	95.5 (87.5, 99.1)	95.7 (88.0, 99.1)	39.0 (31.5, 46.9)
Total (all facilities)	*255*	*117*	*110*	*128*	*364*	*63.6*	*67.2*	*65.4*	*0.31*	*43.1 (37.0, 49.5)*	*93.6 (87.2, 97.4)*	*94.0 (88.1, 97.6)*	*41.3 (35.1, 47.7)*
IPT_p													
Ashanti region	73	22	18	53	130	37.9	64.2	54.6	0.09	24.7 (15.3, 36.1)	93.0 (83.0, 98.1)	81.8 (59.7, 94.8)	49.1 (39.3, 58.9)
Central region	71	41	32	50	130	57.1	67.6	63.1	0.26	45.1 (33.2, 57.3)	84.7 (73.0, 92.8)	78.0 (62.4, 89.4)	56.2 (45.3, 66.7)
Northern region	91	67	60	32	130	76.0	62.8	70.8	0.42	65.9 (55.3, 75.5)	82.1 (66.5, 92.5)	89.6 (79.7, 95.7)	50.8 (37.9, 63.6)
Private Hosp./Health Centre	100	69	56	43	156	66.3	60.1	63.5	0.27	56.0 (45.7, 65.9)	76.8 (63.6, 87.0)	81.2 (69.9, 89.6)	49.4 (38.5, 60.4)
Teaching/Reg./Dist. Hosp.	135	61	54	92	234	55.1	67.7	62.4	0.25	40.0 (31.7, 48.8)	92.9 (86.0, 97.1)	88.5 (77.8, 95.3)	53.2 (45.5, 60.8)
Total (all facilities)	*235*	*130*	*110*	*135*	*390*	*60.3*	*65.1*	*62.8*	*0.26*	*46.8 (40.3, 53.4)*	*87.1 (80.8, 91.9)*	*84.6 (77.2, 90.3)*	*51.9 (45.7, 58.1)*
Tetanus toxoid													
Ashanti region	67	8	8	63	130	21.3	68.1	54.6	0.09	11.9 (5.3, 22.2)	100 (94.3, 100)	100 (63.1, 100)	51.6 (42.4, 60.8)
Central region	70	24	21	57	130	44.7	68.7	60.0	0.20	30.0 (19.6, 42.1)	95.0 (86.1, 99.0)	87.5 (67.6, 97.3)	53.8 (43.8, 63.5)
Northern region	88	50	46	38	130	66.7	62.3	64.6	0.29	52.3 (41.4, 63.0)	90.5 (77.4, 97.3)	92.0 (80.8, 97.8)	47.5 (36.2, 59.0)
Private Hosp./Health Centre	95	50	43	54	156	59.3	64.7	62.2	0.24	45.3 (35.0, 55.8)	88.5 (77.8, 95.3)	86.0 (73.3, 94.2)	50.9 (41.0, 60.8)
Teaching/Reg./Dist. Hosp.	130	32	32	104	234	39.5	68.0	58.1	0.16	26.4 (17.5, 32.9)	100 (96.5, 100)	100 (89.1, 100)	51.5 (44.4, 58.6)
Total (all facilities)	*225*	*82*	*75*	*158*	*390*	*48.9*	*66.8*	*59.7*	*0.19*	*33.3 (27.2, 39.9)*	*95.8 (91.5, 98.3)*	*91.5 (83.2, 96.5)*	*51.3 (45.6, 57.0)*

Abbreviations: ANC, antenatal care; CI, confidence interval; Dist., District; Hosp., Hospital; IPT_p, intermittent preventive treatment for malaria in pregnancy; MRB, maternal record booklet; NA, negative agreement; NPV, negative predictive value; OA, overall agreement; PA, positive agreement; PPV, positive predictive value; Reg., Regional.

[a] Two health centres in the Northern region were not conducting syphilis testing at the time.

[b] One health center in the Northern region was not conducting HIV testing.

Table 3
Number of antenatal clinic registrants before (2009) and after (2010) the rollout of syphilis point-of-care testing policy screened for syphilis or HIV or given intermittent preventive treatment for malaria in pregnancy (IPT_p) or tetanus toxoid administration, by region and health facility level, among 4141 antenatal care (ANC) register records reviewed in 2009 and 4141 in 2010.[a]

Region and type of health facility	Records reviewed or available [b]	Syphilis screening		HIV screening		IPT_p		Tetanus toxoid	
		No. (%)		No. (%)		No. (%)		No. (%)	
		2009	2010	2009	2010	2009	2010	2009	2010
Ashanti region									
Health Centre 1	120	0 (0)	83 (69.2)	26 (21.7)	92 (76.7)	20 (16.7)	50 (41.7)	4 (3.3)	0 (0)
Private Hospital	119	0 (0)	17 (14.3)	0 (0)	13 (10.9)	1 (0.8)	9 (7.6)	7 (5.9)	15 (12.6)
District Hospital 1	419	302 (72.1)	111 (26.5)	189 (45.1)	75 (17.9)	0 (0)	9 (2.2)	0 (0)	9 (2.2)
District Hospital 2	420	0 (0)	4 (1.0)	59 (14.1)	28 (6.7)	NR	NR	NR	NR
District Hospital 3	414	0 (0)	53 (12.8)	75 (18.1)	100 (24.2)	170 (41.1)	11 (2.7)	182 (44.0)	11 (2.7)
Subtotal	*1492*	*302/1492 (20.2)*	*268/1492 (18.0)*	*349/1492 (23.4)*	*308/1492 (20.6)*	*191/1072 (17.8)*	*79/1072 (7.4)*	*193/1072 (18.0)*	*35/1072 (3.3)*
Central region									
Health Centre 2	119	30 (25.2)	28 (23.5)	1 (0.8)	42 (35.3)	47 (39.5)	36 (30.3)	51 (42.9)	46 (38.7)
Health Centre 3	120	1 (0.8)	6 (5.0)	0 (0)	25 (20.8)	1 (0.8)	8 (6.7)	0 (0)	9 (7.5)
District Hospital 4	265	173 (65.3)	55 (20.8)	155 (58.5)	189 (71.3)	71 (26.8)	98 (37.0)	27 (10.2)	18 (6.8)
District Hospital 5	420	343 (81.7)	1 (0.2)	300 (71.4)	243 (57.9)	34 (8.1)	0 (0)	93 (22.1)	0 (0)
Regional Hospital	236	200 (84.7)	148 (62.7)	154 (65.3)	0 (0)	NR	NR	NR	NR
Subtotal	*1160*	*747/1160 (64.4)*	*238/1160 (20.5)*	*610/1160 (52.6)*	*499/1160 (43.0)*	*153/924 (16.6)*	*142/924 (15.4)*	*171/924 (18.5)*	*73/924 (7.9)*
Northern region									
Health Centre 4	119	NT	NT	0 (0)	0 (0)	91 (76.5)	18 (15.1)	101 (84.9)	21 (17.7)
Health Centre 5	120	NT	NT	NT	NT	59 (49.2)	37 (30.8)	82 (68.3)	75 (62.5)
District Hospital 6	420	0 (0)	0 (0)	35 (8.3)	163 (38.8)	NR	NR	NR	NR
District Hospital 7	416	0 (0)	184 (44.2)	NR	NR	282 (67.8)	372 (88.9)	290 (69.7)	322 (77.4)
Teaching Hospital	414	0 (0)	15 (3.6)	3 (0.72)	106 (25.6)	29 (7.0)	33 (8.0)	48 (11.6)	20 (4.8)
Subtotal	*1498*	*0/1250 (0)*	*199/1250 (15.9)*	*38/953 (4.0)*	*269/953 (28.2)*	*461/1069 (43.1)*	*458/1069 (42.8)*	*521/1069 (48.7)*	*438/1069 (41.0)*
Level of health facility									
Private Hosp./Health Centre	717	31/478 (6.5)	134/478 (28.0)	27/597 (4.5)	172/597 (28.8)	219/717 (30.5)	158/717 (22.0)	245/717 (34.2)	166/717 (23.2)
Teaching/Reg./Dist. Hospital	3424	1018/3424 (29.7)	571/3424 (16.7)	970/3008 (30.0)	904/3008 (32.2)	586/2348 (25.0)	521/2348 (22.2)	640/2348 (27.3)	380/2348 (16.2)
Total (all facilities)	4141	1049/3902 (26.9)	705/3902 (18.1)	997/3605 (27.6)	1076/3605 (29.8)	805/3605 (26.3)	679/3605 (22.2)	885/3605 (28.9)	546/3605 (17.8)

Abbreviations: Dist., District; Hosp., Hospital; NR, intervention not recorded in antenatal clinic register; NT, syphilis/HIV tests not conducted in facility; Reg., Regional.

[a] Facilities that did not record the intervention (NR) or carry out HIV/syphilis tests (NT) were excluded from the analysis.

[b] Records reviewed/available each year (equal number of records were extracted in each facility for 2009 and 2010).

highest in the Northern region and better in the smaller health facilities compared with larger hospitals (Table 2).

3.2. Uptake of key antenatal interventions

A total of 8282 ANC client records were reviewed from 15 selected facilities; specifically, 4141 records each in the pre- and post-POCT rollout phases. Altogether, nearly 90% of the women booked for ANC in the first two trimesters and the majority (91%) of women screened for syphilis did so at this time. According to data from the ANC registers, less than a third (17.8% to 29.8%) of women received all interventions at each period, with HIV testing having the highest uptake.

All health facilities in the Central region and one district hospital in the Ashanti region were already screening pregnant women for syphilis in the pre-rollout phase in 2009. By 2010, 16 months after national rollout, all but two health centers in the Northern region were screening pregnant women for syphilis (Table 3). In one district hospital in the Northern region, pregnant women were not screened for syphilis throughout the entire period of this evaluation, despite national policy. However, paradoxically, overall, more pregnant women were offered ASTs in 2009 compared with 2010 (26.9% vs 18.1%), representing a statistically non-significant absolute decrease of 8.8% ($P = 0.47$).

Almost all health facilities that were previously not screening pregnant women for syphilis had absolute increases in AST uptake, following the rollout. In contrast, with the exception of one health center, all other facilities that performed AST in 2009 had an absolute reduction in AST uptake in 2010 (Tables 3 and 4). Generally, significant absolute decreases in AST (up to 81% in one district hospital) were observed in the larger hospitals, while marginal absolute reductions or significant absolute increases (up to nearly +70% in one health center) were observed in the smaller facilities. At the regional level, the Central region had the highest absolute reduction in AST (43.9%; $P = 0.07$). Provision of syphilis treatment to seropositive women could not be ascertained because there were no columns in the ANC register to record it. Adjusting for under-recording, as recommended [17], indicated an AST uptake of 50.0% and 33.6% in 2009 and 2010, respectively, thus leading to a much larger decrease (16.4%) in estimates of uptake following POCT rollout (Table 5).

Except for two health centers in the Northern region, all other facilities offered HIV tests to pregnant women before or after syphilis POCT rollout (Table 3); no HIV results were recorded in the registers of one district hospital within the review period. Altogether, there was a marginal, non-significant absolute increase of 2.2% in HIV testing in 2010 compared with the same period in 2009 ($P = 0.8$). Across regions, the Northern region had a statistically significant absolute increase of 24.2% in HIV testing ($P = 0.04$), while the other two regions recorded non-significant absolute decreases of less than 10% (Table 4). Adjusted HIV testing uptake estimates were higher in 2009 and 2010, with an increase in uptake of 5% (Table 5).

All health facilities administered IPT_p and tetanus toxoid as part of routine ANC in both years; three district hospitals (one in each region) did not record both interventions in their ANC register during either period (Table 3). Altogether, there were non-significant absolute decreases of about 4% and 11% in IPT_p and tetanus toxoid administration, respectively (Table 4). Comparatively, adjusted uptake estimates for IPT_p and tetanus toxoid administration were higher in both years and led to decreases in uptake of 8.8% and 33.3%, respectively (Table 5).

4. Discussion

4.1. Validation sub-study

Compared with the MRB as the gold standard, the completeness and accuracy of ANC register data were reasonable for syphilis and HIV testing, and constitute potential sources of information for monitoring maternal care. Although commonly used to assess the performance of laboratory tests [18], sensitivity and specificity (including PPV and NPV) analyses have also been used to validate and adjust for under-recording in register records [9,10,14,17]. The validation measures in the present study were characterized by: (1) variable levels of sensitivity, indicating variability of under-recording of test results and treatments in the registers; (2) high levels of specificity, indicating that in

Table 4
Differences in proportion of antenatal clinic registrants screened for syphilis or HIV or given intermittent preventive treatment for malaria in pregnancy or tetanus toxoid administration, by region and level of health facility level, before (2009) and after (2010) rollout of point-of-care testing policy using antenatal care register records.[a]

Region and type of health facility	Syphilis screening		HIV screening		IPT_p		Tetanus toxoid	
	% Diff. (95% CI)	*P* value	% Diff. (95% CI)	*P* value	% Diff. (95% CI)	*P* value	% Diff. (95% CI)	*P* value
Ashanti region								
Health Centre 1	69.2 (60.8 — 77.5)	<0.001	55.0 (44.3 — 65.7)	<0.001	25.0 (13.8 — 36.2)	<0.001	−3.3 (−6.6 to −0.1)	0.04
Private Hospital	14.3 (7.9 — 20.6)	<0.001	10.9 (5.3 — 16.6)	<0.001	6.7 (1.6 — 11.8)	0.01	6.7 (−0.7 to 14.1)	0.08
District Hospital 1	−45.6 (−51.6 to −39.5)	<0.001	−27.2 (−33.2 to −21.2)	<0.001	2.1 (0.8 — 3.5)	0.003	2.1 (0.8 — 3.5)	0.003
District Hospital 2	1.0 (0.02 — 1.9)	0.05	−7.4 (−11.5 to −3.3)	<0.001	–	–	–	–
District Hospital 3	12.8 (9.6 — 16.0)	<0.001	6.0 (0.5 — 11.6)	0.04	−38.4 (−43.4 to −33.4)	<0.001	−41.3 (−46.3 to −36.3)	<0.001
Subtotal	*−2.3 (−46.3 to 41.7)*	*0.89*	*−2.8 (−30.1 to 24.6)*	*0.79*	*−10.4 (−57.0 to 36.1)*	*0.53*	*−14.7 (−60.7 to 31.1)*	*0.38*
Central region								
Health Centre 2	−1.7 (−12.7 — 9.3)	0.74	34.5 (25.6 — 43.3)	<0.001	−9.2 (−21.4 to −2.9)	0.12	−4.2 (−16.8 to 8.4)	0.56
Health Centre 3	4.2 (−0.1 — 8.4)	0.06	20.8 (13.5 — 28.2)	<0.001	5.8 (1.0 — 10.6)	0.02	7.5 (2.7 — 12.3)	0.002
District Hospital 4	−44.5 (−52.1 to −37.0)	<0.001	12.8 (4.7 — 20.9)	0.005	10.2 (2.3 — 18.1)	0.01	−3.4 (−8.2 to 1.4)	0.19
District Hospital 5	−81.4 (−85.2 to −77.7)	<0.001	−13.6 (−20.0 to −7.2)	<0.001	−8.1 (−10.7 to −5.5)	<0.001	−22.1 (−26.1 to −18.2)	<0.001
Regional Hospital	−22.0 (−29.8 to −14.3)	<0.001	−65.3 (−71.4 to −59.2)	<0.001	–	–	–	–
Subtotal	*−43.9 (−92.8 to 5.0)*	*0.07*	*−9.6 (−52.0 to 32.9)*	*0.57*	*−1.2 (−18.6 to 16.2)*	*0.84*	*−10.6 (−33.3 to 12.0)*	*0.23*
Northern region								
Health Centre 4	–	–	–	–	−61.3 (−71.4 to −51.3)	<0.001	−67.2 (−76.7 to −57.7)	<0.001
Health Centre 5	–	–	–	–	−18.3 (−30.6 to −6.0)	<0.001	−5.8 (−18.0 to 6.3)	0.34
District Hospital 6	–	–	30.5 (25.1 — 35.8)	<0.001	–	–	–	–
District Hospital 7	44.2 (39.4 — 49.0)	<0.001	–	–	21.2 (15.7 — 26.6)	<0.001	7.7 (1.7 — 13.7)	0.01
Teaching Hospital	3.6 (1.8 — 5.4)	<0.001	24.9 (20.6 — 29.2)	<0.001	1.0 (−2.6 to 4.6)	0.62	−6.8 (−10.5 to −3.0)	<0.001
Subtotal	*15.9 (−45.1 to 76.9)*	*0.38*	*24.2 (2.6 — 45.8)*	*0.04*	*−0.3 (−40.6 to 40.0)*	*0.98*	*−7.7 (−40.7 to 25.1)*	*0.51*
Level of health facility								
Private Hosp./Health Centre	21.5 (−30.2 to 73.3)	0.28	24.3 (−2.3 to 50.9)	0.06	−8.5 (−39.8 to 22.8)	0.52	−11.0 (−40.4 to 18.4)	0.38
Teaching/Reg./Dist. Hospital	−13.0 (−44.0 to 17.9)	0.36	−2.2 (−24.4 to 20.0)	0.82	−2.8 (−24.9 to 19.4)	0.76	−11.1 (−31.0 to 8.9)	0.21
Total (all facilities)	−8.8 (−34.7, 17.1)	0.47	2.2 (−15.2 to 19.6)	0.79	−4.1 (−19.2 to 11.0)	0.56	−11.1 (−24.8 to 2.6)	0.10

Abbreviations: CI, confidence interval; Diff., difference = (Proportion in 2010 – Proportion 2009); Dist., District; Hosp., Hospital; IPT_p, intermittent preventive treatment for malaria in pregnancy; Reg., Regional.

[a] Facilities that did not record the interventions or carry out HIV/syphilis tests were excluded from the analysis.

Table 5
Comparison of antenatal care register and adjusted estimates of uptake and differences in uptake of antenatal syphilis and HIV testing, intermittent preventive treatment for malaria in pregnancy, and tetanus toxoid administration in 2009 and 2010.

Intervention	Sensitivity (%)	ANC register estimates (%)			Adjusted estimates (%)		
		2009	2010	Difference	2009	2010	Difference
Syphilis screening	53.8	26.9	18.1	−8.8	50.0	33.6	−16.4
HIV screening	43.1	27.6	29.8	2.2	64.0	69.1	5.1
IPT_p	46.8	26.3	22.2	−4.1	56.2	47.4	−8.8
Tetanus toxoid	33.3	28.9	17.8	−11.1	86.8	53.5	−33.3

Abbreviations: ANC, antenatal care; IPT_p, intermittent preventive treatment for malaria in pregnancy.

most cases where the intervention was not given, no results or treatments were recorded in the ANC register (i.e. false-positive recordings were uncommon); (3) high PPVs, indicating that almost all the interventions recorded in the register were also found in the MRB; and (4) higher levels of completeness and accuracy for recording AST results compared with the other interventions.

The variable sensitivities and high specificities and PPVs found in the study are consistent with results of other validation studies in the antenatal setting [10,14]. Being a relatively recent intervention, it is possible that midwives/staff made conscious efforts to record AST results in the ANC register, thus explaining the better sensitivity and accuracy observed herein. Therefore, it is conceivable that syphilis POCT rollout improved the quality of ANC register data; however, this is difficult to ascertain since we could not validate pre-rollout register data. Documentation of AST results in the ANC register also appears to have been influenced by the seroprevalence of treponemal infections in each region. AST results were recorded in the ANC registers of all facilities in the Central region, which had the highest treponemal seroprevalence, while they were least recorded in antenatal registers in the Northern region, where maternal syphilis was least prevalent.

These findings have some implications for the use of ANC register data in monitoring uptake of antenatal interventions in Ghana. Such data constitute an important resource for surveillance of maternal health care, provided that sensitivity, specificity, PPV, or NPV are all high. The quantification of under recording in ANC registers allows for adjustment of uptake estimates.

4.2. Uptake of key antenatal interventions

Within the limitations of register data, there were significant changes in the uptake of the various interventions at the facility level, but generally non-significant differences at the regional level. Nearly all women booked for ANC before the third trimester. Most women who were screened for syphilis did so before the third trimester, offering a good opportunity to prevent congenital syphilis [1,3,19].

The rollout offered regions and facilities that were hitherto not routinely screening pregnant women for syphilis with an opportunity to start testing. Expectedly, these facilities witnessed increases in screening uptake due to their baseline value of zero. Quite detrimental to the program, however, was the fact that all facilities that were previously screening pregnant women for syphilis experienced a reduction in the uptake of AST; an effect which was more marked in the larger facilities. In a related (unpublished) study, most staff attributed the decrease in screening uptake in 2010 largely to frequent stockouts and non-replenishment of expired syphilis test kits. This suggests that the national program could have learnt from the good performance of facilities that were already offering AST prior to the rollout. If some elements of the existing system were not functioning properly and could be rectified, then these should have been fixed rather than implementing an entirely new system [20,21]. For example, in a well-functioning system with rapid plasma reagin testing, rapid syphilis POCTs could be introduced as confirmatory tests rather than replacing the entire testing system [20].

The decrease in uptake of three interventions may suggest a general problem of stockouts due to failures in the procurement chain or perhaps a variation in motivational levels given that some facilities managed to increase uptake. The overall marginal increase in HIV testing may be attributed to it being a better resourced program [5] and to test kits being supplied through a parallel system.

A much larger absolute decrease of about 16% was noted after adjusting for under-recording of AST results in the register. It is possible that the decrease could have been even larger (i.e. our pre-rollout uptake may have been underestimated, as the sensitivity could have been lower), since the rollout may have improved the quality of syphilis data in the ANC register. Further, uptake of treatment for syphilis-seropositive mothers was not documented owing to the lack of a syphilis treatment column in the ANC register, which proved to be a useful addition in Uganda [22].

The existence of separate registers for various interventions probably makes it easier to monitor each program's progress. However, this leads to fragmentation in documentation of client records and increases staff workload [23]. It also fails to give a complete summary of antenatal client evaluations and management and defeats the purpose of integrated and focused ANC. Documentation of important client examinations and treatments in the ANC register makes it easier to assess and monitor obstetric care from a single source.

4.3. Limitations

A key limitation of our validation study is that the MRB may not be a perfect gold standard. The assumption that the interventions were not given if they were not recorded in the MRB may not be entirely true as staff may sometimes forget to appropriately record results or treatments. However, the effects of this are expected to be quite minimal. Other limitations include its restriction to "larger" healthcare facilities owing to sample size requirements; thus, the effect of the rollout could not be assessed in "smaller" healthcare facilities. Data were limited to four months in each year, which could have coincided with periods of stockouts in some facilities. Nevertheless, this provides an indication of the availability of test kits and may suggest that facilities would have experienced longer stockout periods had the review period been extended. The different times of the rollout across the country and the non-availability of registers for earlier years (for example, 2008) in some facilities made it difficult to prolong the review period. Finally, the assumption that the sensitivities and specificities of recording the interventions in the ANC register were the same before and after the POCT rollout may not be entirely accurate, as the rollout could have improved the quality of ANC register data.

5. Conclusions

Although the chosen antenatal interventions were under-recorded in most facilities, generally, the accuracy appeared high since most PPVs were above 80%. However, given the variable levels of completeness and accuracy for key indicators, routine monitoring of such prenatal interventions using ANC register data may result in an underestimation of their uptake. Meticulous recording by healthcare providers and regular audits could improve the quality and potential utility of ANC register data. Whenever possible, ANC register and MRB data should be combined to improve data quality.

Within the limitations of register data, the national rollout of syphilis POCTs did not result in an overall increase in AST. However, significant increases were observed in healthcare facilities that were previously not performing AST. A key lesson to be learnt from the rollout is "not to replace," but to learn from and improve on existing functioning systems. A column for recording syphilis treatment should be included in the ANC register and efforts should be made to integrate all client records into the ANC register to provide a single comprehensive source of client data.

Acknowledgments

This research was supported by the Commonwealth Scholarships Scheme, UK Department for International Development (DFID) Realising Rights Research Programme Consortium, the University of London Central Research Fund, and the Bill and Melinda Gates Foundation. We are grateful to Professor David Mabey, Dr Helen Weiss, and Dr Veronique Filippi for their expert advice. We acknowledge the support of the Medical Directors and staff of the selected health facilities.

Conflict of interest

The authors declare that they have no conflicts of interest.

References

[1] World Health Organization. The Global elimination of congenital syphilis: rationale and strategy for action. Geneva: WHO; 2007.
[2] Gloyd S, Chai S, Mercer MA. Antenatal syphilis in sub-Saharan Africa: missed opportunities for mortality reduction. Health Policy Plan 2001;16:29–34.
[3] Mabey DC, Sollis KA, Kelly HA, Benzaken AS, Bitarakwate E, Changalucha J, et al. Point-of-care tests to strengthen health systems and save newborn lives: the case of syphilis. PLoS Med 2012;9:e1001233.
[4] Hawkes S, Matin N, Broutet N, Low N. Effectiveness of interventions to improve screening for syphilis in pregnancy: a systematic review and meta-analysis. Lancet Infect Dis 2011;11:684–91.
[5] Tulloch O, Mayaud P, Adu-Sarkodie Y, Opoku BK, Lithur NO, Sickle E, et al. Using research to influence sexual and reproductive health practice and implementation in Sub-Saharan Africa: a case-study analysis. Health Res Policy Syst 2011;9(Suppl. 1): S10.
[6] Ghana Health Service. HIV sentinel survey report 2004. Accra: National AIDS/STI Control Programme/Ghana Health Service; 2005.
[7] Ghana Health Service. HIV sentinel survey report 2008. Accra: National AIDS/STI Control Programme/Ghana Health Service; 2009.
[8] World Health Organization. Joint United Nations Programme on HIV/AIDS, United Nations Children's Fund. Global HIV/AIDS response: epidemic update and health sector progress towards universal access. Geneva: World Health Organization; 2011.
[9] Taylor LK, Travis S, Pym M, Olive E, Henderson-Smart DJ. How useful are hospital morbidity data for monitoring conditions occurring in the perinatal period? Aust N Z J Obstet Gynaecol 2005;45:36–41.
[10] Lain SJ, Hadfield RM, Raynes-Greenow CH, Ford JB, Mealing NM, Algert CS, et al. Quality of data in perinatal population health databases: a systematic review. Med Care 2012;50(4):e7-20.
[11] Ghana Health Service. 2010 HIV sentinel survey report. Accra: National AIDS/STI Control Programme/Ghana Health Service; 2011.
[12] Ghana Statistical Service (GSS), Ghana Health Service (GHS), ICF Macro. Ghana demographic and health survey 2008. Accra: GSS, GHS and ICF Macro; 2009.
[13] Ghana Health Service. National safe motherhood service protocols. Accra: Ghana Health Service; 2008.
[14] Bell JC, Ford JB, Cameron CA, Roberts CL. The accuracy of population health data for monitoring trends and outcomes among women with diabetes in pregnancy. Diabetes Res Clin Pract 2008;81:105–9.
[15] Roberts CL, Cameron CA, Bell JC, Algert CS, Morris JM. Measuring maternal morbidity in routinely collected health data: development and validation of a maternal morbidity outcome indicator. Med Care 2008;46:786–94.
[16] Looney SW, Hagan JL. Statistical methods for assessing biomarkers and for analyzing biomarkers data. In: Rao CR, Miller JP, Rao DC, editors. Handbook of Statistics, volume 27: Epidemiology and medical statistics. Amsterdam: Elsevier; 2008. p. 109–47.
[17] Cameron CA, Roberts CL, Olive EC, Ford JB, Fischer WE. Trends in postpartum haemorrhage. Aust N Z J Public Health 2006;30:151–6.
[18] Mabey D, Peeling RW, Ballard R, Benzaken AS, Galbán E, Changalucha J, et al. Prospective, multi-centre clinic-based evaluation of four rapid diagnostic tests for syphilis. Sex Transm Infect 2006;82(Suppl. 5):v13–6.
[19] Watson-Jones D, Gumodoka B, Weiss H, Changalucha J, Todd J, Mugeye K, et al. Syphilis in pregnancy in Tanzania. II. The effectiveness of antenatal syphilis screening and single-dose benzathine penicillin treatment for the prevention of adverse pregnancy outcomes. J Infect Dis 2002;186:948–57.
[20] London School of Hygiene and Tropical Medicine. The rapid syphilis test toolkit: A guide to planning, management and implementation. Management 3: Developing syphilis testing and treatment algorithms using rapid tests. London: London School of Hygiene and Tropical Medicine; 2011.
[21] World Health Organization. The use of rapid syphilis tests. Geneva: WHO; 2007.
[22] The Elizabeth Glaser Pediatric AIDS Foundation. Eliminating congenital syphilis in Uganda. Mbara: The Elizabeth Glaser Pediatric AIDS Foundation; 2011.
[23] Gloyd S, Montoya P, Floriano F, Chadreque MC, Pfeiffer J, Gimbel-Sherr K. Scaling up antenatal syphilis screening in Mozambique: transforming policy to action. Sex Transm Dis 2007;34:S31–6.