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Misdirection in the margins of malaria elimination methods

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ABSTRACT

This paper proposes the term misdirection as a process by which attention is diverted from certain scientific approaches in the malaria elimination paradigm to justify specific methodological, scientific and political decisions. Misdirection, as it applies in magic, creates a sort of tunnel vision in which attention is diverted away from any action occurring outside the frame of the current paradigm. A crucial component of this misdirection process is the global standardization of intervention methodologies operating independent of local social contexts and the perceived impossibility to 'localize' such interventions. This conviction requires – and is simultaneously supported by- the production of decontextualized evidence through the application of methodologies aiming at generalizability, in detriment of social context and variability. This process produces *pseudo* measurements and conclusions that are at the same time *real* in their adherence to paradigmatically valid methodologies and *fake* as they either remain empty of empirical significance or whose validity cannot be assessed as we have lost sight of the (local, social, cultural) variation it has decided to ignore. Using the example of research on the effectiveness of bed nets and topical repellents as malaria prevention tools and their expected use within the current paradigm of malaria elimination, we show how the inherent ambiguity of the *pseudo* allows consequent misdirection processes.

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Introduction

'Misdirection', as it applies in magic, is the process through which attention is diverted away from actions occurring outside the frame of viewers to centre their focus on specific actions of interest. We propose the term misdirection as a process by which attention is diverted away from certain kinds of knowledge that do not fit the hegemonic paradigm and will apply the term to analyse the process of justification of methodological, scientific and political decisions in the current malaria elimination paradigm that draws attention away from alternative potentially effective solutions to favour universalistic biomedical and biotechnical interventions. This process of misdirection, either based on direct agency or following unconscious underlying values and logics of daily scientific praxis in specific epistemic communities, simultaneously forges the scope, meaning and form of further research and intervention.

A crucial component of this misdirection process is the global standardization of intervention methodologies operating independent of local social contexts and the perceived impossibility of 'localizing' such interventions. This conviction requires – and is simultaneously supported by – the production of decontextualized evidence by methodologies that exclude social variability and

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complexity. This circular system of knowledge production hinges on measuring universally valid characteristics of an intervention with methodologies that aim to produce non-contextual evidence. As local social factors and social variation across settings are consequently not detected – as they are not measured – the adequacy of the universalistic characteristics of the intervention to the detriment of more context-specific applications are confirmed. Diverting attention away from social context and variability could be interpreted as a prerequisite for this universalist sleight of hand to work.

We start by briefly outlining the field of global malaria elimination and describe how it became increasingly driven by a set of specific scientific methodologies linked to globally standardized indicators. We will then present two concrete cases that illustrate the process through which social factors are excluded in studies applying standard methodologies and established research procedures to produce non-contextual metrics for the uptake of health interventions. We consequently analyse how and why some uses of specific standardized methodologies in malaria elimination research lead to the generation of *pseudo* outcomes as the measurements and conclusions are to some extent *real*, in their adherence to paradigmatically valid methodologies, but are, to some extent, *fake* as they remain empty of empirical significance, or are produced in ways that this significance cannot be assessed. We propose that it is the ambiguity inherent in the *pseudo* that allows consequent misdirection processes.

Malaria control and elimination

Malaria, a parasitic infection of red blood cells transmitted by female anopheles mosquitoes, is estimated to kill roughly 2000 people per day, most of whom are children in Africa (Bhatt et al., 2015). Malaria was once prevalent throughout much of the inhabited world, but has been eliminated from the USA and Canada, Europe, and Russia. Malaria prevalence resurged in tropical countries from the 1970s to the 1990s, related to a combination of relaxation of control efforts, increasing antimalarial drug resistance, and insecticide resistance in the mosquito vectors. Since then, prevalence has fallen again as a result of substantial increases in donor funding, improved control, and a resurrected enthusiasm for elimination and eradication (Packard, 2007). The increased deployment of insecticide-treated bed nets (protecting users from infected mosquito-bites) and increased availability of effective artemisinin-combination therapies (Bhatt et al., 2015) in combination with the wide-spread availability of rapid diagnostic tests are largely responsible for the decrease in global morbidity and mortality. The analysis of the 2017 WHO World Malaria Report, however, suggests a reverse trend, indicating a newly increasing malaria burden between 2014 and 2016.

An essential component in malaria control has been to avoid human contact with malaria vectors, which can be achieved through a variety of interventions such as the distribution of bed nets, topical and spatial repellents, eve nets, and insecticide treated curtains or clothing (Killeen & Moore, 2012; Kimani, Vulule, Kuria, & Mugisha, 2006; Sluydts et al., 2016; Wilson, Chen-Hussey, James, Logan, & Lindsay, 2014). More so than any other intervention, it appears to have been the distribution of bed nets that has led to substantial reductions in malaria transmission worldwide. Bed nets have been shown to be by far the largest contributor (68% of cases averted) to the 40% reduction of *Plasmodium falciparum* infection prevalence in endemic Africa between 2000 and 2015 (Bhatt et al., 2015). While additional and innovative interventions/strategies are under evaluation to further reduce transmission as countries move towards malaria elimination goals, currently none of these are likely to match the impact of Insecticide-treated nets (ITNs) and Long-lasting insecticide-treated nets (LLINs).

Over time, malaria control and elimination have developed into a complex global field characterized by a mix of research initiatives and international partnerships engaging states, global organizations (e.g. WHO), philanthropic agencies, academia, nongovernmental organizations (NGOs), and the pharmaceutical industries. Not coincidentally, malaria control and elimination have also become increasingly driven by a set of specific measures of evaluation, often considered characteristic of technocratic and neoliberal approaches (Adams, 2010; Morse & Bell, 2011),

revolving largely around randomized controlled trials, the development of cross-national indicators and cost-effectiveness.

Global malaria research and the push towards indicators

Measuring and comparing progress towards malaria elimination, and the effectiveness of current control measures, to a large extent depends on the use of indicators (Gerrets, 2015). There are different but interrelated reasons for their appeal, both in the malaria field and more generally in the field of global health (Davis & Fisher, 2012; Gerrets, 2015). A first factor is the growth of cross-national research and surveillance, which has spurred the demand for malaria indicators. Malaria researchers typically work in a global health context and shape their data according to a world-wide standardized 'information infrastructure' (Bowker & Star, 1999) that is built around an array of globally used malaria indicators and measures. Indicators are a crucial part of this information structure because they function as a means of commensuration, which means they engender comparability of heterogeneous units through disregarding non-quantifiable as well as many quantifiable characteristics (Espeland & Stevens, 1998). By developing numerical representations of complex phenomena, globally standardized indicators simplify unwieldy masses of information (reducing complexity) and facilitate scientific communication over distance. Indicators render complex phenomena more simple, assessable and comparable with other complex phenomena that have also been represented numerically. Commensuration thus enables the comparison of different medical interventions and the diffusion of new models or solutions across settings/countries. It allows cross-national and even global comparisons of the effect and cost-effectiveness of different interventions (or models, solutions or policy decisions) in research settings or in public health practice.

A second and related reason is that global indicators cater well to policy makers in the field of disease control. Indicators allow monitoring progress towards disease control/elimination targets over time in specific geographical areas. The systematic international comparative analysis of interventions and policy schemes provides scripts for control and elimination policies and can promote mutual learning between partners. More broadly, malaria indicators are believed to enhance the rationality of malaria policies by providing a more generalizable, robust, and reliable information base (Biehl & Petryna, 2013).

A third reason why indicators in malaria control are considered fruitful is that they contribute to the funding and the evaluation of disease control policies. Malaria indicators have proliferated with performance-based financing systems to provide accountability to funders. Financial support for research and innovation involves risk, and addressing that risk demands calculation. To overcome the uncertainty inherent in research, providers of financial investment are keen on neatly delineated and calculable problems (Adams, 2016; Erikson, 2012). When they rely on quantitative data, donors can evaluate the financial performance of a potential health solution and be convinced that the risks associated with their 'investment' decisions are worth taking (Erikson, 2015). This development has propelled the spread of results-based financing, cost-benefit analyses and various monitoring and evaluation procedures (Adams, 2016; Rottenburg, Merry, Park, & Mugler, 2015).

As malaria researchers work in a global context, they usually shape their abstractions, objectifications, quantifications and categorizations of the world so that they conform to the standardized information infrastructure of global malaria indicators. To that end, they must try to transcend specific contexts by describing what they see in codes and categories of globally standardized numbers. Global standardization is manifested throughout the whole malaria research process, from the configuration and programming of the equipment, to the strict procedures for setting up Randomized Controlled Trials to the codes for analysing the material. The cut-off points for determining the amount of parasitemia that classifies as a severe or mild malaria infection, for example, like most data about malaria, are concrete products of this kind of medico-technical process of standardized commensuration.

Notwithstanding the important advantages to this quantitative indicator-driven approach, scholarly literature has already laid bare some of its significant political and epistemological disadvantages. The drive to produce standardized, decontextualized numerical data discredits insights from experiential epistemologies and outsources large parts of national health systems to transnational consortia of experts (Lorway, 2017). Whilst the response to global donor's data demands has led to ever more sophisticated surveys, models and indicators, it has also eclipsed the building up of much needed national health information systems (Storeng & Béhague, 2017). At the same time, the move to accountability and performance-based financing has focused health care interventions on the production of measurable results as an end in and of themselves, sometimes at the expense of effective prevention measures (Fan, 2017). In this article we'll predominantly focus on how the production of globally standardized metrics occludes the complexities of malaria elimination and diverts attention away from insights and measures that do not match this global information infrastructure. Crucial in this process is the production of decontextualized evidence by methodologies that exclude social variability. By shaping research to fit with the demands of large-scale numerical indicators. one necessarily loses sight of some level of heterogeneity of contexts in which malaria transmission, prevention, control and treatment take place.

The cases presented below question to what extent these measurements, and the related omission of social factors, are still empirically meaningful to the contexts they represent.

Exemplary cases

Case 1: slash-and-burn farming and human mobility in Vietnam

A baseline malariometric survey was conducted in the context of a community-based cluster-randomized trial on long-lasting insecticidal hammock nets to reduce malaria transmission in a forest malaria setting among the *Ra-glai* minority in South-Central Vietnam. Bed net use was estimated at 86% based on the response to the question 'did you use a bed net last night?'. Nevertheless, malaria prevalence and incidence remained high and epidemiologists identified being *Ra-glai* – or part of the ethnic minority population- as a risk factor for malaria even when controlling for potential confounding factors. Consequent ethnographic research revealed that *Ra-glai* slash-and-burn farmers combined living in government supported villages along the road with a second home or shelter at their slash-and-burn fields in the forest to meet work requirements during the labour intensive (malaria transmission) rainy season. Traditionally the *Ra-glai* lived in villages located in forested mountainous areas, now referred to as *lang cu* (i.e. old village). Over the past decades they were resettled by the government to the lower valleys and moved to the 'new villages' or *lang moi* where each family was provided with a brick house and a plot of land for sedimentary agriculture. While during the dry season the farming workload diminishes and activities shift to the 'official' villages, the most important activity during the rainy season is slash-and-burn farming on fields in the forest where there is a three times higher risk of infection with plasmodium (Erhart et al., 2004). *Ra-glai* families spend nights at their fields because, among other factors, they lose less time traveling between their houses and fields; are able to safeguard their harvests from rodents, cattle and other animals; and, have better access to the forest for gathering forest produce and hunting. Further research, combining epidemiology and medical anthropology, led to the incorporation of previously unmeasured dimensions, such as place of residence during the malaria transmission season (Peeters Grietens et al., 2012). This revised operationalization of the concept in a subsequent malariometric survey – among the same population during the same season – incorporating specific questions on bed net use at slash-and-burn fields and at government supported villages, led to the estimates of the population routinely protected by bed nets at night dropping by half. Although reported bed net use in the village remained consistently high in both surveys, only 53% of participants stated to use a bed net at their farms and consistent bed net

use at both locations was 42% (Peeters Grietens et al., 2012), as compared to the initially estimated 86%.

Case 2: topical repellents' 'use'- fulness for public health

The efficacy of topical repellents in addition to long-lasting insecticidal nets in controlling malaria in a low-endemic setting was assessed in cluster-randomized trial in the 117 most endemic villages in Ratanakiri province, Cambodia. All selected clusters received one long-lasting insecticidal net per individual, and topical repellents (picaridin KBR3023, SC Johnson, Racine, WI, USA) were distributed in the intervention group, along with instruction and promotion of its daily use (Sluydts et al., 2016). 'Compliance' was a key aspect of the trial as sufficient numbers of actual users were required to allow for a successful trial outcome. As part of the malariometric surveys of the trial, the trial epidemiologists assessed 'daily repellent use' using the question 'did you use the repellent on the skin yesterday'. Respectively 71.7% and 69.1% of the population in both years of the intervention stated having done so (Gryseels, Uk, et al., 2015). As anthropologists working in the trial, we also confirmed these reported user rates in an independent cross-sectional survey, in which 73.3% of respondents stated having used the repellent the day prior to the interview, based on the same question to assess use (Gryseels, Uk, et al., 2015). However, our ethnographic research showed that '[r]epellent use depended on a combination and convergence of location, time (i.e. seasonality and economic and livelihood activities), level of insect nuisance, age and gender (…)' (Gryseels, Uk, et al., 2015). Hence, we operationalized 'daily repellent use' differently in our anthropological work, including the differential regularity of use across place and time. These changes in operationalization allowed us to assess consistency of answers to various questions in the survey, which reduced self-reported user percentages from 70% to 30%. Given high levels of suspected response bias, we also conducted an additional structured observation component, leading to 7.9% of individuals observed to have used the repellent on the evening of the survey, another indication of daily use (Gryseels, Uk, et al., 2015). In the end, the trial did not show any reduction in malaria prevalence in the intervention clusters, leading to the conclusion that topical repellents are not useful tools for malaria elimination strategies (Sluydts et al., 2016).

Pseudo and science

The above cases illustrate how the re-introduction of social contextual specificities in the uptake of health interventions can radically change the estimates produced (from 86% to 42% in bed net protection when including human mobility; from 70% to 8% daily repellent use when integrating usage patterns and ways of limiting social desirability bias). The inherent variability of the biosocial world and its contextual complexity exposes our concern that certain types of indicator-driven research are not necessarily capable of measuring and reflecting local and social empirical realities, questioning the aggregation, equivalence and comparability of these indicators across settings.

In the Vietnam case, we aim to measure the extent to which bed nets protect people from biting vectors (i) while sleeping (or resting in bed) (ii) at night. Measuring this protection, however, is not straightforward. Concepts such as 'bednet protection' cannot directly or routinely be observed, and therefore have to be inferred. Defining the theoretical concept and its transformation into concrete, observable, and measurable factors (i.e. its operationalization) is an implicit process used when posing the indicator-driven survey question 'did you sleep under a bed net last night?'. The question 'did you sleep under a bed net last night?' is commonly used in epidemiological research, clinical trials, malaria-indicator surveys and other standardized measurement tools to assess this 'bednet protection'. However, the question remains as to how far this particular operationalization actually reflects empirical reality and whether it is adequate to assess potential existing variation in actual protection offered by nets, first *in* (contextual specificities) and, second, *across* settings (in relation to equivalence) (for more detail on the theory on measurement error, see (Adcock, 2001). Examples abound in qualitative and structured observational research about

how standard bed net measurements fail to account for local variation, such as the alternation between different types of nets offering differential protection (Gryseels, Durnez, et al., 2015; Peeters Grietens et al., 2013); human resting behaviour and outdoor sleeping (Gryseels et al., 2015; Monroe et al., 2015); and, frequent entering and exiting of bed nets (Harvey, Lam, Martin, & Paredes Olórtegui, 2017). In this last case, the question 'did you sleep under a bed net last night?' was not equivalent to its simple variant 'did you sleep under a bed net *the whole night* last night?' (our emphasis) (Harvey et al., 2017). It is hard not to get the impression that whenever someone looks closer, bed net use is *consistently* inconsistent. The radical abstraction and exclusion of social contextual specificities and variability in standardized measurements in relation to the 'traveling' of the concrete question 'did you sleep under a bed net last night?' across study designs, research and implementation, and social contexts leads to *pseudo* outcomes as the logic of comparability is pushed to such an extreme we really do not know what is being measured anymore.

The topical repellent case further confirms how reintroducing social context and variability into the operationalization of measurements on the uptake of health interventions leads to radically different (from 70% to 8% daily repellent use) and otherwise unmeasured outcomes. In addition, the case illustrates a second path to the *pseudo* when excluding key social parameters in the presentation and comparison of results across study contexts. As no impact of the intervention could be measured in this particular setting and study, the researchers concluded that mass distribution of topical repellents in addition to long-lasting insecticidal nets has '*no public health value*' in general – or '*has no added public health value in preventing malaria in low endemic countries from the Greater Mekong sub-region*' (Sluydts et al., 2016). In this case, the chosen evaluation's methodological requirements do not allow for a causal link to be made between human behavior and the primary outcome of the trial. The context of the study population's low use of repellents and underlying sociocultural logics is therefore removed from the trial outcome, making the decontextualized and empirically empty abstraction 'repellents do not work' transferable to other settings.

This evidence, however, cannot be fully supported because the specificities of the study site and population are not represented in relation to the use of repellents, or in the uptake of the intervention as a malaria elimination strategy; nor are these specificities accounted for in other potential settings. Since no information on contextual specificity is provided, user rates of repellents and other outcomes cannot be directly compared and hence no comparable measures with other repellent studies exist. This particular study was carried out in a border province that is geographically and politically located at the fringes of the nation-state (both on the Cambodian and Vietnamese sides of the border). The local population is almost exclusively composed of ethnic minority groups whose subsistence derives from slash-and-burn farming on plots located near or in the forest and, less frequently, on wet rice fields (Gryseels, Uk, et al., 2015; Peeters Grietens et al., 2015). The ethnic minority context (reflected in the historical difficulties between majority Khmer and minority groups, doctor-patient interactions, access to care, geo-political factors, resistance to state interventions, etc.) and the slash-and-burn setting, for example, directly relate to the uptake of the intervention and make the results on repellent uptake *a priori* un-generalizable to other low endemic areas of Cambodia and less so the Greater Mekong Subregion, even when considering epidemiological factors such as vector types, vector biting rates, and stratification of transmission intensity. Hence, such study and case-specific results cannot simply provide direct 'evidence' for 'general' malaria elimination strategies without, at least, further theorization. Interestingly, in epidemiological studies, clinical trials and quantitative studies more generally, strict mechanisms are in place to see which results are 'generalizable' from samples to study populations, or how to measure a potential difference between two samples or populations (e.g. intervention/control). However, once context-specific results are presented, they are re-presented as universal realities or are considered at least immediately applicable in larger indiscriminate areas (e.g. the Greater Mekong Subregion; Sub-Saharan Africa) without reflection on the conditions under which this knowledge was produced and whether it can or cannot be reproduced, under what circumstances

the proposed theory holds or not or can be transferred to other contexts. It is, nevertheless, 'the researcher's responsibility to paint a full picture of the context and then allow the reader to determine if the work is transferable to their context' (Jensen, 2008). This sleight of hand renders locally-specific recommendations and implications for policy universalistic, isolating them from their social and cultural context and converting them into *pseudo* outcomes, somewhere on the line of real and fake, as we can no longer fully assess what they are worth as we have lost sight of the local variation it obscures. This universalization process, however, often forms the basis for further research and for policy decision-making that have direct effects for the globalized malaria elimination efforts.

Ignorance or surprise

Interestingly, despite the relatively general acknowledgement of high levels of bias in survey research on bed net use, for example, and the qualitative and limited quantitative evidence on social variability and its relevance to determine the uptake of health interventions in peer-reviewed literature, this has *not* sparked a general discussion on the validity of measurements; theoretical validity of the concepts; how to improve measurements in and across settings and other data quality concerns. This raises the question of why these aspects are still somehow in the margins of the paradigm. In the chapter of his book 'Ignorance and Surprise' called '*More Questions Than Answers: The Case of Malaria Control*', Matthias Gross specifies how after the failure of the first attempts at eradication (1950s) a whole new sets of crucial 'unknowns' emerged that had not been taken into consideration (Gross, 2010). 'Scientists were unclear about how to proceed since exact knowledge about what was not known (what I [the author] have called nonknowledge) was not available. It took a few years before this ignorance was specified … so that it could be qualified as nonknowledge and used for future planning' (Gross, 2010). Examples of such specific knowledge about what was not known were the fact that malaria parasites had become resistant to malaria drugs, and the consequences of malaria control and treatment measures on natural immunity. These unknowns were then integrated into research, planning and implementation for further progress in malaria control. Gross continues to outline that proceeding in spite of non-knowledge is part of the malaria elimination strategy. It is clear, in the same way Gross discusses for ecological transformation, that the push for malaria elimination has, as a goal, continuity, in spite of non-knowledge. The endeavor is 'causally dependent on a clearly stated "negligence" that allows side effects to happen' (Gross, 2010). As Gross points out, 'the strategy is to continue even though the risks cannot be known before implementation' (p. 68). Current examples of these side effects are parasite resistance to antimalarial drugs and mosquito resistance to pesticides, increasing donor-fatigue (Shretta et al. 2017) or population resistance to interventions (Scott, Dove, Jonsson, & Aung-Thwin, 2011). Scientists also believe in malaria progress despite 'nescience' (Gross, 2010) (i.e. we are unaware of what we don't know). We hypothesize that for many malariologists how to deal with social context and complexity constitutes a form of nescience or of nonknowledge that is accepted in order to proceed. However, alternatively, the lack of recognition and/or willingness to invest (financially, scientifically) in recognizing social variability and the localization of interventions could be interpreted as what Gross terms 'negative knowledge' or 'the active consideration that to think further in a certain direction will be unimportant' (Gross, 2010) or 'even dangerous' (p. 68).

Towards misdirection

In the malaria world, current standardized approaches (i.e. survey research in epidemiology and surveillance such as Malaria Indicator Surveys), following the outlined operationalization, often show high use of bed nets, which – in turn- has led to a perceived *universal coverage* with bed nets in many malaria-endemic settings. The 'target' of *universal coverage*, following the WHO (WHO, 2013), is defined by two indicators: (i) the percentage of people who have access to LLINs in the household

(assuming that one LLIN covers two persons); and (ii) the percentage of people reporting to have slept under an LLIN the previous night. The WHO defines 'operational success (as opposed to a target of 100% coverage) as the observation in surveys of at least 80% coverage in terms of these indicators' (WHO, 2013). The combination of two non-contextualized criteria therefore determines *universal coverage*: 80% of people having one LLIN for two people – regardless of social contextual specificity such as household composition and sleeping patterns (who sleeps with who), intra-household access (who has access to available nets) – and, 80% of people stating in quantitative surveys having used the net the night before. Mediated by the concept of *universal coverage*, the scores on the question 'did you sleep under a bed net last night?' have now become key to defining people's protection from infected vectors and the operational success of bed net campaigns. However, in contexts where these percentages are likely to be inaccurate, the assumed protection and potential maximum reduction in malaria transmission that could be feasibly achieved with nets is likely to be misrepresented, as can be preliminary conclusions on local malaria transmission dynamics. In addition, in perceived contexts of universal coverage, researchers attribute persisting malaria to transmission occurring at times, places and during human activities that are not covered by bed nets or can be tackled with Indoor Residual Spraying i.e. the so-defined 'residual' transmission. Persistent transmission, however, might be due to a combination of early and outdoor biting, night-time transmission when people are awake and outdoors for social or economic activities (which cannot be addressed by bed nets), and by the now – by definition- ignored inconsistent or lack of bed net use at night.

Despite the limited accuracy of net coverage data, it is still used to provide key information for modelling purposes and cost-benefit analyses of existing and newly developed additional control interventions (such as vaccines). In addition, it determines shifts in research priorities and defines the non-contextual *nature* of strategies for further malaria control and elimination. In other words, it re-confirms the success of and need for 'universal' interventions for increasingly localized malaria. Consequently, when no further progress is expected with a specific universal research and intervention approach (e.g. malaria control and prevention using bed nets under universal coverage assumptions), priorities are shifted towards other and new universal medical and biotechnical interventions (e.g. malaria eradication using vaccines, mass drug administration, spatial repellents and/or attractants). Importantly, this move side-lines alternative localizable plausible solutions within the medical-technological field (e.g. adapting bed nets to user preferences) or outside of this field in collaboration with other disciplines or sectors (e.g. efforts to increase bed net use by people at risk, implementation research and/or participatory and formative approaches; creating a 'net culture'; and, at policy level, multi-sectoral approaches, e.g. improvements in housing structure, water and sanitation, tourism, etc). We consider this a misdirection process, and a way to define the boundaries of the current paradigm. Following Kuhn (Kuhn, 1970), the ruling paradigm – encompassing the whole of techniques, patents and values shared by the members of the scientific community – defines 'normal science', or the science which can decide if a certain problem will be considered scientific or not and how to deal with it methodologically. Scientific questions and methods from outside this paradigm will be ignored until the paradigm 'shifts'.

Real trials and tribulations: conclusions

As malariologists work in a global context, they largely shape their representations of the malaria world to conform to the globally standardized information infrastructure. To that end, they transcend specific contexts by describing what they see in codes and categories of globally standardized numbers. However, there are serious challenges matching the global to the local. The cases presented on the evaluation on malaria control strategies aim to illustrate the *tension* between the requirement of comparable and globally standardized data and the validity of the measures produced in relation to the empirical realities they aim to reflect. As a concrete example, the unmeasured unreliability of standard measurements of net use in specific settings allow the conclusion that in most contexts universal coverage has been achieved and that hence new additional universalist solutions need to be

found. The misdirection process described in this manuscript renders the findings, and their underlying assumptions, at once real and fake by 'directing' people's attention to the scientific facts constructed by particular approaches, while hiding others. Importantly, these data practices are *real* in their fidelity to disciplinary procedures but to some extent *fake* in their fidelity to empirical reality. The *pseudo* hence creates the ambiguity that facilitates processes of misdirection. In agreement with Vincanne Adams (Adams, 2016), in the contexts we have described '[g]etting the empirical facts needed for metrics may entail a kind of violence to the empirical truths they aim to produce' (p. 226) raising the question of 'what do we do when we start to treat fidelity to our research method as evidence of success even when this means compromising good care or empirical evidence on the contrary?' (p. 226). Indeed, what we have often observed in scientific practice is that the fidelity to standard operating procedures is perceived as a better indicator of quality than the fidelity to empirical reality.

Improving measurement of indicators in relation to the uptake of malaria preventive measures, including more context-sensitive operationalization with more attention for equivalence and risk of bias, could be a way forward. Following Adcock's (Adcock, 2001) general methodological discussion, we do not propose abandoning generality to the benefit of exclusively context-specific measurements, but we propose that greater context sensitivity (attention to local variability) can contribute to developing measures that apply more effectively in and across contexts. Discussing potential 'breaks' in the universalist circle of measurement and implementation and including ways to incorporate local, social and cultural requirements in biotechnological innovation could be an additional option. This requires more awareness that indicators, despite the indirect acknowledgement of their limitations, produce realities beyond these limitations where they are perceived as 'true' values directly influencing policy decisions.

The described misdirection processes are reflected in the epistemic conventions, the study design and the methodological choices that precede and lead to the utilitarian operationalization of concepts. Uncritical endorsement of specific sectors, disciplines, and methods that better serve the purpose of obtaining anticipated results systematically pushes other methodologies and legitimate quality concerns in the margins (e.g. flexible emergent theory designs such as ethnography; analysis of systematic non-response, operationalization, equivalence). Inter- and transdisciplinary approaches could be applied to co-produce more accurate data and refine indicators, co-develop adequate evaluation and monitoring tools, and co-create systemic research for multi-sectoral approaches, strategies for generalisation, and data for policy (Michael & Madon, 2017). However, it is well known that building successful interdisciplinary collaborations hinges on many different factors such as institutional conditions established by funders, the general rules and organizational context for collaboration, the institutionalized expectations about collaborations, the degree to which experts are enabled to learn intellectual practices in neighbouring domains (e.g. analysis styles and disciplinary languages) and the role of metacognitive capacity in monitoring cross-disciplinary information processing within groups (Boix Mansilla, Lamont, & Sato, 2016). More work will be needed to tease out exactly how the institutional, cognitive and interactional preconditions of malaria research have to be changed so they can act as enabling factors for concrete research collaborations that are better attuned to the local variability and social complexity of malaria risk.

Disclosure statement

No potential conflict of interest was reported by the authors.

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