Innovative community-based vector control interventions for improved dengue and Chagas disease prevention in Latin America: introduction to the special issue

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Dengue fever and Chagas disease are important public health problems in Latin America. Dengue is a re-emerging viral disease, mainly transmitted by Aedes aegyptii mosquitoes, leading to an increasing number of outbreaks notably in urban areas of the continent.1,2 Chagas disease, a parasitic disease transmitted by Triatamine bugs, is a major cause of morbidity and mortality among the continent’s rural poor and persisting in different social-ecological settings.3,4 In spite of their epidemiological difference, both are vector-borne neglected tropical diseases (NTDs) for which primary prevention can currently mainly be achieved through vector control.5

In the case of dengue, routine vector control usually consists of source reduction strategies, including larviciding and/or insecticide space-spraying.6 However, vertically organized and insecticide-based vector control efforts often lack effectiveness and sustainability, and the need for community-based vector control strategies that include environmental management has been highlighted.7–9 With Chagas disease, routine interventions are usually based on insecticide spraying to eliminate household infestation. With a focus on domestic transmission, the peri-domestic transmission context is often neglected.

Current strategies for integrated vector management call for the adaptation of vector control interventions to local vector ecology, epidemiology and resources.10 Therefore, further insights relevant to specific ecosystems, into transmission dynamics and the possibility of intersectoral ecosystem management programs for dengue and Chagas disease prevention and control are urgently needed. This will play a crucial function in defining locally relevant and appropriate interventions with the prospects for sustainable control of vector populations.

This special issue reports findings of a research and capacity building program on innovative community-based vector control interventions for improved dengue and Chagas disease prevention in Latin America. The overall objective of the research initiative was to improve dengue and Chagas disease prevention by better understanding, through multi-level/multi-scale and trans-disciplinary analysis, ecosystem-related, biological and social (‘eco-bio-social’) determinants, and to develop and evaluate community-based public health interventions targeting dengue and Chagas disease vector habitats and delivered through intersectoral actions. The research program was a collaborative effort between the Special Programme for Research and Training in Tropical Diseases (TDR) and the Ecosystems and Human Health Program of the International Development Research Centre (IDRC).

Methodology of the research

Eight multi-disciplinary research groups in seven countries of Latin America (Bolivia, Brazil, Colombia, Ecuador, Guatemala, Mexico, Uruguay) participated, forming a community-of-practice for eco-health research on vector-borne diseases, with a focus on dengue in urban and peri-urban settings and on Chagas disease in rural settings. The overall initiative was based on the expectation that new scientific knowledge leads to improved dengue and Chagas disease prevention by informing and developing interventions in specific social-ecological settings (outcomes). Strategic research and implementation research, both accompanied by appropriate capacity strengthening efforts, were integral elements of the basic concept. The components of the research process are represented in Figure 1.

Based on a common core protocol and standardized data collection instruments, the research teams undertook an eco-bio-social situation analysis to characterize and map the ecosystem, vector ecology, the social context, including stakeholder

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environment, and community dynamics, including gender implications. A cross-site situation analysis on the five dengue studies was published earlier. The paper by Gürtler and Yadon in this special issue summarizes the situation analysis in the three Chagas disease research sites.

**Dengue research studies**

The five studies on dengue were all carried out in urban contexts, in medium to large size urban agglomerations of Latin America: Acapulco/Mexico, Fortaleza/Brazil, Girardot/Colombia, Machala/Ecuador and Salto/Uruguay. In these urban settings, standard dengue vector control measures, routinely carried out (without or with limited community participation) by municipal or other governmental control services, usually consist of space-spraying or with limited community participation. The intervention was organized through urban communities by community health agents (‘Agentes Comunitarios de Salud’) and through the organization of Chagas disease research studies. A cross-site situation analysis on the five dengue studies was published earlier. The paper by Gürtler and Yadon in this special issue summarizes the situation analysis in the three Chagas disease research sites.

The study in Brazil took place in Fortaleza (Ceará State) in the north-east of Brazil: a city particularly vulnerable to infestation with the dengue vector A. aegypti due to its tropical climate, high demographic density and uncontrolled urbanization. The intervention was organized through urban communities by enhancing their participation in local environmental management actions focusing on discarded containers that were found in the situational analysis to be the most productive vector breeding sites and around houses. In all intervention clusters, eco-health activities were organized, including the removal of discarded small recipients, cleaning of backyard areas and covering of large water containers on the ground and on the roof, but without the use of larvicides or insecticides.

The study in Colombia was conducted in Girardot, a municipality located 120 km from Bogotá on the right border of the Magdalena and Bogotá River. The intervention evaluated the efficacy, feasibility and cost-effectiveness of a combined approach of insecticide-treated window and door curtains (insecticide treated net [ITN] curtains) alone or in combination with covering the large productive water containers (>200 litre) with ITN materials. In the intervention clusters, long-lasting insecticide treated curtains on windows and water containers were deployed through local community networks and local entrepreneurs.

**Chagas disease research studies**

The projects on Chagas disease were carried out in rural research sites of Bolivia, Guatemala and Mexico, in areas where the socio-ecological setting is characterized by poverty and where social and environmental determinants lead to transmission in diverse domestic and peri-domestic contexts.

The study in Bolivia was carried out in poor rural communities of the Gran Chaco, inhabited by Guarani Indians, and the Andean Dry Valley with Quechua Indians constituting the main population groups. The social-ecological setting is determined by domiciliated Chagas disease transmission through Triatoma infestans. The intervention consisted of housing improvement and the management of domestic animals, in particular those that enter houses: sleeping dogs, hens laying eggs, etc. and those that are used to sleeping outside but near to the house walls. The delivery strategy was based on strong community structures. In the Chaco Region, intervention support and ownership was ensured by ‘Capitanías’, the traditional political structure of the Guarani indigenous people of the Bolivian Chaco. In the Valley Region, intervention support and ownership was provided by ‘Sindicatos’, the traditional political structure of the Guarani indigenous people of the Bolivian Chaco. Sensitization of the community was done by community health agents (‘Agentes Comunitarios de Salud’) and through the organization of Chagas disease ‘health fairs’ (‘ferias de salud’).

The study in Guatemala was carried out in 18 communities (9 intervention, 9 control communities) in the municipality of Comapa, Department of Jutiapa, Eastern Guatemala. The transmission dynamics are determined by house infestation by non-domiciliated T. dimidiata. The intervention was focused on peridomestic animal management, with an emphasis on reducing rodents as reservoirs inside the house and integrated improved...
insecticide application, education regarding Chagas disease and
risk factors, and a participatory rodent control program with
mechanical trapping and environmental management to reduce
rodent habitats.

The study in Mexico\textsuperscript{50} was carried out in three rural villages
with a population of mainly Mayan descent in the State of
Yucatan. The social-ecological setting is characterized by seasonal
house infestation (during March to July between the wet and
dry seasons) with limited colonization of non-domiciliated intrusive
triatomines \((T.\ dimidiata)\). A participatory action research approach led to a multi-stakeholder partnership built upon com-
community and local government involvement, including a Chagas
disease awareness campaign and cooperation between social
workers and carpenters. The intervention consisted of housing
improvement to prevent bug entry, including window screens
mainly for bedroom windows, produced by local carpenters, and
the management of the peri-domestic environment, including
cleaning and animal management.

Conclusions from the studies

After completion of the situational analysis, the dengue research
studies led to cluster randomized community trials in order to
test the efficacy of different vector control approaches in terms
of reducing vector densities and to analyze the feasibility and
evaluate the sustainability of the community-based intervention
strategies. In all sites, integrated, locally appropriate, control tech-
ologies for reducing both the immature and/or adult forms of the
mosquitoes were used and implemented through community-
based partnership models. The intervention tools ranged from
insecticide treated window screens or curtains and water
container covers (Mexico\textsuperscript{16}, Colombia\textsuperscript{14}) to non-chemical inter-
ventions, partnering communities and control program, to elimi-
nate or cover the most productive vector breeding sites through
waste management (Bolivia\textsuperscript{11}) to educational efforts
in schools and communities (Ecuador\textsuperscript{15}).

The reduction of vector densities compared to control clusters
was significant in Mexico, Brazil, Colombia and Ecuador (in spite of the
‘contamination’ of the control group with a large-scale larvi-
ciding program carried out concurrently); it was also present but
not statistically significant in Uruguay (probably due to the small
sample size). Building partnerships with communities and other
stakeholders was crucial and the additional costs for health ser-
ices were seen to be acceptable so that a scaling up program,
financed by control programs or Ministries, is currently being
initiated.

New strategies of empowering communities in contributing to
garbage collection and recycling (Brazil, Uruguay) and of involving
primary and secondary schools (Ecuador) to promote vector con-
trol activities at home and in the community were tested. They
showed high acceptance rates, visibility and considerable impact
on vector densities. Strengthening community involvement and
establishing prolonged interaction of community representatives
with control services, municipalities and other public actors were
shown to be time consuming and costly at the beginning, but
rewarding during the process and with excellent potentials for
sustainability (Sierra E. A., unpublished data).

The earlier findings that routinely used ‘larval surveys’ to deter-
mine the presence or absence of dengue vectors should be
complemented by annual or biannual ‘pupal productivity sur-
veys’\textsuperscript{21,22} during the wet season in order to identify productive
container types for targeted interventions could be confirmed.
Likewise, the characteristics of water containers producing most
dengue vectors could be identified: outdoor, rainwater filled,
not protected, untreated and in shaded areas. For such targeted
interventions, new and innovative dengue vector control tools
have been developed and tested and they have been shown to
have a decisive impact on the vector populations. In particular,
(1) window and door screens (with insecticide treated netting
material) in a fixed aluminium frame adapted to local window
types (Mexico), and (2) water container covers using a similar
design but with a flexible opening (Colombia); both devices were
highly appreciated by the population and vector control services.
This innovative approach is attractive for dengue control services
in several countries (Brazil, Colombia, Mexico, Uruguay). Policy
makers and practitioners were an active part of the research ini-
tiative and committed to scaling up the interventions at city levels
in four sites (Brazil, Colombia, Mexico, Uruguay).

The three Chagas disease studies provide evidence on innova-
tive interventions that go beyond routine indoor residual spraying
of insecticides against domestic vectors of Chagas disease by
national control services. These studies renewed the attention
to interventions that address social and environmental determi-
nants (e.g., improvement of housing conditions, notably in the
Bolivia study) through social participation. Targeting the peri-
domestic transmission context (Mexico) and a focus on perido-
mestic animal management (Guatemala) were innovative fea-
tures of the research portfolio on Chagas disease. Both
domestic and peri-domestic transmission contexts can be
addressed through participatory multi-stakeholder processes,
which combine routine indoor residual spraying with improve-
ment of housing conditions, management of domestic and peri-
domestic animals, and general environmental hygiene.

Thus, the research initiatives featured in this special issue, have
generated evidence on the feasibility and impact of innovative,
locally adapted approaches to vector control of two important
vector-borne diseases in Latin America, dengue and Chagas dis-
ease, through community-based partnership models and through
environmental management approaches.

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