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Cost and Effectiveness Analysis of "Strategically Packaging" Malaria Interventions - Evidence from a Retrospective Analysis in Senegal

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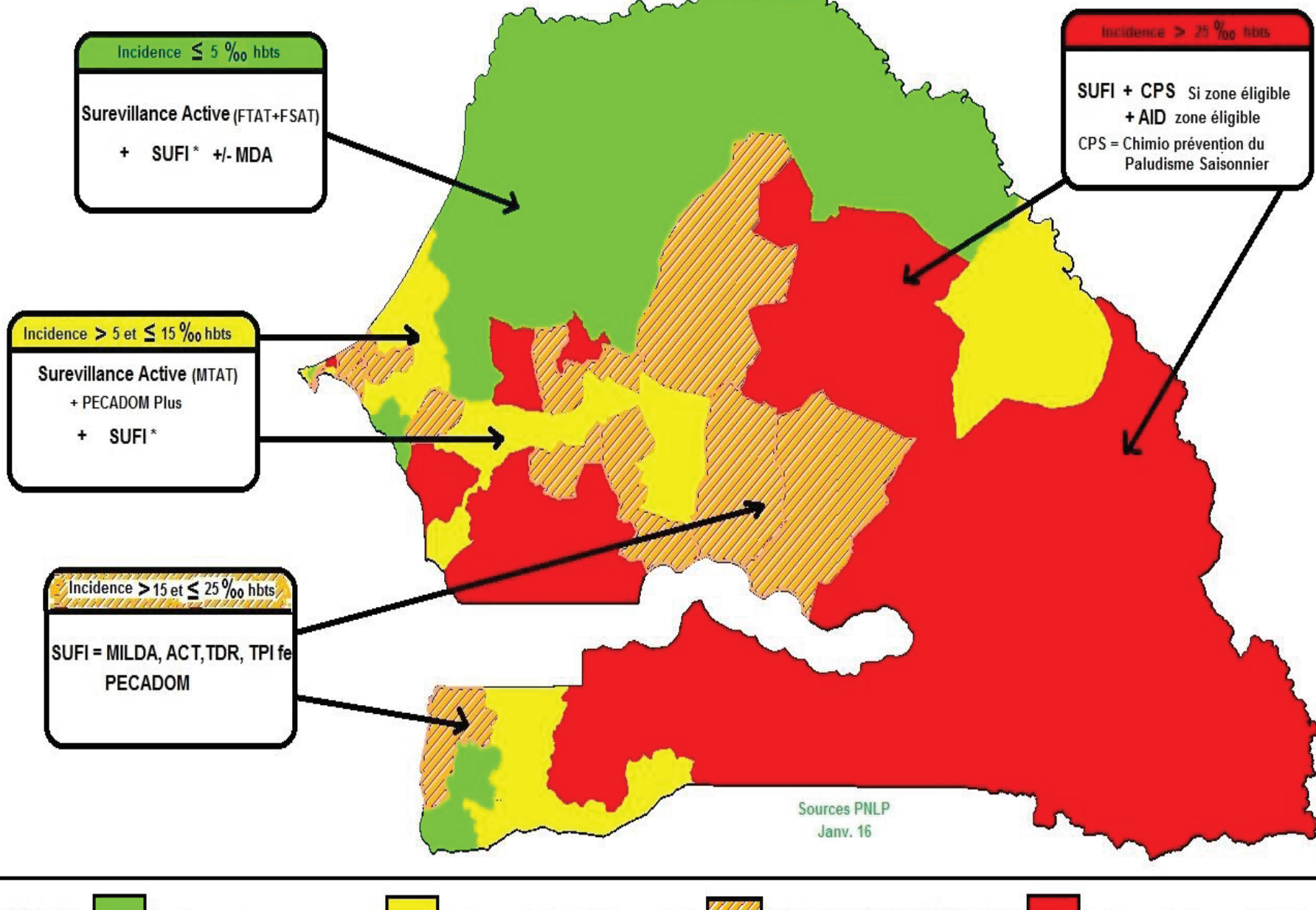
Background

- Resources for malaria control and elimination interventions are limited
- Cost-effectiveness data is necessary for decision-making and planning
- Lack of cost-effectiveness data for intervention combinations or "packages"

Senegal Malaria control packages
1. SUFI (Scale Up For Impact) only: LLINs + IPTp + RDTs + ACTs + PECADOM (community-based case management)
2. SUFI + Seasonal Malaria Chemoprevention (SMC)
3. SUFI + Indoor Residual Spraying (IRS)
4. SUFI + SMC + IRS
5. SUFI + Reactive Case Investigation (Focal Screen and Treat and Mass Screen and Treat)

Interventions targeted to incidence, by district
Sénégal : Cartographie des Interventions par strate sur la période de 2016 à 2020.
(Source: National Malaria Control Strategic Plan 2016-2020)

Objectives

- Estimate cost-effectiveness ratios (CER) for different packages of malaria interventions in Senegal using routine data, as opposed to modelling
- Utilize results to identify potential efficiency gains and to draw lessons as malaria epidemiology evolves in Senegal
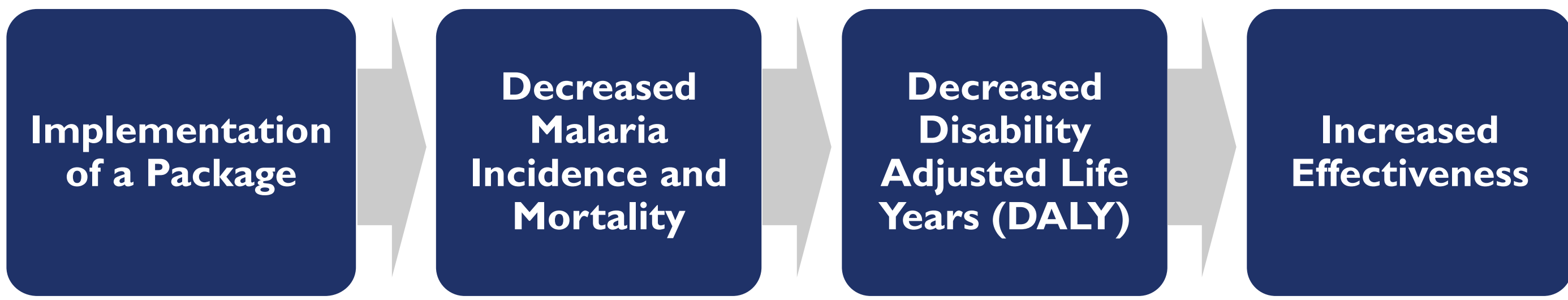
Data

- Retrospective analysis of 2013-2014: first two years that all packages were occurring
- District level data for Senegal's 76 districts (incidence, mortality, intervention coverage, outputs and costs)
- Costing analysis: only direct financial implementation costs
- Coverage/output and cost data for interventions obtained from NMCP or implementing partners
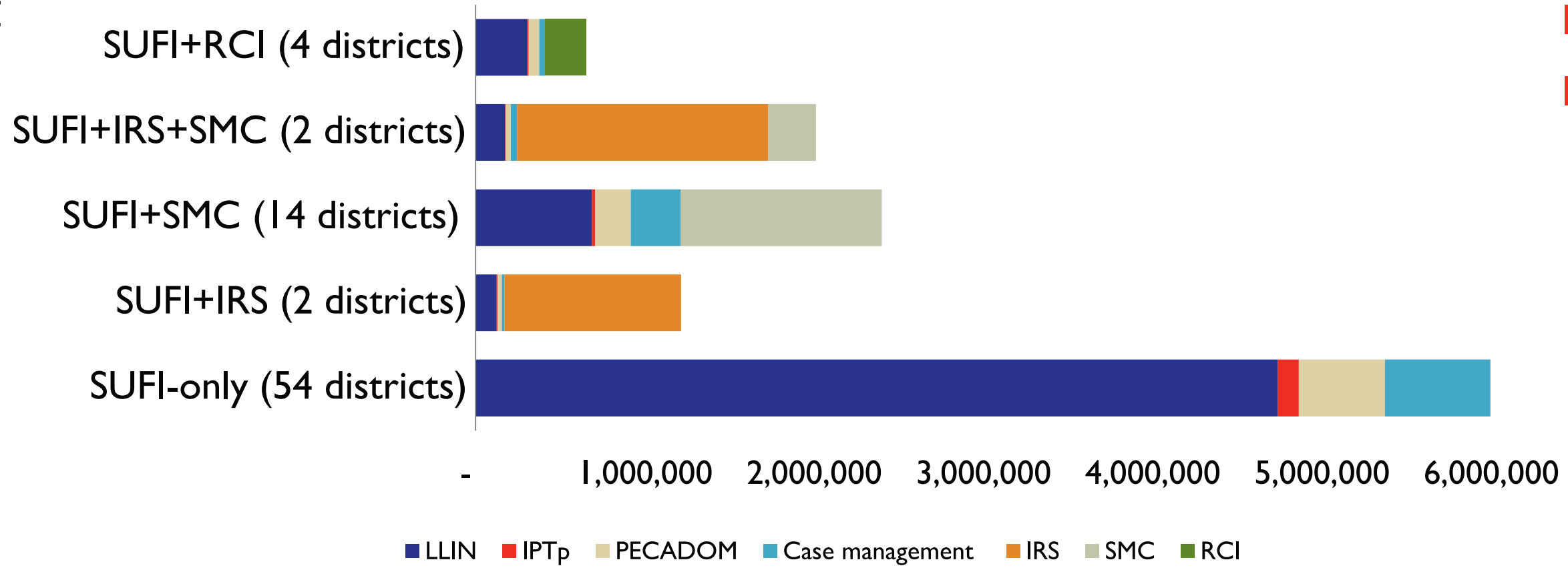
Methods

- Total annual costs estimated using top down and bottom up approaches
- Intervention costs aggregated to obtain package costs
- Package effectiveness measured in disability-adjusted life years (DALYs) averted for the study period
- CER: Cumulative costs of a package in its area of implementation divided by cumulative DALYs averted

Implementation of a Package → Decreased Malaria Incidence and Mortality → Decreased Disability Adjusted Life Years (DALY) → Increased Effectiveness

Results

Total Costs of Interventions/Packages

- SUFI only had the highest total cost; LLINs accounted for almost 80 percent of total cost
- SUFI (LLINs, IPTp, case management, PECADOM) is the largest component of all other packages, except those with IRS
- Seasonal malaria chemoprevention (SMC) accounts for almost half of total cost of SUFI+SMC package

Total annual cost of packages (USD)
SUFI+RCI (4 districts), SUFI+IRS+SMC (2 districts), SUFI+SMC (14 districts), SUFI+IRS (2 districts), SUFI-only (54 districts)
Legend: LLIN, IPTp, PECADOM, Case management, IRS, SMC, RCI

Unit Costs of Interventions/Packages

- Lower unit costs of prevention-related interventions, vs. treatment-related
- Indoor residual spraying (IRS) had highest unit cost of preventive interventions, reactive case investigation (RCI) highest among treatment interventions
- Packages with IRS had highest unit cost
- SUFI only had lowest unit cost, followed by SUFI+RCI

Unit Cost per Intervention

Intervention Type	Unit cost per beneficiary (USD)	Intervention Coverage
Prevention		
IRS	3.57	98.3%
SMC	2.38	97.2%
LLIN	0.91	57.8%
IPTp	0.56	66.3%
Treatment		
RCI	9.82	NA
PECADOM	9.25	NA
Case management	1.43	NA

Unit Costs by package

Packages	Unit cost per capita* (USD)
SUFI+SMC+IRS	4.55
SUFI +IRS	4.19
SUFI +SMC	1.52
SUFI +RCI	1.09
SUFI only	0.54

*Unit cost is calculated using the population of the areas where a package is implemented

Package Effectiveness

- Decrease in malaria incidence and mortality over the study period
- Packages with SMC had largest decrease in incidence
- Packages with IRS had largest decrease in mortality

Malaria burden changes over study period by package

Package	Number of Districts	Change in Average Incidence Rate 2013-2014	Change in Average Mortality Rate 2013-2014
SUFI only	54	-31.9%	-33.4%
SUFI + IRS	2	-37.6%	-78.8%
SUFI + SMC	14	-52.6%	-73.7%
SUFI + SMC + IRS	2	-52.2%	-88.9%
SUFI + RCI	4	-52.0%	-7.6%

*Incidence, mortality, and DALYs rates are respectively in number per 1,000 population. The comparison is over the period 2013 -2014.

Package Cost Effectiveness

- Per WHO guidelines, all packages were "very cost effective," meaning CER was less than country GDP per capita of $1,067 in 2014
  - Exception: SUFI+RCI package is "cost effective," meaning CER less than 3 times the GDP per capita
- Relative to other packages, SUFI+SMC is most cost effective, SUFI+RCI is least cost effective

Cost effectiveness ratios by malaria package

Packages	Cost per DALY averted (USD)	Sensitivity analysis* Lower value	Sensitivity analysis* Upper value
SUFI only	133	104	182
SUFI+IRS	591	463	816
SUFI+SMC	81	65	106
SUFI+SMC+IRS	275	219	367
SUFI+RCI	1,349	985	2,141

For the number of DALYs averted, we calculated extreme values as well as the mid-point for sensitivity analysis.

Discussion

- Deploying interventions in packages based on incidence could be recommended to other countries
- All packages were "cost effective" based on WHO threshold
  - Not advisable to compare cost-effectiveness of elimination packages to control
  - SMC + IRS more cost effective than IRS only
  - Efficiency gains possible with increased LLIN and IPTp coverage
- Strong surveillance and outcome monitoring systems needed for country-specific studies

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