Swiss Tropical Institute
Institut Tropical Suisse
Schweizerisches Tropeninstitut

Operations, Costs and Cost-Effectiveness:

Five Insecticide-Treated Net Programmes

(Eritrea, Malawi, Tanzania, Togo, Senegal)

Two Indoor Residual Spraying Programmes

(KwaZulu-Natal, Mozambique)

Christian Lengeler, Joshua Yukich, Fabrizio Tediosi
Swiss Tropical Institute, Basel, Switzerland

With contributions by: Nick Brown, Des Chavasse, Lesong Conteh, Marcy Erskine, Greg Foster, Tewolde Ghebremeskel, Catherine Goodman, Kara Hanson, John Justino, Mbaye Khouma, Rajendra Maharaj, David McGuire, Jeptha M'tema, Romanus M'tunge, Jo Mulligan, Fana Sakho, Brian Sharp, Warren Stevens, Juan Manuel Urrutia, Ch. Yuma, Mehari Zerom

Support for this review was provided by the United States Agency for International Development (USAID) & Research Triangle Institute (RTI). The views expressed in this document are solely those of the authors and do not imply an endorsement by the US Government or its contractors.

Aims of the review

To systematically review and compare the cost, cost-effectiveness, and main operational features of large-scale indoor residual spraying (IRS) and insecticide-treated nets (ITNs) for malaria control in sub-Saharan Africa.

IRS: KwaZulu-Natal, Southern Mozambique (LSDI)

ITNs: Eritrea, Malawi, Tanzania, Togo, Senegal

Methods of the review (1) – General principles

- Costing followed standard guidelines (Creese & Parker 1994; Stevens *et al*. 2005; Kolaczinski and Hanson 2006).
- Only national or at least large-scale programmes.
- Provider perspective, with exception of user contributions to purchase of nets and insecticide kits.
- Time frame varied according to availability of data (if possible at least 3 years, including startup costs).
- Costs were collected retrospectively from financial and operational records; in addition, costs and activity information were collected through stakeholder interviews and direct observation, as needed.

Methods of the review (4) – Health benefits

Deaths averted

- **Mortality impact for ITNs taken from the Cochrane review:**

  5.5 deaths averted per 1000 person-years of protection in children under five years (U5s).

- **For lack of better data, we assumed the same effect for IRS; there is much historical evidence of impact of IRS and some direct comparisons (Lengeler and Sharp 2003). Currently ongoing Cochrane review on IRS (Tanser, Pluess, Lengeler & Sharp).**

- **No quantification of protective effect in older individuals (especially relevant in areas with high HIV levels).**

- **No quantification of protection in pregnant women (although positive effects on newborns covered in U5s mortality).**

- **No effect of untreated nets – instead we calculated the effect of LLIN in the sensitivity analysis.**

IRS programmes under review:

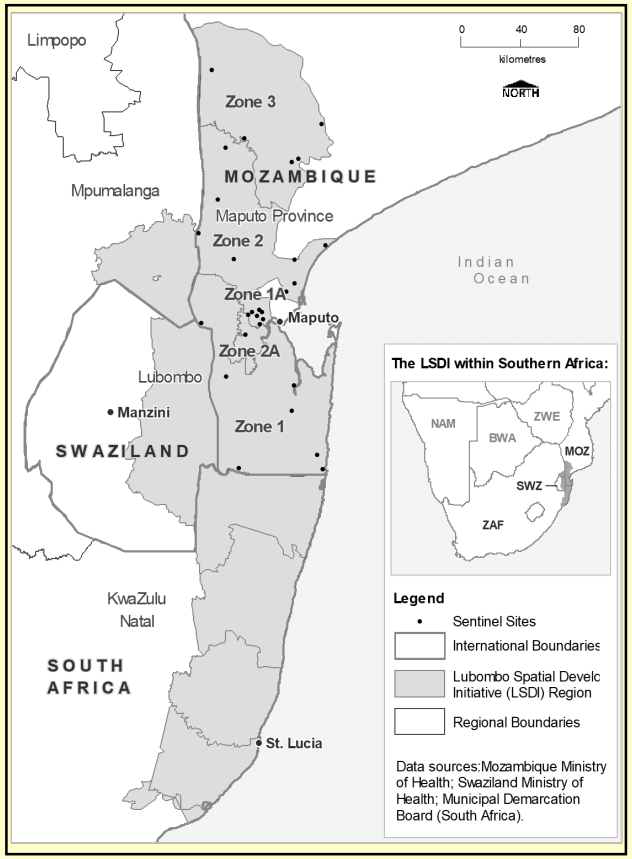
IRS programmes are the "model" vertical programmes… but they can be well integrated into the health system!

KwaZulu Natal:

- **Funded by the SA Dept. of health since 1932**
- **Seasonally hired spraymen (200) and supervisors (25) with 25 vehicles.**
- **Currently using DDT (traditional houses) and pyrethroids (Western-type structures)**

Southern Mozambique LSDI:

- **Funded by a consortium including GFATM**
- **Seasonally hired community-resident spraymen (80) and supervisors (2) with 2 vehicles.**
- **Currently using DDT (traditional houses) and pyrethroids (Western-type structures)**



ITNs: Current main implementation models

Public sector

1. Free distribution of ITNs through health facilities and community groups (Eritrea).
2. Free distribution of ITNs in the frame of vaccination campaigns (Ghana, Togo, Zambia, Niger, Mozambique, Kenya, Rwanda).

Commercial / mixed

3. A comprehensive market approach (NETMARK project in Senegal, Mali, Ghana Nigeria, Mozambique, Uganda, Zambia, Ethiopia) – with and without subsidies.
4. Social marketing (Malawi, Kenya) – with subsidized ANC sales, with and without product distribution.
5. Integrated (NATNETS Tanzania): commercial sector distribution, social marketing with no product distribution and vouchers for pregnant women and infants at measles vaccination

Key characteristics of programmes

	Population covered (millions)	Period	Total # of nets	Total # re-treatments	Total economic cost (mio USD)
Eritrea	2.9	2001-05	900,000	2,000,000	4.4
Malawi	12.2	1999-05	4,700,000	500,000	15.7
Tanzania	35.7	2002-05	6,400,000	7,800,000	30.5
Togo	5.3	2004	900,000	0	6.5
Senegal	10.0	2000-05	750,000	250,000	6.2
KwaZulu-Natal	0.6 (7.3 in past)	1997-99	300,000 structures		2.2
Mozambique	0.8	1999-01	150,000 structures		1.0

Coverage rates of high-risk groups in study sites (latest figures available – %)

	Household ownership		Children under five slept under net last night		Pregnant woman slept under net last night	
	Any net	ITN	Any net	ITN	Any net	ITN
Eritrea 2004	79	73	na	59	na	50
Malawi 2004	43	34	38	36	34	31
Tanzania 2006	57	29	41	28	34	18
Togo 2004	na	60	na	54	na	45
Senegal 2005	38	20	14	7	14	9

Coverage in both IRS areas above 80% for risk groups

Average annual economic cost for ITN and IRS programmes. Conventional ITNs (2005 USD).

ITN program	Average cost per ITN distributed	Average cost per TNY	Cost per death averted	Cost per DALY averted
Eritrea	4.74	1.43	1,722	52
Malawi	3.36	3.04	1,222	37
Tanzania	4.80	2.17	1,745	53
Senegal	8.05	6.05	2,926	89
Togo (only LLIN)	3.23	3.23	1,174	36
IRS program	**Cost pp protected (whole pop.)**	**Cost per under-five child protected**	**Cost per death averted**	**Cost per DALY averted**
KwaZulu-Natal	3.27	23.96	4,357	132
Mozambique	3.90	21.63	3,933	119

Average annual economic costs for ITN and IRS programmes. LLIN with 5 years duration (2005 USD)

ITN program	Average cost per LLIN distributed	Average cost per TNY	Cost per death averted	Cost per DALY averted
Eritrea	7.78	1.18	431	13
Malawi	5.05	1.79	651	20
Tanzania	5.74	1.62	588	18
Senegal	7.36	1.67	606	18
Togo	3.23	1.90	692	21
IRS program	**Cost pp protected (whole population)**	**Cost per under-five child protected**	**Cost per death averted**	**Cost per DALY averted**
KwaZulu-Natal	3.27	23.96	4,357	132
Mozambique	3.90	21.63	3,933	119

Epidemiological determinants

- Seasonality is a major factor influencing the CE of IRS because of the need for increasing numbers of spray rounds with increasing length of the transmission season.
- Consensus among IRS implementers is that beyond two spray rounds per year IRS becomes very difficult to implement.
- Hence, in areas of year-round transmission, ITNs will have a significant feasibility and cost-effectiveness advantage.
- Especially true with the use of shorter-lived insecticides such as carbamates as opposed to insecticides with longer residual lifetimes.
- In areas of shorter and lower transmission and typically also in epidemic-prone zones, IRS may have significant advantages because IRS programmes protect the entire population and the burden of disease is likely to be distributed much more evenly across all age groups.
- IRS can be restricted to periods in which there is a clear risk of epidemic.

Level of involvement of public, private and NGO sectors in studied vector control programs

Programme	Public sector	Commercial sector	NGO sector
Eritrea	♦♦♦		♦
Malawi	♦♦	♦♦	♦♦
Tanzania	♦♦	♦♦♦	♦♦
Senegal	♦	♦♦♦	♦♦
Togo	♦♦		♦♦♦
KwaZulu-Natal	♦♦♦		
Mozambique	♦♦♦	♦	♦

Conclusions (1)

- For the first time, comparable large-scale programme data are available to provide a solid evidence base in the debate on the best approach to vector control in sub-Saharan Africa.
- Vector control is remarkably cost-effective in SSA: cost per DALY averted ranged between USD 13-29 for LLIN programmes and 119-132 for IRS programmes; cost per death averted ranged between USD 431-960 for LLINs and USD 3,933-4,357 for IRS.
- For any ITN strategy, the use of LLIN rather than conventional nets should be promoted, regardless of the higher initial investment.
- The vaccination campaign approach fits best the RBM concept of "catch-up", while the 4 other models aim both for "catch-up" and "keep-up" over time; both strategies need to be combined.
- The longer the transmission season, the more LLINs are the better strategic option for vector control. IRS is likely to be better in epidemic-prone areas.