MACEPA PATH
Malaria Control and Elimination Partnership in Africa

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Reactive case detection in transition to programmatic surveillance in northern Senegal

Yakou Dieye[1], Caterina Guinovart[2], Gnagna Dieng[1], Moussa Diop[1], Jean Louis Lankia[1], Michael Hainsworth[1], Megan Littrell[1], Llorenç Quintó[3], Moustapha Cissé[4], Oumar Sarr[4], Serigne Amdy Thiam[5], Coumba Ndoffene Diouf[5], Mamadou Kandji[5], Mame Latte Mbengue[5], Bayal Cisse[5], Seynabou Ndiaye[5], Eladji Doucoure[5], Ndiaye Faly Diop[5], Niene Seck[5], Aliou Ndour[5], Tidiane Thiam[5], Aichatou Barry[5], Touti Ndiaye[5], Duncan Earle[1], Philippe Guinot[1], Richard W. Steketee[1]
[1]PATH Malaria Control and Elimination Partnership in Africa (MACEPA); [2]PATH MACEPA/ISGlobal collaboration; [3]ISGlobal, Barcelona, Spain; [4]Programme Nationale de Lutte contre le Paludisme, Ministry of Health, Dakar, Senegal
[5]Regional and District Health Directorates, Ministry of Health, Matam and Louga regions, Senegal

Background

As more countries move toward malaria elimination, new strategies need to be implemented in low transmission settings to deal with residual or imported cases before elimination is reached. In northern Senegal, malaria case investigation (CI) and reactive case detection (RCD) are currently being implemented.

Case investigation is the characterization of all passively detected malaria cases (sociodemographic characteristics, symptoms, history of travel, use of malaria control tools, etc.), which is followed by RCD to actively search for more infections and/or administer antimalarial treatment at the index case household and neighboring households.

The success of this approach rests on the assumption that infections are clustered and that tracking passively detected index cases will find the most infections. However, many questions remain about the effectiveness and operational feasibility of these strategies. Available data from the field should inform policies.

Since 2012, Senegal has been implementing CI with RCD in the north, where malaria transmission is the lowest in the country. It initially started in Richard Toll District, where RCD was done using focal test and treat (FTAT) in the index case household and five closest neighboring compounds, changing to focal screen test and treat (FSTAT)—only testing with a rapid diagnostic test those with risk factors—in neighboring compounds, and finally to focal drug administration (FDA) where all eligible individuals in only the index case household are treated.

Since 2016, RCD and targeted response has been implemented by the National Malaria Control Program in 10 districts in northern Senegal covering a population of about 1.7 million, with over 90% of passively detected cases investigated. A summary of FDA results by district is presented in Table 1.

Figure 1. 10 Districts and 235 Health Posts conducting CI+RCD

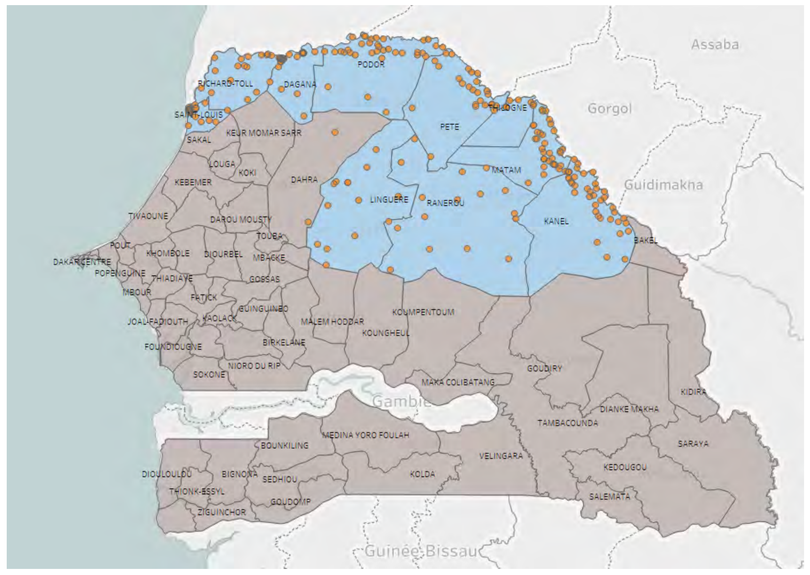


Table 1. Summary of FDA operations in northern Senegal

District	LINGUERE	KANEL	MATAM	RANEROU	THI-LOGNE	DAGANA	PETE	PODOR	RICHARD-TOLL	SAINT-LOUIS	Total
Population	123021	268072	229373	59743	92049	87604	192592	229141	180743	329192	1791530
Number of public health posts	16	41	26	15	13	13	27	35	27	22	235
Number of index cases diagnosed, n	601	176	254	131	116	61	104	176	180	370	2169
Number of travelers, n (%)	45 (7.5)	5 (2.8)	60 (0)	26 (19.8)	10 (8.6)	31 (50.8)	32 (30.8)	73 (41.5)	117 (65)	122 (33)	521 (24)
Number of eligible Index cases, n (%)	582 (96.8)	140 (79.5)	198 (0)	122 (93.1)	93 (80.2)	58 (95.1)	98 (94.2)	171 (97.2)	158 (87.8)	319 (86.2)	1939 (89.4)
Number of Index cases investigated, n (%)	608 (101.2)	147 (83.5)	198 (0)	136 (103.8)	87 (75)	59 (96.7)	96 (92.3)	163 (92.6)	158 (87.8)	293 (79.2)	1945 (89.7)
Number of Index cases investigated in same HH, n	61 (10)	60 (34)	17 (7)	31 (24)	12 (10)	8 (13)	1 (1)	6 (3)	16 (9)	24 (6)	236 (11)
Mean number of index cases investigated per health post and per week, mean (range)	4 [1-35]	2 [1-12]	2 [1-9]	4 [1-19]	1 [1-5]	1 [1-2]	1 [1-2]	1 [1-4]	2 [1-14]	2 [1-10]	2 [1-35]
Median number of days between index case diagnosis and initiation of case investigation, mean (range)	3 [0-50]	7 [0-38]	5 [0-30]	4 [0-24]	4 [0-29]	4 [0-30]	7 [0-69]	16 [0-82]	2 [0-19]	5 [0-46]	4 [0-82]
Number of index cases investigated having slept in more than one HH, n (%)	2 (0.3)	5 (2.8)	1 (0.4)	2 (1.5)	0 (0)	0 (0)	1 (1)	7 (4)	0 (0)	3 (0.8)	21 (1)
Mean number of HHs per investigation, mean (range)	1 [1-2]	1 [1-2]	1 [1-2]	1 [1-2]	1	1	1 [1-2]	1 [1-2]	1	1 [1-2]	1 [1-2]
Mean number of individuals per HH inves-tigated, mean (range)	18 [1-117]	29 [2-141]	20 [3-221]	18 [1-87]	15 [2-60]	17 [6-55]	14 [2-33]	15 [5-36]	17 [1-98]	23 [1-486]	20 [1-486]

Methods

- A descriptive analysis was performed of the history of operational CI with RCD in Richard Toll District and expansion to additional districts.
- To evaluate whether CI with RCD had an impact on malaria incidence we conducted a segmented regression of time-series analysis:
  - Negative binomial regression models to compare incidence rates using rapid reporting data (all malaria cases reported by month).
  - Random effect on health post.
  - Adjusted by rainfall and vegetation index.
- This methodology does not use a comparison area and has been used historically in malaria impact evaluations using health management information system data.
- Based on pre-intervention data, the model estimates what would have happened in the post-intervention period had the intervention not been implemented (counter-factual secular trends) in comparison with what actually happened.
- Analysis limited to areas for which we have at least one year of post-intervention period data (i.e., the areas that started FDA in Oct 2016):
  - Richard Toll
    - Pre-intervention: Aug 2010–Jul 2013
    - Post-intervention 1 (during which FTAT/FSTAT was conducted): Aug 2013–Sep 2016
    - Post-intervention 2 (FDA conducted): Oct 2016-Sep 2017
  - Matam + Thilogne + Linguère districts
    - Pre-intervention: Aug 2012–Sep 2016
    - Post-intervention: Oct 2016–Sep 2017

Results

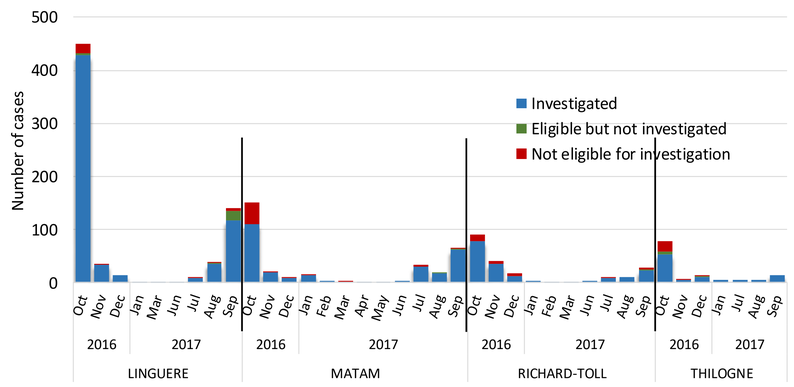
In Richard Toll District (pop. ~180,000) CI+RCD was conducted using FTAT or FTAT+FSTAT from 2012 to September 2016. With an annual incidence of less than 2 per 1000, the number of index cases was low and CI coverage was high. There were approximately 50 contacts tested or screened per index case in index case or neighboring households. Fewer than 0.5% of contacts were RDT+, with the majority of those occurring within the index case household (Table 2).

Table 2. Summary of FTAT and FSTAT investigations in Richard Toll District

Richard Toll District: Case Investigation (FTAT or FSTAT)	2012 (pilot)	2013	2014	2015	2016 (partial)
Index cases	110	234	134	323	41
% with travel history	65%	68%	73%	72%	73%
% investigated	86%	100%	100%	81%	80%
Number of contacts tested/ screened	5520	10071	5749	13128	1802
Ratio of contacts to index case tested/screened	58	43	43	50	55
Number (%) of contacts RDT+	23 (0.4%)	42 (0.4%)	14 (0.2%)	31 (0.2%)	7 (0.4%)
Number (%) of RDT+ from index case household	14 (61%)	23 (55%)	12 (86%)	28 (90%)	6 (86%)

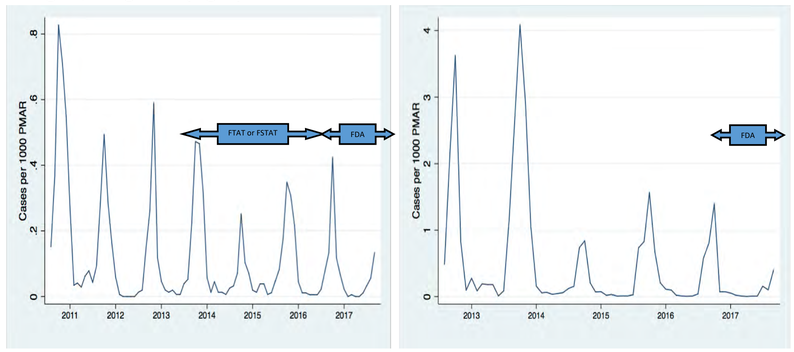
Operational considerations led to the introduction in October 2016 of FDA delivered to index case household members in Richard Toll and three other districts that had previously not received other interventions—Matam, Thilogne, and Linguère (excluding 1 health post) (pop. ~445,000). Case rates were low and CI coverage high (Figure 2). Data from District Health Information System 2 (DHIS2) indicated a declining trend in monthly malaria incidence in all four districts. (Figure 3).

Figure 2. FDA: Cases per month in four districts October 2016 to September 2017



Results (cont.)

Figure 3. Reported monthly incidence (DHIS2) in Richard Toll (left) and Matam, Thilogne, Linguere (right)



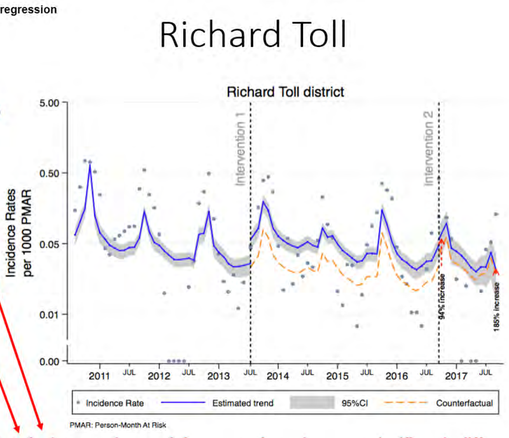
Segmented regression of time-series analysis indicates a statistically significant declining trend in pre-intervention malaria incidence in both intervention areas. In Richard Toll, after operational start-up of CI+RCD with FTAT/FSTAT in 2013, actual incidence does not significantly differ from what would have been expected without the intervention. In all four districts, after implementation of FDA in 2016, actual incidence in the following one year also did not significantly differ from the counterfactual (Figure 4).

Figure 4. Reported monthly incidence (DHIS2) in Richard Toll (top) and Matam, Thilogne, Linguere (bottom)

Parameter estimates from the negative binomial segmented regression predicting monthly counts

Variable	Coef.	(95% Conf. Interval)	p-value
Baseline level *(Intercept)*	-14.61	(-16.17; -13.05)	< 0.0001
Baseline monthly trend	-0.02	(-0.03; -0.01)	0.0022
Level change after intervention 1	0.90	(0.54; 1.27)	< 0.0001
Monthly trend change after intervention 1	-0.01	(-0.02; 0.01)	0.4718
Level change after intervention 2	1.48	(0.72; 2.13)	0.0001
Monthly trend change after intervention 2	-0.03	(-0.11; 0.04)	0.4119
EVI with 2 month lag	0.04	(0.03; 0.05)	< 0.0001
Rainfall (mm) with 2 month lag	0.01	(0.01; 0.01)	< 0.0001

Richard Toll



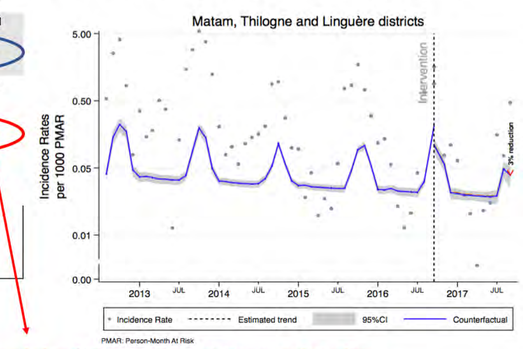
There was a significant decreasing trend before the intervention

The trend after the interventions and the counterfactuals are not significantly different => the interventions do not seem to have had an impact during the period analyzed

Parameter estimates from the negative binomial segmented regressionpredicting monthly counts

Variable	Coef.	(95% Conf. Interval)	p-value
Baseline level *(Intercept)*	-10.51	(-11.48; -9.55)	< 0.0001
Baseline monthly trend	-0.01	(-0.02; -0.01)	0.0001
Level change after intervention	-0.03	(-0.33; 0.28)	0.8260
Monthly trend change after intervention	0.00	(-0.03; 0.04)	0.9899
EVI with 2 month lag	0.00	(-0.00; 0.01)	0.4589
Rainfall (mm) with 2 month lag	0.01	(0.01; 0.01)	< 0.0001

Matam+Thilogne+Linguère



There was a significant decreasing trend before the intervention

The trend after the intervention and the counterfactual are not significantly different => the intervention does not seem to have had an impact during the period analyzed

Conclusions

- Implementation of FTAT and FSTAT RCD is feasible in low transmission settings.
- FDA is operationally simpler, and in very low transmission settings likely addresses the majority of focal cases while offering some protection to uninfected individuals in index case households.
- CI+RCD with FTAT or FSTAT appears to be having an impact on already decreasing malaria transmission in very low or low incidence settings.
- While FDA does not appear to have had an impact on transmission, implementation is very recent and may need additional time to adequately evaluate impact.
- Consideration of additional factors need to be studied to evaluate the cause of decreasing malaria in these settings.