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Assessing scalability factors of a malaria intervention using Malakit and target drug administration among hard-to-reach populations: An original approach focusing on key stakeholders – implementers and decision-makers – in the Guiana shield

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ABSTRACT

Introduction: The Guiana Shield faces significant malaria challenges due to a mobile, hard-to-reach population involved in goldmining. Interventions like Malakit (self-testing and self-treatment kits), Targeted Drug Administration against *P. vivax*, or their combination, aim to combat malaria. These community-based interventions, evaluated in Brazil, French Guiana, and Suriname, show promising results and potential for scale-up. The research aimed to assess the scalability of these interventions by identifying and mapping stakeholders and doing a SWOT analysis for scale-up.

Methods: This pre-planning assessment, conducted from June 2023 to March 2024, involved a collaborative, participatory approach. The process included working sessions with the resource team, semi-structured interviews with stakeholders, and participant observation during formal meetings with stakeholders and the resource team. Field notes have been taken and deductive qualitative analysis has been made using the ExpandNet/WHO Framework. Data was used to design Mendelow's Matrix and SWOT analysis.

Results: Stakeholders were categorized into implementers, decision-makers, beneficiaries, and partners. Mendelow's matrix and SWOT analysis highlighted strengths like Malakit's effectiveness, while weaknesses included data gaps and regulatory challenges. Opportunities for scaling up were linked to malaria elimination initiatives in Brazil, French Guiana, and Suriname, while funding and regulatory issues posed threats.

Discussion and conclusion: Stakeholder analysis is crucial in scaling up public health interventions, identifying key contributors and challenges. Financial and regulatory barriers can hinder scalability, but political and epidemiological factors offer opportunities. Effective collaboration across countries, engaging stakeholders, and advocating for evidence-based decisions are essential for malaria elimination in Brazil, French Guiana, and Suriname.

1. Introduction

The Guiana Shield - a region located between Colombia, Venezuela, Guiana, Suriname, French Guiana and the Amazon region of Brazil is a major hotspot for malaria transmission in South America with *Plasmodium vivax* predominance [1,2]. The endeavor to eliminate malaria

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within the region presents considerable challenges because the predominant malaria reservoir consists of a mobile and hard-to-reach population [3,4]. This population mostly consists of Brazilians (95–98 %) working in artisanal and small-scale gold mining (ASGM) within the Amazon rainforest. Among the indigenous cases of malaria diagnosed in French Guiana in 2023, a third of the infections occurred mainly at gold-mining sites (33 %) [5]. The observational study conducted in 2015 at the border between French Guiana and Suriname found that 22.3 % (95 % CI [18.3–26.3], n = 94/421) of people involved in ASGM were infected and, of those, 84 % were asymptomatic [4]. A study based on the Brazilian Malaria Epidemiological Surveillance System data from 2003 to 2015 found at the Brazilian border with French Guiana that greatest number of malaria cases was diagnosed among people involved in ASGM [6]. This population lives in conditions of vulnerability and unfavorable health settings due to poor access to healthcare and exposure to zoonoses, vector-borne diseases including malaria, or heavy metal poisoning [7–10]. Moreover, this population exhibits circular migration patterns within the region, thereby sustaining cross-border malaria transmission. This migration thus leads to shared public health concerns among neighboring countries that face common challenges in setting up health cooperation initiatives and in reaching health objectives such as World Health Organization (WHO) E−2025 [11].

The WHO delineates that underserved populations in the malaria response, including migrants, are often marginalized from disease control efforts, leading to compromised healthcare access, limited malaria prevention initiatives, and constrained control services [12]. Thus, when considering mobile and hard-to-reach migrant populations, innovative strategies and global policies are crucial in addressing healthcare disparities, ensuring access to essential services, accelerating progress toward global malaria targets and facing malaria elimination challenges.

Recently, two interventions to fight malaria in the Guiana Shield region have been developed targeting people involved in ASGM: Malakit and Targeted Drug Administration (TDA) for *P. vivax* [13,14].

(i) Malakit Intervention is based on the distribution of kits for malaria self-testing and self-treatment – called “malakits” – containing Rapid Diagnostic Tests (RDTs), artemisinin-based combination therapy and paracetamol to be used in case of an episode of malaria-like symptoms while being in remote areas, far from health-services [13]. The distribution of malakits to individuals involved in ASGM follows specific training for their use [15].

(ii) TDA Intervention aims to reduce the transmission of the *P. vivax* preventing the typical relapses that can occur when the parasite is carried at the hypnozoite-stage in the liver of people affected by *P. vivax*. This is done offering presumptive treatment (a three-day course of chloroquine combined with a seven-day course of primaquine or a single dose of tafenoquine) to asymptomatic individuals who are considered at risk of carrying *P. vivax* hypnozoites (anyone reporting an episode of malaria within the previous year, or working in an area at risk of malaria transmission) [14].

Both interventions are community-based and are delivered by Community Health Workers (CHWs), who also provide health education about malaria to the target population at inclusion sites located in remote, logistical and resting areas for goldminers in Brazil and Suriname, mostly at the border with French Guiana [16,17].

The delivery of TDA and the distribution of malakits can also be combined. This association of interventions is currently evaluated in the Curema project, an international public health intervention research project involving institutions from Brazil, French Guiana, and Suriname [14]. The Malakit intervention alone was evaluated between 2018 and 2020 as a proper interventional research project (Malakit project) and showed an increase in compliance to malaria diagnosis before treatment uptake (from 54.2 % to 68.1 % OR = 1.8; 95 % CI [1.1–3.0]) and good acceptability among the target population [18,19]. The PCR-Plasmodium prevalence in the ASGM population decreased between from 22.3 % to 5.3 % in the Surinamese border and from 3.9 % to 2.5 % in the Brazilian one. Finally, when comparing the predicted number of malaria cases with and without Malakit intervention, a probable impact on malaria transmission was also shown with an acceleration of the decrease in malaria prevalence reaching the 43 %. Consequently, the Surinamese National Malaria Elimination Program integrated the intervention through a vertical scale-up consisting in the institutionalization of the innovative intervention strategy and its implementation at a sub-national level maintaining the same target population and almost the same number of inclusion sites of Malakit project [20,21]. Other countries have also expressed interest in adopting the intervention.

The WHO defines scale-up as the *deliberate efforts to increase the impact of health service innovations that have been successfully tested in pilot projects to benefit a larger number of people* and to support the development of policies and programs sustainably [22]. It is crucial to extend effective public health interventions and innovations to larger population groups, sites, or longer time frames to maximize their impact on health [23–25]. Planning for the potential future development of an intervention from the beginning of its implementation and assessing the scaling-up elements is also crucial to anticipate needs for the scaling-up process [26]. Pilot interventions are not always implemented at full scale; and, when it is done, effectiveness is often highly reduced in the field due to contextual factors and implementation gaps [27].

The Surinamese experience showed that collaboration between healthcare institutions, scientists, and communities is essential for a successful scaling-up process, highlighting the importance of continued collaborative efforts and stakeholders’ engagement in scaling-up innovations aiming at fighting malaria [20]. Building on the experience of the Malakit project, the Curema project’s design includes a participatory approach and active stakeholder involvement to facilitate scalability [14]. Thus, current discussions on a possible scale-up are ongoing in Brazil, French Guiana, and Suriname where the interventions are being tested.

Using an interactive approach, this pre-planning assessment aimed to investigate the scalability of Malakit and TDA interventions by identifying stakeholders, mapping their power and interest, and analyzing strengths, weaknesses, opportunities, and threats for a possible scale-up.

2. Materials and methods

This pre-planning assessment was a collaborative effort based on an interactive and participatory approach that involved both the resource team and the stakeholders (Fig. 1). It was conducted from June 2023 to March 2024 from the Hospital of Cayenne, French Guiana which is the sponsor of the research.

2.1. Participants in the pre-planning assessment

2.1.1. Resource team

The team coordinating at the central level the implementation of the Malakit and Curema research projects – including field projects coordinators and 3 out of 5 of the principal investigators – was considered the "Resource Team" and were affiliated with Department of Research, Innovation, and Public Health, Cayenne Hospital. The team had research expertise and several members were affiliated with academic institutions. During the pre-planning assessment, the team consisted of seven members with diverse health backgrounds and from three different countries.

2.1.2. Stakeholders

Stakeholders were defined following the historical definition as “*Any*

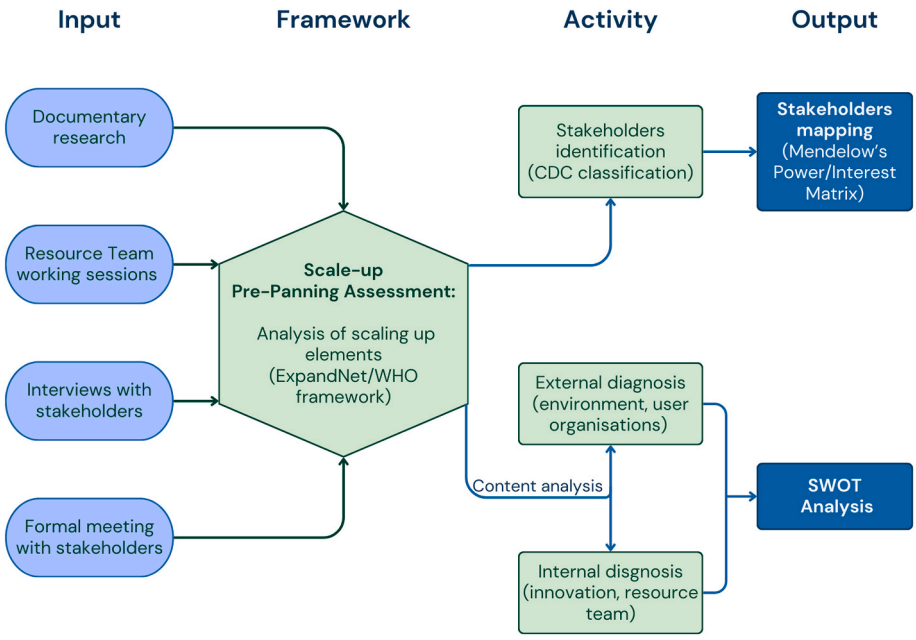

Fig. 1. Outline of the methodology used for the pre-planning assessment.

group or individual who can affect or is affected by the achievements of the organization's objective" [28]. Stakeholders can be related to the intervention outcome, in positive or negative ways, with high or low influence on it.

The criteria for identifying the stakeholders were.

(i) Having already been identified as a stakeholder for the Malakit or Curema research projects.

or.

(ii) Being defined as a stakeholder for Malakit or TDA Intervention scale-up following the definition [28].

The identification process involved three steps: firstly, the present article's first author conducted individual documentary research and created a preliminary list; then, the other members of the resource team expanded the list during the working sessions; and finally, the stakeholders interviewed suggested additional potential stakeholders. Stakeholders were categorized based on their role in the projects using the CDC classification [29].

- *Implementers*: Those directly involved in the implementation of the scaling-up process
- *Decision-makers*: Those in a position to do or decide something that could enable or prevent the scale-up
- *Beneficiaries*: Those being served or affected by the scaling-up
- *Partners:* Those who can actively support and/or invest in the scaling-up process

2.2. Working sessions

2.2.1. Resource team working sessions

In July and August 2023, two working sessions were held with the resource team. During the first session, individual interviews were conducted to identify stakeholders and collect relevant information. Detailed notes and quotations were transcribed during the interviews. During the second session, collective, team members were asked to map stakeholders using a collaborative worksheet representing Mendelow's matrix. The sessions were held in French or English, based on team members' preferences.

2.2.2. Interviews with stakeholders

In August and September 2023, face-to-face interviews were conducted with selected stakeholders according to the following criteria: i) speaking French or English (convenient, based on participant request); ii) being considered as having power according to Mendelow's classification to prioritize the full involvement of *promoters* in decision-making and to enhance the interest and participation of *latents* (cf. subsection 2.3.2 for definitions). The semi-structured interview guide - developed using ExpandNet WHO Framework for scaling-up processes [30] - allowed to gather data from stakeholders: their power and interest in scaling up Malakit and TDA interventions, and their perspectives on strengths, weaknesses, opportunities, and threats. Detailed notes of the interviews were taken and quotations were transcribed.

2.2.3. Formal meetings with stakeholders

From August to October 2023, four organizations, including two health authorities from different countries and two potential user organizations, participated in six formal meetings with the resource team on the project scalability and transferability. They were: the Brazilian Ministry of Health (MoH); the Regional Health Agency (RHA) of French Guiana; Delocalized Prevention and Care Centers (CDPS) of Cayenne Hospital, French Guiana; and the French Red Cross, section from French Guiana. Participant observation was conducted, and detailed notes and quotations were transcribed during these meetings.

2.3. Tools for results analysis

2.3.1. Content analysis

Qualitative analysis of field notes from stakeholders' interviews and formal meeting was deductive, based on the ExpandNet WHO Framework for scaling-up processes. Items describing the elements of scaling-up were used for the coding: "Environment" including as a sub-item "Policy/politics", "Bureaucracy", "health sector", "Socioeconomic/cultural context", "People's needs and rights"; "Innovation"; "Resource team", "User organization(s)". For each item, data were classified in two categories if considered as scalability levers or obstacles. The coding was done manually with the assistance of Microsoft Excel 365 [30].

To ensure quality, the assessment adheres to the Consolidated

Criteria for Reporting Qualitative Research (COREQ) [31].

2.3.2. Mapping of stakeholders: Mendelow's 2x2 power/interest matrices

We used Mendelow's 2x2 Power/Interest Matrix to analyze the stakeholders' power and interest in scaling-up the proposed interventions [32]. Members of the resource team and participants interviewed were involved in this mapping activity. "Power" refers to their ability to influence organizational strategy or scale-up resources, while "interest" pertains to the attention given to scalability success. Participants were acquainted with the definitions of the terms "power" and "interest" and asked to grade stakeholders according to these two dimensions. Matrices were drawn up for each country concerned and for each intervention, yielding a total of six matrices. Each stakeholder was positioned on each of the country-intervention matrices according to their power and interest. To validate the stakeholder maps created, the article's first author verified the achievement of a consensus regarding stakeholders' positions by bilateral meeting with the participants on the activity and using the information collected through stakeholder interviews and meetings.

According to Mendelow's model theory, the grid position assigned to a stakeholder provides recommendations to the appropriate actions that should be taken with them enabling the resource team to tailor an advocacy and strategic action plan to achieve a scale-up: *Promoters* (high power and high interest) = *Coproduction*; *Latent* (high power, low interest) = *Consultation; Defenders* (low power, high interest) = *Collaboration; Apathetic* (low power, low interest) = *Communication* [32–34].

2.3.3. Analyzing strengths, weaknesses, opportunities, and threats: SWOT matrices

Based on documentary research conducted from June 2023 to March 2024 and on the content analysis of field notes, a SWOT analysis was carried out to identify the strengths, weaknesses, opportunities, and threats for the scaling-up efforts in each country and for each intervention (Malakit and TDA) experimented within the Curema project. The ExpandNet/WHO Framework was employed to explore the elements of scaling-up and develop internal and external diagnoses for SWOT analysis. These diagnoses were based on the assessment of "Innovation" and "Resource team" vs "User organization(s)" and "Environment" elements, respectively.

2.4. Ethics

The Curema protocol was approved by the ethics committees of the countries involved in the project (Brazil: CONEP:5,507,241 and Suriname: CMWO05/22). This research is part of the secondary objectives of the Curema protocol: "assess facilitating factors as well as barriers to delivering such an intervention in a pre-elimination setting and community involvement to be taken into account for further implementation". According to article R1121-1 of the French Code of Public Health, the regulatory classification of this evaluation is "research not involving the human being" (outside the scope of the Jardé Law). An oral information was given.

Data collected were recorded under French law and the European Union General Data Protection Regulation and field notes were anonymized.

3. Results

From June 2023 to October 2023, a total of 23 participants (Table 1) were involved in at least one of the working sessions, as follows: six members of the resource team, four stakeholders from potential user organizations (CDPS and French Red Cross), ten stakeholders from regulatory, strategic and political authorities (Brazilian and Surinamese MoH and RHA of French Guiana), two stakeholders from international organizations (WHO/PAHO), a stakeholder from a Research Institute (Fiocruz).

The working sessions included five interviews with members of the resource team, a group activity proposed to the whole resource team, six face-to-face semi-structured interviews with stakeholders lasting up to 60 min and conducted in English or French, and six formal meetings with stakeholders from various organizations and countries.

3.1. Identified stakeholders

A diverse array of stakeholders from various sectors such as politics, epidemiology, public health, healthcare, civil society organizations, etc., were identified to be involved in the scaling up of Malakit and TDA interventions. They were grouped into implementers, decision-makers, beneficiaries, and partners such as funders, academics, research institutes, technical experts, government officials, and representatives of other sectors (Table 2).

3.2. Mendelow's matrices

A total of six Mendelow's matrices were developed to represent interest and power in each country and for each intervention (Fig. 2). Based on their position in the matrix, stakeholders were classified into the four groups ("promoter", "latent", "defender", and "apathetic"). Similarities were found among the three countries.

Generally, regulatory, strategic, and political authorities were found to have high power and interest in the potential scale-up of both interventions, while user organizations and beneficiaries varied in their

Table 1
Participants' characteristics (N = 23).

		Resource team working session (N = 6)	Semi-structured interviews (N = 6)	Formal meetings (N = 15)
Country	**Brazil**	0	0	7
	French Guiana (France)	6	2	8
	Suriname	0	2	0
	Supranational	0	2	0
Gender	**Male**	1	2	5
Occupation	**Research**	6	0	3
	Healthcare	0	0	4
	Regulatory, strategic and political authorities	0	4	8
	International Organizations	0	2	0
Involvement in Malakit research project implementation	**Yes**	3	2	2
Involvement in Curema research project implementation	**Yes**	6	2	2
Involvement in the previous Malakit scale-up in Suriname	**Yes**	3	2	1

Table 2
Stakeholders classification per type and per country.

		Brazil	French Guiana	Suriname
Implementers	Resource Team	Malakit- Curema Research Team – DRISP CHC		
	User Organization(s)	NGO *DPAC fronteira*, Brazilian Malaria Control Program	French Red Cross, CDPS, Armed Forces Health Service (AFHS)	Surinamese Malaria Program
Decision-makers		Brazilian Ministry of Health (MoH), Health Surveillance Secretariat (SVS), Brazilian Malaria Control Program, Special Indigenous Health District (DSEI)	French Ministry of Health (MoH), Regional Health Agency (RHA) of French Guiana	Surinamese Ministry of Health (MoH), Surinamese Malaria Program
Beneficiaries		People involved in ASGM, Indigenous populations, General population		
		Army and military		
Partners	**Funders**	WHO (E2030)	WHO (E2025)	
		Brazilian MoH, PAHO, WHO Special Program for Research and Training in Tropical Diseases (TDR)	European Union (EU), French MoH, Departmental Council of French Guiana (*Collectivité Territoriale de Guyane*- CTG), European Amazon Interregional Cooperation Program (PICIA)- EU,	Suriname MoH, PAHO, Global Fund (GF), WHO Special Program for Research and Training in Tropical Diseases (TDR), Bill & Melinda Gates Foundation (BMGF), Clinton Health Access Initiative (CHAI), Program for Appropriate Technology in Health (PATH)
	Academic and research institutes	Amapá Federal University (UNIFAP), Fiocruz	Cayenne Hospital (CHC), Pasteur Institute, French Public Health Agency (SPF), University of French Guiana	SWOS
	Technical expertise	World Health Organization (WHO), Pan American Health Organization (PAHO)		
				Malaria Elimination Taskforce (MET)
	Government officials and representatives of other sectors	State of Amapá, Municipality of Oiapoque	French Ministry of Europe and Foreign Affairs, French Ministry of the Armed Forces, French Development Agency, AFD Cayenne	

Acronyms: Cayenne Hospital Center (CHC), Delocalized Prevention and Care Centers (CDPS), Research, Public Health, and Innovations Department (DRISP), the Foundation for Scientific Research in Suriname (SWOS), the Oswaldo Cruz Foundation of Rio de Janeiro (Fiocruz), Association for Development, Accompaniment, Animation, and Cooperation (DPAC Fronteira). Stakeholders taking part in the reflections concerning the pre-planning assessment are underlined in the table above.

levels of interest. Depending on the countries, some differences were found in the levels of interest for certain stakeholders across the interventions as reported below.

Possible user organizations varied across countries due to the healthcare system and were classified as defenders or promoters depending on their nature: in Brazil and Suriname, the National Malaria Programs were identified as the user organizations and classified as promoters; whereas in French Guiana the user organizations identified as possible field implementers were NGOs or healthcare structures – thus organizations external from health authorities - classified as defenders. Beneficiaries had different levels of interest and could be either defender or latent: the intervention target population had more interest than the distal beneficiaries such as the indigenous or general population. Partners, such as technical experts and grant providers, had a large amount of power for influence, although their interest was variable.

In this pre-planning assessment, no differences were found between Mendelow's matrices for the Malakit vs TDA interventions for Brazil. Instead, differences were pointed out in the interest level for the RHA and the MoH for French Guiana with a higher interest for Malakit vs TDA intervention. For Suriname, like Brazil, there were no substantial differences between Mendelow's matrices for both interventions, except for grants providers and international organizations, which showed a higher level of interest for Malakit.

3.3. SWOT analysis results

The findings of the SWOT analysis are illustrated in Table 3.

Strengths and weaknesses were similar across countries and interventions, whereas opportunities and threats depended on contextual changes in environmental analysis.

The Malakit intervention had already been evaluated as effective in the context of the research project and well accepted by the target population, which represents the major strength of its scalability. However, a major weakness is the lack of a reliable estimation of cost-effectiveness. A point of caution often made by various stakeholders was that malakit is an effective tool to target hard-to reach populations, but that it should not be used as a method to solve health system shortcomings in certain areas.

> *"Malakit can be an interesting tool, but its scale-up must be limited to the specific context of gold miners who are far from the health care system. It cannot be the only tool in the fight against malaria. It is needed where there is no access to the health care system, and where a method of providing health care is not feasible."* (Field note from semi-structured interview)

The TDA intervention was designed to address the current epidemiological situation – with a predominance of malaria cases by *P. vivax* – representing an important strength. Nevertheless, the Curema project is still ongoing. Consequently, the effectiveness of the intervention is not yet known. The current lack of certain and validated results left stakeholders uncertain about whether to support or oppose this intervention scale-up and to express a defined opinion.

> *"It is important to check the results of this intervention, for the scaling-up it is necessary to wait for the evaluation. Especially due to ethical concerns: providing treatment [tafenoquine] with significant side effects to someone that you don't know to be ill or not."* (Field notes from semi-structured interview)

In case of a potential scale-up in the three countries, concerns regarding adaptations and regional coordination were raised:

> *"How to adapt the kits and the infographics in the three countries depends on the different suppliers in each country. But, we must avoid confusion to avoid loss of effectiveness - so standard kits?, standard visuals? - Therefore, the need for a consortium: a cross-cutting steering committee that can manage the scaling-up in the three countries as support and back-up for the different user organizations in charge of implementation in the field."* (field note from resource team interview)

Beyond the scalability of these interventions, the lack of formal institutional collaboration on the fight against malaria, especially at the regional level, despite bilateral efforts, remained a major threat mentioned by several respondents:

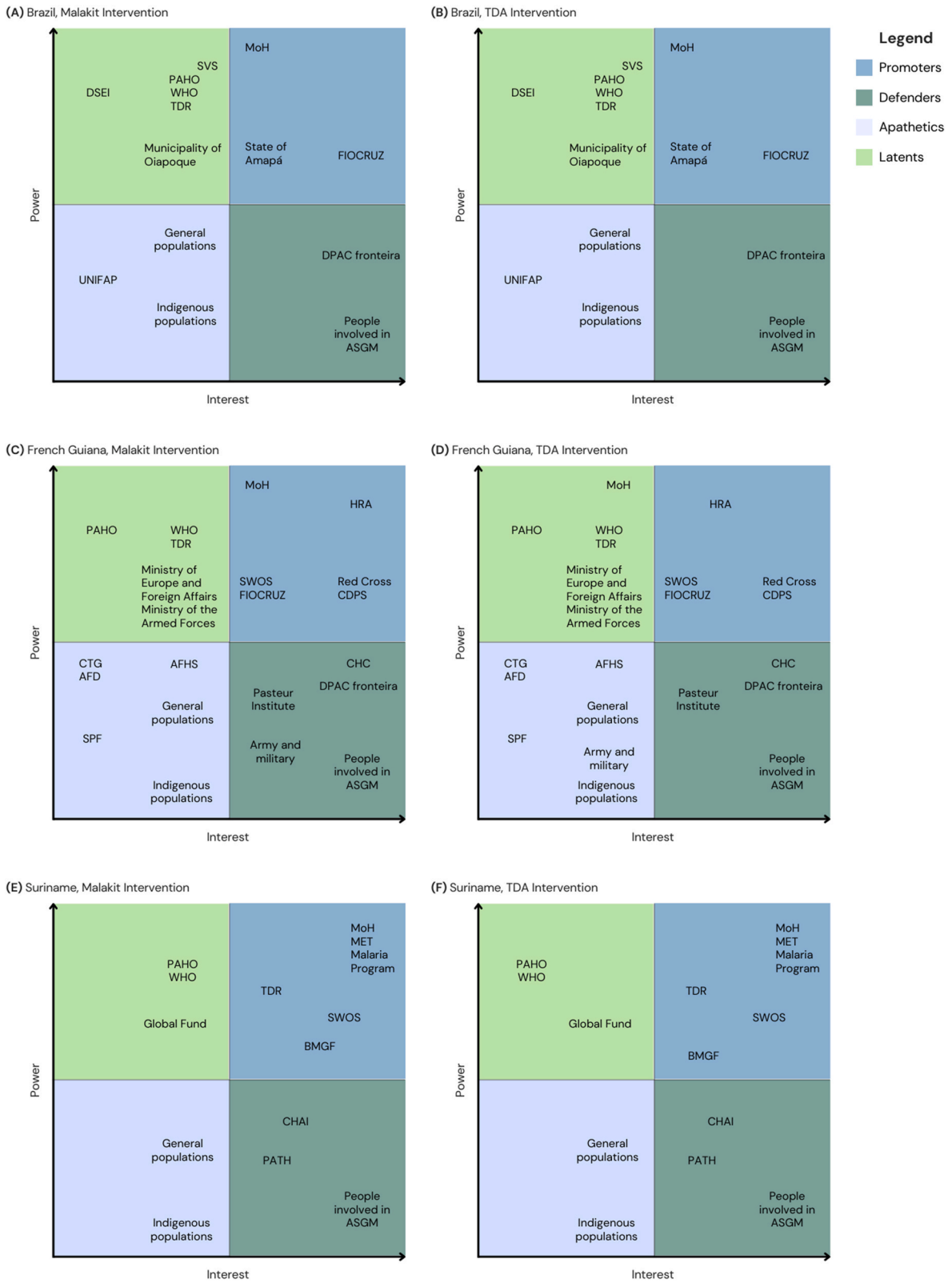

Fig. 2. Mendelow's 2x2 Power/Interest Matrix per Country-Intervention pairs.

"We cannot eliminate malaria alone, thus we need to form a consortium, and we support the idea." (field note from semi-structured interview)

3.3.1. *Brazil*

The Malakit and TDA interventions align with Brazil's goal of malaria elimination by 2035 [35]. Despite a decreasing trend in malaria incidence from 2009 to 2020, it seems to be reversed since 2017 and the initial objective of elimination by 2030 was stated in several studies as not achievable [36–39].

Election cycles, political will, and policies adopted by the MoH

Table 3
SWOT analysis.

		Brazil	French Guiana	Suriname
Malakit	**Strenghts**	Strategy already tested as effective; Good acceptability among the target population; Well-known tool by the MoH; One of the project leaders is soon to join a Brazilian research institute.	Intervention already tested as effective; Good acceptability among the target population; Well-known tool by the MoH; Solid operational link between the resource team and the RHA Resource team from the country.	Intervention already tested as effective; Good acceptability among the target population; Well-known tool by the MoH; Solid operational link between the resource team and the malaria program (MoH); Already scaled-up (2020–2022).
	Weakness	Lack of economic data and cost-effectiveness analysis; The resource team has technical and research expertise and a network of contacts in this field, but less at the decision-making level.	Lack of economic data and cost-effectiveness analysis; Process and field actors (CHWs) not aligned with French regulations and recommendations; The resource team has technical and research expertise and a network of contacts in this field, but less at the decision-making level.	Lack of economic data and cost-effectiveness analysis; The resource team has technical and research expertise and a network of contacts in this field, but less at the decision-making level.
	Opportunities	WHO E−2030 commitment to eliminate malaria; Recent political change and elections; Amapá, Pará and Roraima chosen as pilot countries to fight against malaria.	WHO E−2025 commitment to eliminate malaria; Specific funding for malaria elimination; RHA is drafting a new malaria elimination program; Epidemiological situation starting in late 2023.	WHO E−2025 commitment to eliminate malaria; Malaria Program (MoH) already involved in Malakit research; Strong collaboration PAHO-Malaria Program (MoH).
	Threats	Bureaucratic and regulatory challenges; Political-sensitive job positions at the MoH and the malaria program; Public opinion on goldminers; Reduced perceived problem for lower incidence (elimination phase).	Bureaucratic and regulatory challenges; Reduced perceived problem for lower incidence (elimination phase); Weak institutional cooperation with neighbors.	Reduced interest in the intervention if implemented in French Guiana; Weak institutional cooperation with neighbor countries; Weak funding (National resources, Global Fund); Reduced perceived problem for lower incidence (elimination phase).
TDA	**Strenghts**	Tool adapted to current epidemiology (P. vivax vs. P. falciparum); One of the project leaders soon to join a Brazilian research institute.	Tool adapted to current epidemiology (P. vivax vs. P. falciparum); Solid operational link between the resource team and the Regional Health Agency; Resource team from the country.	Tool adapted to current epidemiology *(P. vivax vs. P. falciparum*) Solid operational link between the resource team and the malaria program (MoH).
	Weakness	Effectiveness assessment still ongoing; The resource team has technical and research expertise and a network of contacts in this field, but less at the decision-making level.	Effectiveness assessment still ongoing; Process and field actors (CHWs) not aligned with French regulations and recommendations; The resource team has technical and research expertise and a network of contacts in this field, but less at the decision-making level.	Effectiveness assessment still ongoing; The resource team has technical and research expertise and a network of contacts in this field, but less at the decision-making level.
	Opportunities	WHO E−2030 commitment to eliminate malaria; Recent political change and elections; Amapá, Pará and Roraima chosen as pilot countries to fight against malaria.	WHO E−2025 commitment to eliminate malaria; Specific funding for malaria elimination; RHA is drafting a new malaria elimination program; Epidemiological situation starting in late 2023.	WHO E−2025 commitment to eliminate malaria; Malaria Program (MoH) already involved in Malakit research; Strong collaboration PAHO-Malaria Program (MoH).
	Threats	Bureaucratic and regulatory challenges; Political-sensitive job positions at the MoH and the malaria program; Public opinion on goldminers; Reduced perceived problem for lower incidence (elimination phase).	Bureaucratic and regulatory challenges; Reduced perceived problem for lower incidence (elimination phase); Weak institutional cooperation with neighbors.	Reduced interest in the intervention if implemented in French Guiana; Weak institutional cooperation with neighbor countries; Weak funding (National resources, Global Fund); Reduced perceived problem for lower incidence (elimination phase).

impact malaria trends: experts call for a change in policies to adopt effective strategies to fight malaria and to commit to concrete actions to address malaria, especially among gold miners and indigenous people [39,40]. Recently, Amapá, Pará, and Roraima have been suggested as pilot states for fighting malaria enabling the potential implementation of Malakit or TDA-like interventions in gold mining areas in the country.

> *"The head of Brazil's malaria elimination program expressed his willingness to implement a Curema-like intervention in Amapá and/or Roraima"* (field note from formal meeting)

However, issues related to gold mining – especially illegal gold mining – and the increase of infectious diseases among indigenous communities are sensitive topics for Brazilian public opinion and may pose a threat to the scalability of the interventions [41–45].

> *"While public opinion is highly critical of the* garimpeiros [= Brazilian word referring to people working on ASGM]*, the Ministry of Health has to deal with the health consequences and take into account the need for action in illegal gold-mining areas, where malaria control has always been a major problem. There are still fears about the possible reaction of public opinion, but a certain pragmatism is taking hold."* (field note from resource team interview)

3.3.2. French Guiana (France)

Even if the RHA has been supporting Malakit project and Curema project since 2016, the major opportunity for a scale-up of the interventions in French Guiana is the recent engagement of France in the E−2025 initiative and its commitment to the WHO Strategy to eliminate malaria in French Guiana by 2025. This commitment provides leverage for the local implementation of innovative interventions aimed at

eliminating malaria.

> *"Indeed, if the E-2025 objective is not achieved, it is France, via the Ministry, which has formally committed itself by signing the agreement. This gives us even more strength in terms of advocacy and funding requests [to the MoH]."* (Field note from semi-structured interview)

Moreover, facing a new malaria outbreak that started in late 2023, health authorities have been looking for new strategies, including potentially scaling up Malakit or TDA interventions [5]. However, various regulatory and bureaucratic aspects need to be addressed for a successful scaling-up in the country and some components of the intervention need to be adapted to fit the current regulation. These include medical devices and drug regulation, and lack of legal recognition of community health workers as authorized to deliver malaria treatments and can impact the potential of scalability of these interventions: i.e. TDRs used for malaria are not authorized by manufacturers in self-test mode; Primaquine for TDA of *P. vivax* is recommended in France only after a quantitative screening test for ruling out G6PD deficiency has been carried out; and an ECG is recommended before dispensing a combination of artemether and lumefantrine [46].

> *"The user organization expresses interest in the possibility of being the actor implementing the intervention [Malakit] in the territory [French Guiana], but expresses reticence towards certain aspects of feasibility in the field in connection with the current regulation or standard practices used. One example cited is that currently the indication used in hospital is that an ECG is always performed before ACT is administered to the patient to rule out the existence of Long QT syndrome."* (Field note from formal meeting)

Also, the status of CHWs lacks a formal recognition in France, thus performing activities of a health professional as a CHW would be considered an illegal practice of medicine [47]. The Regional Health Agency of French Guiana declared that the recent release of "Décret n° 2023-260 du 7 avril 2023″ on the right of exemption of the RHA director general under certain conditions could potentially positively affect the scalability of the intervention, enabling tasks delegation to non-medical professions in the health sector area, such as nurses [48].

3.3.3. Suriname

Suriname's participation in the E−2025 initiative supports the scalability of the interventions experimented within the Curema project in its national malaria elimination strategy. The Malakit intervention has already benefited from a national institutionalization [20]. However, concerns have been raised regarding the intervention's lack of data collection for positive cases, affecting the malaria surveillance system and the certification process by the WHO [49]. This has been pointed out as a limitation of Malakit intervention when the tool is distributed to the internal population:

> *"The surveillance system and data sources are a success of the Malaria Program, therefore the lack of feedback information on positive tests is one of the main constraints to the use of Malakit* [in their territory]. *However, the distribution of this kit is useful in preventing external cases of malaria from entering Surinamese territory, which now has zero cases [of malaria] and is awaiting WHO certification." (field note from semi-structured interview)*

According to the Malaria Program, an interest in scaling up the TDA intervention countrywide was highlighted, under the condition of tafenoquine use instead of primaquine, pending results of outcome and implementation evaluation and setting up of regulatory procedures.

Funding for scaling up was already identified as a major difficulty during the scale-up 2020–2022 and, also during this scalability assessment, it was declared to be a major concern for scalability. Financial threats were linked to the current domestic economic crisis and the uncertainty about the continuity of external financial support such as grants from the Global Fund used during Malakit scale-up in 2020. Moreover, the Surinamese Malaria Program pointed out that the elimination may result in a perception of low or no urgent problem among external and internal funders.

> "*Financing could be challenging*" (field note from semi-structured interview)

4. Discussion

4.1. Stakeholders' analysis: a crucial step in the pre-planning assessment for scaling-up

The crucial role of stakeholders in public health interventions has been widely recognized and extensively studied in the literature. Strong collaborations with stakeholders are essential for successful scale-up of public health innovations [50]. This has also been emphasized in our context during the Malakit scale-up experience in Suriname, becoming one of the justifications for the stakeholder analysis carried out in the pre-planning assessment [20]. In fact, stakeholder analysis is the entry step to identify key stakeholders, answer their questions, understand their possible contributions, analyze and find solutions to scale-up issues by adding indicators to be evaluated during the pilot or ancillary studies strategy [51–53]. Using Mendelow's model, stakeholders are categorized, and specific actions are recommended for each category helping the development of internal roadmaps. As an example, mapping potential user organizations in French Guiana allowed the resource team to decide with which institutions to undertake the scaling-up process. This analysis should be ongoing, starting from the pre-planning assessment, to ensure the effectiveness of the action plan and should help decision-makers consider whether or not to scale-up the project in case effectiveness is shown [54–56].

4.2. Scale-up barriers: funding for sustainability and regulatory issues

The scaling-up process can be influenced by various factors, such as financial constraints and regulatory issues [50–53]. Financial constraints are a frequent challenge, especially in low and middle-income countries, which often rely on external donors for funding [54–57]. This was the case of Malakit scale-up in Suriname, supported by the Global Fund in 2020–22 [20]. Fixed-term funding agreements were identified during this pre-planning assessment as a major barrier to scale-up, notably for Suriname, where the economic crisis may not permit national-driven funding and where concerns exist regarding external funders. Regulatory constraints related to drug and diagnostic tools also threaten scaling up according to this pre-planning assessment. Overcoming these challenges requires a deep understanding of the intervention and contextual factors, the feasibility in the field and real-world settings, the political commitment, and the availability of evidence provided by research. In the context of innovative intervention for malaria elimination, an article highlighted the importance of the political commitment to enforce the regulatory process [58]. This article also pointed out that regulatory and decision-making bodies need efficacy and safety evidence before committing to innovation, and that it is the role of research bodies to provide this evidence [58]. As found during this pre-planning assessment and in the literature, becoming a WHO-certified intervention could facilitate their scalability, but it involves meeting specific steps and criteria. Among them: the involvement of a diverse array of experts with diverse perspectives and expertise to constitute guideline development groups; the intervention of the WHO Guideline Review Committee ensures high-quality, consistent guidelines by standardizing processes, ensuring no commercial funding, managing conflicts of interest, reviewing systematic evidence; and a transparent recommendation development focused on reaching a consensus [59].

4.3. Windows of opportunity: new political and epidemiological levers

In the three countries considered in the present assessment, there is substantial interest from health authorities and institutions in scaling up the proposed interventions, representing a significant opportunity. The role of political agendas has been repeatedly highlighted in the literature as a crucial factor influencing intervention scaling [46,50,56,57]. Moreover, recent qualitative studies involving decision-makers stressed the importance of "windows of opportunity" to successfully start the scale-up project [54,60]. Some of those levers and windows of opportunity were identified during our assessment.

The recent commitments of France, Suriname, and Brazil to E-2025 or 2035 initiatives together with the electoral cycle, especially in Brazil, may represent new priorities in the political agenda that can facilitate the scale-up. This was highlighted by stakeholders during interviews and formal meetings. The RHA in French Guiana declared major support from the MoH in terms of financing and actions for malaria elimination initiatives. In Brazil new initiatives have been launched especially to fight malaria in the target population. Sustaining political commitment is crucial for long-term intervention, especially in the context of malaria elimination [61]. This is even more true when considering health systems such as that of Brazilian, where several structural levels – from the national to the municipal – are involved in healthcare and are also highly dependent on electoral cycles at those levels. This aspect opens the question of ensuring the continuity and sustainability of a scale-up over time.

The decrease in malaria incidence during the elimination phase is associated with a reduction of malaria perception as a problem both in the general population and key stakeholders. For instance, a KAP study conducted in a low-endemicity area on the northern coast of Ecuador found that only a small proportion of families (10–30 %) still participated in vector control activities [62]. Similarly, as feared by some of the stakeholders involved in this pre-planning assessment, decision-makers could have a decreased perception of the problem of malaria elimination and not provide adapted funding.

On the other hand, in certain cases, the epidemiological context can be a catalyst for funding or stakeholders' commitment. This is the case of French Guiana where an outbreak in late 2023 and early 2024 seems to have enhanced the scalability of the proposed interventions and speed up the process of scale-up in comparison to epidemic-free periods. Similar patterns have already been described in the literature, particularly during the Covid-19 pandemic [63–67]. In fact, the interaction between the health crisis and technological development has been noticeable at that time and the resilient response to the pandemic has represented an important window of opportunity for the development and the scale-up of innovation in public health. Among the innovations and transformations linked to the pandemic, we find the adoption of digital tools, the expansion of telemedicine in routine activities, the development of new work patterns and management, the increasing research and use of mRNA vaccines, etc [63–67].

The reactivity of the resource team and stakeholders – especially promoters and defenders – in seizing contextual opportunities when windows open is a key element to consider for enhancing health intervention scalability.

4.4. The resource team and its role: from research to action

Translating research into action and policy takes an average of 17 years [68]. A systematic review of the use of scientific evidence in the public health decision-making processes described some of the major barriers to evidence-based decision-making. Among them, it can be found: the degree to which decision-makers understand and embrace research evidence which could be seen as inaccessible to decision-makers; a gap between researchers and decision-makers due to different backgrounds, education, and practices; the competitive influences that can occur such as strategic fit, pressure from stakeholders or politicians, and public opinion; and constraints on the decision-making process due to rules or regulations [69]. Another review of policymakers' perceptions on the use of research evidence in health policy decision-making showed as common barriers the lack of personal contacts between decision-makers and researchers, power struggles, and financial constraints [55]. These aspects, together with a sustainable stakeholders' commitment, raise questions about which role researchers and resource teams should play in scaling up effective interventions.

At this stage of assessing scalability in a pre-planning context, the key issue is to define what the stakeholders would need to make the scale-up decision, including the levers and obstacles to a possible scale-up, and to guide them on how to do it. This is also the need of researchers and resource teams, who need to explore the research project's potential implications in terms of actions and policy. Moreover, it is important to keep a certain degree of intervention adaptability – especially when the implementers are no longer the researchers from the resource team. Once the research intervention has been completed and results of its effectiveness and implementation are available, the advocacy role appears particularly critical for enhancing scalability. It is essential to consider the various complexities of each country's healthcare system and advocate at all levels to ensure the successful implementation of the policy. Indeed, the literature shows that advocacy plays a crucial role in persuading decision-makers to support innovation and lobby for funding and to translate effective research findings into real public health interventions [69–71].

In our context, the previous collaboration between the resource team and health authorities in Brazil, French Guiana and Suriname, together with the participatory approach used within the Curema project, the workshops organized with key stakeholders from the region, and this interactive pre-planning assessment could all be seen as an effort to (i) foster the connection between the research and the decision-making process, (ii) bridge the gap between these two aspects or at least come close to it, and (iii) advocate for the scaling up of effective innovations.

An innovative methodology to bridge the gap between research and policy and to help researchers greatly increase the policy impact from their work is the activity called "Policy Lab" [72,73]. This methodology is based on engagement approaches, and collaborative workshops bringing together researchers, policymakers and other key stakeholders. "Policy labs" are shown effective in bringing evidence close to decision-making processes, enhancing listening among different actors, and building solutions to barriers and constraints [72,73]. Thus, they could be a good tool to be further implemented in the Curema project context and in general in malaria elimination context, too.

4.5. Three countries, one region: work jointly to eliminate malaria

Even if the three countries are independent and each institution has its own legitimate area of action, the experience of a tri-national research project and the findings of this pre-planning assessment highlighted the need for cooperation and joint actions in the region. In fact, the stakeholders from the three countries emphasized the importance of joint efforts with neighboring countries calling once more for a regional initiative to control and eliminate malaria in the Guiana Shield following the view point published by Sanna et al. [11]. Collaboration across different countries can be challenging notably because of communication gaps and differing priorities, such as working with geographically dispersed partners who speak different languages, managing divergent opinions and different legitimacies of actions, facing competing priorities in different countries and different powers, etc [70]. A qualitative survey conducted in India and Southeast Asia among a diverse array of stakeholders working on malaria elimination found that setting up collaborations and coalitions across different countries to reach malaria elimination targets remained challenging due to communication gaps, lack of coordination, or missed opportunities [61]. Nevertheless, joint actions have a pivotal role when facing challenges

linked to hard-to-reach communities characterized by mobility patterns, such as illegal migrants far from healthcare settings. This aspect was not only pointed out by policy stakeholders in India and Southeast Asia, but also by many participants in our pre-planning assessment showing similarities with the Amazon region [61]. In fact, the ASGM population represents a malaria reservoir, increasing border transmission across the Amazon region and demonstrating how crucial multinational efforts are for malaria control and elimination, despite difficulties in collaboration [38,74–77].

4.5.1. Limitations

The study had limitations due to the lack of representation from various project stakeholders like suppliers, pharmaceutical sectors, civil authorities, and recipients. This might affect the generalization of the findings beyond the specific participants. However, the present assessment successfully engaged key stakeholders from different sectors and countries using participatory, interactive and multi-activity approaches [78].

5. Conclusions

The interventions experimented within the Curema project were planned for scalability from the beginning. Despite financial and regulatory challenges, there is currently an opportunity for scaling up in Brazil, French Guiana, and Suriname due to political and epidemiological levers. Identifying and involving stakeholders in a pre-planning assessment and advocating for evidence-based decision making have been highlighted as crucial steps to support the scaling-up process and foster regional cooperation for malaria elimination. Stakeholder analysis should be refined during the scaling-up and the process should be continuously reviewed to capture further changes in contextual factors that might influence the scale-up.

CRediT authorship contribution statement

Carlotta Carboni: Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Alice Sanna:** Writing – review & editing, Conceptualization. **Yann Lambert:** Writing – review & editing. **Lorraine Plessis:** Writing – review & editing. **Teddy Bardon:** Writing – review & editing. **Antoine Adenis:** Writing – review & editing. **Mathieu Nacher:** Writing – review & editing. **Stephen Vreden:** Writing – review & editing. **Martha Suárez-Mutis:** Writing – review & editing. **Maylis Douine:** Writing – review & editing, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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