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One health, one humanity: breaking down silos for a healthier future

by Giancarlo Ceccarelli, Massimo Ciccozzi, Gian Stefano Spoto*

#Health, #humanity, #cooperation. These words, often relegated to the realm of utopian ideals, are in fact the essential building blocks for a healthier and more equitable world. While the concept of #OneHealth – recognizing the interconnectedness of human, animal, and environmental health – is gaining traction, we still face a critical challenge: breaking down the silos that prevent true global collaboration.

Our world is increasingly digital, where keywords are not just hashtags, but powerful tools for connection and action. Yet, the very real threats to global health – pandemics, antimicrobial resistance, and climate change – demand more than digital dialogue. They demand a paradigm shift.

The current geopolitical climate, often characterized by division and self-interest, can make genuine collaboration feel like a Mission Impossible. We see health issues politicized, resources hoarded, and inequalities exacerbated. But the truth is, health is not a political bargaining chip. It is a fundamental human right, intrinsically linked to #justice, #equity, and ultimately, our collective survival.

So how do we bridge this gap between rhetoric and reality?

Investing in Education and Exchange: Empowering future generations of health professionals, particularly from the Global South, is paramount. Expanding access to quality medical education, fostering cross-cultural exchange programs, and supporting the development of healthcare infrastructure in underserved regions are not just acts of altruism, but strategic investments in a healthier future for all.

Recognizing Interconnectedness: The One Health approach, far from promoting a singular, self-serving view of health, emphasizes the interconnectedness of all living beings and our shared environment. As highlighted by the vital work of organizations like the Geneva Environment Network, protecting ecosystems, promoting sustainable practices, and addressing climate change are not separate from – but integral to – safeguarding human health.

Embracing a Holistic Approach: We must move beyond

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fragmented approaches to health, recognizing the crucial role of diverse stakeholders. Veterinarians, environmental scientists, economists, policymakers, and communities themselves must be brought to the table. This requires a shift in mindset, from competition to #cooperation, from isolation to integration.

The challenges are undeniable, but the potential rewards are too great to ignore. By embracing a holistic, collaborative, and human-centered approach to health, we can transform the seemingly impossible into a shared reality. Let us choose to act, not as isolated nations, but as one humanity, united in our pursuit of a healthier and more just future for all.

VETeris – A One Health approach for the health of the elderly

by Andrea Ungar, Chiara Mussi, Maria Chiara Catalani, Ilaria Ambrosino, Ludovica Ceolin, Liliana Colombo, Luca Mechelli*

Abstract
Human health is closely connected to those of other animals and the environment: this is where the "One Health" concept originates. Human-animal relationship, which is gaining increasing attention in the last years, positively impacts on individual's well-being, considering both living with pets ("Pet Ownership") and Animal-Assisted Interventions (A.A.I.). A.A.I., consisting of health intervention programs involving animals, require a specific planning and the engagement of different trained professionals depending on the objective of the intervention and the characteristics of participants and they can be targeted to different users, including older persons. VETeris Association, born from the union of Veterinarians and Doctors specialised in Geriatrics, aims to promote older adults' quality of life and healthy ageing through the relationship with animals, implementing interventions, studies and initiatives which can be extended not only to different Italian regions but also all over the world.

Keywords
One Health, Elderly, Human-Animal Relationship, VETeris Association, Animal Assisted Interventions.

1. One Health: the unbreakable human-animal-enviroment bond

The concept of One Health has been developed after the observation that human health is intricately connected to those of other animals and the environment that they inhabit. One Health [1] is an approach to investigate diseases which acknowledges that humans, animals, plants, and the environment are closely interlinked. In the mid-20th century, Dr. Calvin Schwabe, a veterinary surgeon from United States, compared approaches to human health, animal health and welfare suggesting the concept of "One Medicine" [2]. He highlighted the integrated, cross-disciplinary perspective which members of his profession could contribute to general medicine. He also advocated involvement of social sciences and enhancement communica-

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tion skills to improve working together with the community in efforts to control infectious diseases [2]. In fact, the need for collaboration between the human, animal, and environmental health sectors is an important issue nowadays. This is demonstrated due to the increase in emerging human infectious diseases with a zoonotic origin and in the resistance of microorganisms to antimicrobial drugs [3].The main fields in which this concept of collaboration has been applied are zoonosis and zooprophylaxis, vaccines, and antibiotic resistance. Today a new area is part of the approach to One Health which is that of AAI – Animal Assisted Interventions. The AAI requires an integrated approach between human medicine, psycho-social sciences and veterinary medicine to achieve the goal of "common health". Pets can be important for the physical and mental health of humans, but they can also transmit zoonotic infections or become infected. Due to the changing human-companion animal bond, recommendations are needed regarding responsible pet ownership, including normal hygiene practices, responsible breeding, nutrition, sharing the home environment and a quality of life compliant with biology of the animal to ensure its well-being. Various professional figures from healthcare, environmental, biological, psycho-social, IT sciences and many others contribute to One Health [9].

2. The fundamentals and characteristics of the human-animal relationship

The foundations and the potential of the human-animal relationship were studied in Italy by Roberto Marchesini. The Author defines the human-animal relationship as the "meeting in a threshold". The positive potential of this encounter lies in the "contamination" that arises by crossing the threshold of the other, where the other is different from me and as such enriches me [10].

A beneficial relationship with the animal is based on knowledge of its characteristics and needs, it is a congruous relationship. Another characteristic for a beneficial human animal relationship is in the concept of adequacy or awareness that is the attribution of the right value and necessary interest, both in terms of time and availability towards the care of the animal [11].

An important potential of this relationship is also the ability to stimulate the person to question themselves by recognizing the animal as a referent, therefore as a point of reference and as a term for constructive comparison. The animal becomes a referent if we allow it, within a correct relationship, to become a support but also a proposer of models and questions to answer as a term of constructive comparison [11].

Through this relationship we can stimulate psychological processes, support patients undergoing painful or distressing therapeutic protocols, support the person experiencing psychological or social distress, but also the child in the various stages of development. Companion animals can be sources of support and contribute to the acquisition of skills and the educational process of young people.

Furthermore, a study conducted among homeless people who shared their lives with a dog showed that for these people the relationship with their animals was of fundamental importance. This work has also identified an important gap in social services and the need for a One

Health approach by public administration. The importance of this bond must be recognized for the homeless and for the elderly, by establishing dedicated reception centers that guarantee both animal and human health. Reducing barriers to essential services would help ensure that homeless and elderly pet owners are not forced to choose between a home and their pet, which for many would tend to perpetuate hardship [12].

Due to the increase in life expectancy, the world of the elderly seems to receive more and more attention from healthcare institutions for the commitment of the resources necessary to guarantee an adequate lifestyle and well-being. In this scenario, AAIs prove to be a health and preventive tool of fundamental importance.

Geriatricians and veterinarians therefore felt the need to structure a professional collaboration. This has led to a Scientific Society, with the aim of defining specific medical protocols and working approaches in the context of the elderly – animal relationship, where each competence enriches that of the other.

3. Benefits of human-animal relationship

Living with pets positively impacts on factors influencing the individual cardiovascular risk [4-6]. Indeed, it has been demonstrated that dog-owners walk more than people who don't have a dog. A higher level of physical activity significantly affects the maintenance of functional autonomy, the control of weight and cardiovascular risk. In addition, some studies suggest that physical activity with a dog reduces overweight and it increases adherence to weight loss programs. Living with animals also reduces blood pressure in both hypertensive patients and non-hypertensive subjects and it seems that having an animal reduces mortality related to stroke and heart attack.

Non-human animals, additionally, are often described as a source of comfort, support and protection, as well as examples of patience. The company of an animal attenuates one of the psychological aspects of pain, acting on mood, also preventing depressive symptoms. Additional data show that pet-ownership in adult age improves cognitive performance in older age. Older people living with animals have better cognitive functions: especially verbal learning and memory. There are data demonstrating a reduction of behavioural disorders in elderly patients with dementia [7].

4. Animal Assisted Interventions (AAI)

Animal Assisted Interventions could have therapeutic, rehabilitative, educational and recreational value and involving domestic animals like dogs, cats, rabbits, horses and asses. These interventions are aimed mainly to people with physical, neuromotor, mental and psychic disorders, dependent on any cause, but can also be addressed to healthy individuals. The correct application of AAI requires the involvement of a multidisciplinary team composed, depending on the type of intervention, by health, pedagogical and technical figures with different tasks and responsibilities [8].

According to areas of activity, AAI in Italy are classified in [8]:

– Animal-Assisted Therapy (AAT): intervention with therapeutic value aimed at treating physical, neuro- and psychomotor, cognitive, emotional and relational disorders. They are addressed

to patients affected by pathologies of any origin. This intervention is customised to the patient and requires a medical prescription [8];

– Animal Assisted Education (AAE): an educational intervention that aims to promote, activate and support the resources and potential for individual growth and planning and to promote relationships and social integration of people in difficulty. This intervention can also be group-based and it promotes the well-being of people in their own living environments, particularly within institutions where the individual has to deploy adaptive capacities. The AAE contributes to improve the person's quality of life self-esteem. Through the mediation of pets, behavioural re-education courses are also implemented. The AAE therefore finds application in various situations such as, for example:
  - prolonged hospitalisation or repeated admissions to health facilities;
  - relational difficulties in childhood and adolescence;
  - emotional and psycho-affective distress;
  - behavioural and socio-environmental adaptation difficulties;
  - situations of institutionalisation of various kinds (institutions for the elderly and psychiatric patients, residences;
  - care homes, communities for minors, prisons, etc.);
  - conditions of illness and/or disability involving an integrated home care programme [8];
– Animal Assisted Activity (AAA: an intervention with recreational and socialisation purposes aiming to improve quality of life and proper human-animal interaction. Sport/competitive activities with animals are not included in AAA. In AAA, the relationship with the animal constitutes a source of knowledge, sensory and emotional stimuli. This intervention promotes in the community the value of human-animal interaction for mutual well-being. AAA in some cases could be preparatory to AAT/AAE and they are aimed, among other things, at:
  - developing skills through animal care;
  - increasing relational and communicative readiness;
  - stimulating motivation and participation [8].

5. VETeris (Italian Association of Geriatricians and Veterinarians for Animal Assisted Interventions)

VETeris is an association born from the union of Veterinarians and Doctors specialised in Geriatrics, to promote an active and healthy ageing of the elderly through healthy lifestyles with non-pharmacological interventions. The Italian Association of Geriatricians and Veterinarians for Assisted Interventions with Animals (AAI) was created to optimise pet-therapy guidelines aimed at improving the quality of life of the elderly, creating a real community based on therapeutic benefits. VETeris is in line with demographic forecasts which indicate that by 2030 more than 24% of the European population will be over 65 years old (in Italy there are more than 13 million over65). Furthermore, the project shares the vision of the World Health Organisation (WHO), which has recently implemented the concept of active ageing, defining it as "the process of optimising opportunities for health, participation and security in order to improve the quality of life as we age".

In these recent years VETeris has realised:

- the first "Guidelines on AAI for the well-being and health of older people in Italy;
- clinical research doing a survey at the Azienda Ospedaliero-Universitaria of Careggi, Florence, to analyse the benefits for the elderly of pet-ownership and a census on a sample of the elderly population in Florence on the presence of animals in their homes;
- different projects as pilot studies of AAI in residences for the elderly (Nursing Homes and Day Care Centres);
- according to the Guidelines on Animal Assisted Interventions, counselling for the conscious adoption of animals for the over-65 population;
- consulting activities for the implementation of AAI in all Italy;
- training activities for healthcare (doctors, nurses, healthcare workers), caregivers, family members on the importance and impact of AAI and pet-ownership;
- publicity and promotional campaign for general population.

With the well-being of the elderly population as its primary goal, VETeris has as its main purpose for the next few years to continue promoting and implementing interventions, events and initiatives which can also be extended and sponsored all over the world.

6. Health assessment and monitoring plan of dogs involved in AAIs

The expert veterinarian in AAIs must always carry out a preventive health assessment of the dog involved in the AAIs to verify its health condition. Additionally, they are responsible for establishing the planned health monitoring for the animal throughout the project and defining the management procedures that the co-handler must adhere to, both within and outside the setting. This ensures effective management of health risks related to interactions between the elderly and animals involved in AAIs.

Previous studies have demonstrated that apparently healthy animals involved in AAIs can carry and potentially transmit zoonotic pathogens to humans, even without exhibiting symptoms. This is of particular concern in AAT because the animal teams visit healthcare settings and interact with patients that could be immunocompromised for physiological and/or pathological reasons [13].

In this regard, particular attention should be given to controlling ecto- and endoparasite infestations and the prophylaxis of specific infectious diseases. The ESCCAP (European Scientific Counsel Companion Animal Parasites) Guidelines recommend year-round treatments against fleas and ticks,

since the risk of infestation is constant and exposure is difficult to avoid [14].

Topical or systemic products are available on the market. When using topical products such as spot-on or sprays, it is advisable to avoid touching or petting the animal for the first 48 hours after application [15]. However, there is no risk of contact with the active ingredient when using systemic products in oral tablet form [16]. Since dogs are the main reservoir of Leishmania infantum, it is recommended to use slow-release pyrethroid-based products (e.g. collars with long duration) alongside vaccination for all dogs involved in AAIs [15].

Recent studies have found zoonotic intestinal helminths and protozoa in approximately

24.3% and 30.4% of the dogs involved in AAIs, respectively, highlighting the potential risk of transmitting these parasites to humans [17].

To reduce the risk of transmission of zoonotic endoparasites to humans, ESCCAP guidelines recommend performing a copromicroscopic examination at monthly intervals and treatment based on the results. [18].

Regarding vaccination prophylaxis for infectious diseases, the veterinarian must verify that the AAIs dog has the most appropriate vaccination protocol based on age, lifestyle, and risk of exposure. Special attention should be given to zoonotic infectious diseases (e.g leptospirosis) [19].

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Climate change, Small Island States and international law: the new frontiers of international justice

by Mario Di Giulio, Maria Angela Maina*

Abstract
Climate change has brought about a new frontier in international law, challenging traditional concepts such as the causes for granting the right to asylum and sovereignty due to the loss of territory [1]. The impact of climate change is evident, particularly in small island states where sinking causes the loss of territory, which threatens the loss of sovereignty and habitable land and triggers human migration (the climate refugees emergency) [2]. These aspects have undoubtedly raised complex legal issues that international law struggles to adequately address. Ergo, the desperate need to develop a new frontier of international law that ensures the sovereign status and provides compensation for climate-induced loss of territory and recognition of climate refugees [3]. Shedding light on the plight faced by small island states presents readers with the rationale for an intersectional understanding of global sustainable development that is much needed to achieve the Sustainable Development Goals (SDGs) by 2030. Furthermore, the aspect of inclusiveness of small island states in an effort to leave no one behind.

Keywords
Climate Change, Small Island States, Climate Justice.

1. Sovereignty and loss of territory

As a general principle under international law, the recognition of a state as such is given by the simultaneous existence of a supreme authority over a territory and a population.

Climate change now threatens the very existence of small island states due to rising sea levels and severe weather events: many of these territories are located just a few feet above sea level and are at high risk of territorial loss [4]. According to a 2020 study by the University of California, Los Angeles (UCLA) small island states face the very real prospect of losing their sovereignty if their territory were submerged under the sea [5].

The situation becomes more precarious for self-determining small island states (the right, under international law, to freely determine their political, economic and cultural future). The Colombia Human

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Rights Law Review notes that the self-determination and sovereignty of small island states are inexorably tied to their territories [6]. Their territories provide the basis for their existence, identity and self-governance, which are fundamental to the realization of their right to self-determination [7]. Nevertheless, whether self-determined or not, small island states are facing the loss of territory caused by rising sea levels and extreme weather conditions threatening the loss of territory and statehood [8].

For example, Kiribati is a self-determined small island state made up of 33 atolls and reef islands [9]. It now faces an existential threat of territorial loss due to rising sea levels and coastal erosion. The Kiribati Government has taken adaptive measures, such as building sea walls, relocating communities, and promoting sustainable development. Unfortunately, the loss of territory threatens to undermine Kiribati's right to exercise self-determination and maintain its sovereignty [10].

The Maldives, a small island state and independent country is facing the same difficult situation as Kiribati due to the effects of climate change [11]. The United States Geological Survey reports that, at current rates of global warming, 80% of the Maldives is expected to be inhabitable by 2050 [12].

Loss of territory is something not new in international law where a state loses its territory as a result of an enemy invasion.

Another example is given by The Sovereign Order of Malta, which is a special body under international law, as it has exercised sovereign powers over territories in the past [13]. In this case, the loss of the last governed territory (Islands of Malta) due to Napoleon, did not result in the total loss of sovereignty for this entity that still benefits from a special status in its headquarters, such as limited immunity from other jurisdictions.

In this case, the survival of some sovereign powers granted to this order may be understood with the desire of the nations that defeated Napoleon to restore the status quo after the wars won by Napoleon himself. Other Orders (such as the Teutonic Order). did not follow the same destiny and when they lost the territories that they ruled, they lost their sovereign status too.

Other examples include governments in exile when a country is annexed after a defeat in war as happened for many nations in Europe during World War II. In these cases, however, governments in exile are temporary phenomena in which the governments in exile will return or not depending on the outcomes of the war.

Climate change with the submergence of the territories of small island states is creating a new challenge because while at-risk states purchase lands from other states to relocate their populations, this does not mean that the purchased lands will be subject to the sovereignty of the purchasing state. On the other hand, the loss of territory puts at risk the fact that these states will be recognized as such while their lands will be submerged. This will also lead to the economic exploitation of the waters of the seas when the lands will be submerged because they could no longer be considered exclusive marine areas of the disappeared states.

2. The predicament of climate refugees

The 2020 study from the University of California, Los Angeles (UCLA) also finds that there is no overarching govern-

ing framework for climate refugees – either for cross-border or internally displaced persons due to climate change [14]. The existing legal framework, primarily the 1951 Refugee Convention, is unable to protect climate-induced migrants. The Convention's definition of a refugee grounded on persecution based on race, religion, nationality, or political opinion does not encompass climate-related displacement [15]. This gap has led to calls for the inclusion of climate migrants in international refugee laws, the development of new legal instruments, and the exploration of innovative legal solutions to protect those displaced by climate change. However, these mostly operate on a regional, rather than international, scale. For example, the 1969 Organization for Africa Unity Convention on Refugees (OAU) and the 1984 Cartagena Declaration on Refugees include climate migrants among those fleeing due to "events seriously disturbing public order" [16].

The 2021 Migrants Can Make International Law Journal Article provides 5 categories of climate-induced migration, caused by [17]:

1. Sudden-onset disasters, e.g. flooding;
2. Slow-onset degradation, e.g. sea level rise;
3. Sinking of small island states;
4. High-risk zones declared dangerous for human habitation;
5. Forced displacement due to violence caused by the scarcity of essential resources such as water, arable land or pasture.

With the above-mentioned categories in mind, the need for international law that effectively recognizes climate migration is clear.

The delicate balance between a state's sovereign rights and its obligations under international human rights law is highlighted in the 2020 global landmark case *Ioane Teitiota v New Zealand,* heard by the United Nations Human Rights Committee (UNHRC) [18]. In this case, Ioane was seeking "climate refugee" status in New Zealand from Kiribati due to climate-induced threats. Ioane sought asylum because he faced land disputes and lacked safe drinking water due to the climate crises in Kiribati. His claim was rejected by the New Zealand Immigration Tribunal leading to his deportation. He subsequently lodged a complaint against New Zealand in the UNHRC alleging a threat to his right to life under the International Covenant on Civil and Political Rights (ICCPR). The UNHRC ruling deemed Ioane's deportation legitimate as he did not face an immediate danger to his life in Kiribati. Nonetheless, the Committee recognized that climate change represented a serious threat to life and that this should be taken into account when examining appeals on deportation [19].

3. Climate justice

Most scientists agree that the primary cause of global warming is human activities [20].

These activities have been (and are) carried out by humanity to varying degrees. Western Countries, China and India are the countries that are causing most of the global warming. As often happens, those who are the most affected by global warming do not coincide with those who cause this phenomenon [21]. Furthermore, the ability to react to the damages created by global warming is strongly influenced by the economic power of the countries affected. In addition, climate change affects people differently: on the one hand, elderly people are more ex-

posed to change; the younger one, however, sees their future jeopardized by the risk.

All these differences push courts and lawmakers to find a way to protect those who are in a weaker position.

From all these considerations a new concept is delineating the meaning of justice, considering the climate perspective: climate justice is now a relatively new work that is gaining ground day after day.

4. Need to develop a new legal landscape

In conclusion, climate change is reshaping international law by expanding borders and requiring the evolution of legal norms to address the complexities of climate-induced migration. As the world faces the growing impacts of climate change, the development of a new legal border that balances asylum rights, sovereignty and land protection is crucial to addressing the challenges posed by this global phenomenon.

Even so, climate justice appears to be an effective way to unite nations in assisting those who are unfairly affected by the effects of climate change. The International Court of Justice (ICJ) is the world's highest international court and the only principal UN organ, but it has yet to address the climate crisis, despite the March 2023 UN General Assembly adopted resolution [22]. The resolution calls on the ICJ to provide an advisory opinion on the obligations of states, under international law, to protect other states that are unfairly affected by the climate crisis. The ICJ is currently formulating a historic opinion on this topic to provide much-needed clarification on the obligations of states to protect the climate system under international law and on the legal consequences of harm caused to other states, including small island states [23].

On the other hand, judicial progress is evident in regional courts, while litigation has been used to address the impacts of climate change on human rights. For one, in April 2024, the European Court of Human Rights ruled that Switzerland violated the European Convention on Human Rights by failing to protect its citizens from climate change in a timely and appropriate manner [24].

A further example is the January 2023 request by Chile and Colombia to the Inter-American Court of Human Rights (IACtHR) seeking clarification on the scope of state obligations to respond to the climate emergency under international human rights law, especially considering the vulnerability of communities in Latin America. The IACtHR has not yet issued a response [25]. It is hoped that the ICJ's upcoming advisory opinion will establish the much-needed international jurisprudence to be followed by regional courts for the benefit of present and future generations.

Another plausible recommendation is the case of *underwater self-determination as a justification for compensating climate migrants for their loss of independence*. A 2014 study from Mälardalen University suggests the adoption of a graduated understanding of "self-determination" in which climate migrants may still maintain their collective right to self-determination even after being forced to leave their home country [26]. This "deterritorialized state proposal" suggests that people of a vanishing island state could continue to exercise sovereign control over the abandoned territory. Then, when the last rock disappears, the territory will continue to exist under the sea. Thereafter, the people of the vanished

island state will continue to exercise sovereign control over what were their territorial waters. The author of the study argues that migrants can seek compensation for the loss of independence *The downside: it is impossible to completely compensate for the loss of independence.*

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Walking around the African continent: One Health experiences

by Giovanni Poglayen, Benedetto Morandi, Gianluca Zaffarano, Filippo Maria Dini*

Abstract

The One Health approach integrates human, animal, and environmental health to address several social issues, including zoonotic diseases. The concept, introduced to the veterinary domain in Italy by Adriano Mantovani and developed by his students, emphasizes the interconnectedness of species and their shared environment. The paper traces several research projects performed in Africa that illustrate this approach. In Somalia, Italian cooperation in Mogadishu led to studies on helminths in stray cats and chickens, revealing significant zoonotic threats, particularly from Ancylostomatidae species. A 2008 investigation into 1400 land turtles from North Africa uncovered a high prevalence of various *Salmonella* serotypes and *Hyalomma aegypticum* ticks, underscoring the risks of exotic pets. Research in Sahrawi refugee camps revealrd ultrasonography evidence of echinococcosis in humans and parasitological findings in animals, while a seropositivity rate of 32% for toxoplasmosis, necessitating further study despite limited funding. A study on wild ruminants in South African game preserves linked poor body condition scores to high parasite loads, emphasizing the need for effective management practices to conserve biodiversity and prevent zoonotic diseases. For the first time, *Echinococcus equinus* was reported in a white rhinoceros in Kruger National Park, expanding knowledge on wildlife parasitology. At Songea slaughterhouse in Tanzania, a high prevalence of fasciolosis in cattle was linked to water sources, revealing significant economic and zoonotic impacts, furthermore, the laboratory analyses allowed to exclude some important zoonotic diseases in the slaughtered animals. A study in Limpopo National Park, Mozambique, identified *Echinococcus ortleppi* in cattle, highlighting the challenges of disease monitoring in rural areas. The paper underscores the value of integrating local knowledge and international cooperation in advancing the One Health agenda and addressing neglected zoonotic diseases in Africa.

Keywords

Africa, Zoonoses, One Health, Parasitic Diseases, Neglected Diseases.

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One Health, to which this new journal is dedicated, should convey a new approach to zoonotic diseases. Doubt becomes mandatory as *Homo Sapiens* has since its origins noticed similarities between his peers and animals and has studied and interpreted them up to the Middle Age when a fracture appeared on the theological level. Later on this mutual path has taken shape and it has evolved until nowadays with undeniable similarities at the level of anatomo-physiology, diagnostics, therapy and prophylaxis.

The fact that animals and mankind live in the same environment has led us to also take into account the environmental wellbeing in a harmonic setting involving humans, animals and the environment that has to be preserved.

In modern times, in our country, the *One Health* concept has been introduced in the veterinary domain by Adriano Mantovani in Bologna and it has been developed by his students of which I am honoured to be part (G. Poglayen). This is what led us to interpret most of our parasitological experiences within this very practical approach which can also be described as philosophical [1]. Our Africa (according to the order of publication) begins through a third party in Mogadishu. Through the protectorate on Somalia which was achieved after the second world war, Italy has undertaken many cooperation activities among which the Faculty of Veterinary Medicine whose aim was to involve local professors and instruct prospective graduates on the management of the remarkable zootechnical heritage. Since 1974 the Faculty, headed by the University of Pisa, has seen the involvement of many professors from different Italian Faculties and it has regularly published the results of research conducted in Somalia on a Scientific Bulletin of the Zootechnics and Veterinary Medicine Faculty published in Turin.

With the fall of the Republic of Somalia and the outburst of the civil war everything has been lost and many Somali colleagues were forced to exile. Some of them went to Canada, many in the United Kingdom, where they were granted a fixed state subsidy, and others in Italy, favoured by a language familiar to them but with little to no protection from the economic point of view (meagre scolarships, short term contracts...). Among the latter the head of the Faculty in Mogadishu, Professor Osman Issa Gadale, landed in Bologna and attended the laboratory of Parasitic Diseases where we were able to involve him on research that allowed him to renew the scholarship and to obtain the PhD. Thanks to his contacts with the home country we were able to examine the digestive tract of 50 stray cats (*Felis catus*) captured and eutanasized in Mogadishc. All the animals resulted positive for helminths: *Toxocara cati* (28%), *Ancylostoma braziliense* (78%), *A. tubaeforme* (2%), *Dipylidium caninum* (34%), *Diplopylidium noelleri* (4%), *Joyeuxiella pasqualei* (62%), *Taenia taeniaeformis* (4%), *Taenia* sp (6%) and *Moniliformis* sp (2%). None of these parasites was previously reported in Soamali cats. The approach allowed to study also the parasite distribution inside the hosts to define each role. However, the most important result was the high number of Ancylostomatidae species with a zoonotic role (creeping eruption) in the urban environment during a civil war [2]. The results was also reported on the official journal of the Italian

Parasitology Society, Parassitologia [3].

The undisputed influence and prestige that prof. Osman had still in his homeland allowed us to realize another experience. This time we studied chicken helminths, considering this animal a resource of protein food, very common and easy to obtain. An epidemiological survey was carried out on helminths in the digestive tract of chickens (*Gallus gallus domesticus*) in Somalia [4]. One hundred and forty chickens of a local breed and originating from two different types of rearing system (environment) were used: 125 had been free-range chickens taken to a slaugtherhouse in Mogadishu and 15 were obtained from an intensive-rearing farm. Of the 140 chickens examined 110 were infected (79%). 104 were from free-range flocks and 6 from the intensive-rearing farm. Therefore, 83 % of the animals of the first group and 40% of the second were infected. Differences in prevalence of endoparasites in both environments were statistically significant (P< 0.01). The identified parasite species were: *Ascaridia galli, Subulura suctoria, Raillietina (Raillietina) tetragona, Raillietina (Raillietina) echinobothrida, Raillietina (Skriabjnia) cesticillus, Raillietina (Paroniella) sp, Raillietina (Raillietina) sp, Raillietina* sp, *Cotugna* sp and *Mediorhyncus gallinarum*. The parasites presented various associations. No zoonotic helmints were found but the damage from parasites can itself be considered in modern terms a real zoonosis, particularly in Africa. In fact, according to Mantovani (2013) [5] the term zoonosis should be understood as "any detriment to the health and/or quality of human life deriving from relationships with (other) vertebrate or edible or toxic invertebrate animals". From this perspective, even the death, insufficient growth of a chicken or a reduction in the number of eggs can be considered a zoonosis.

It is not always necessary to travel to african continent to encounter disease agents to be introduced into our country. This is the case of a seizure of 1400 land turtles (*Testudo graeca*) from North Africa carried out in Palermo by the CITES forestry police unit in 2008. The health status of the reptiles was conducted through clinical examination, cloacal swab and search for any ectoparasites (ticks). The results of the consequent investigation are absolutely worrying and show the presence of 20 different salmonella serotypes in 62% of the subjects, of which over a quarter belong to "exotic" serotypes. Even the only tick species isolated in 37% of turtles *Hyalomma aegypticum* is of considerable importance for human health as it is capable of carrying for instances the Crimean-Congo Haemorrhagic virus [6]. It does not seem superfluous to underline the terrible fashion of choosing exotic animals as pets, which are a harbinger of health and environmental risks.

The Sahrawis are a nomadic people driven from their territories by Morocco with the support of Spain. Since 1979 they have lived relegated to 5 refugee camps in the Algerian desert, depending on international support and on the help of NGOs. With a continuous hemorrhage of young people emigrating to Spain we can say that we are driving the proud nomadic people to extinction. The NGO Africa 70 had the merit of successfully reorganizing the veterinary healthcare service from slaughter control to animal care by recovering veterinarians (who graduated in Cuba and subsequently abandoned in the camps)

and training a generation of young support technicians. The sending of Italian colleagues allowed the study and implementation of specific research subsequently published which demonstrates not only help material. Regarding Echinococcosis the presence of cystic lesions was demonstrated by ultrasonograpuy in adult people (22 out of 263) but not serologically confirmed. Out of 37 childrens, one resulted positive [7].

Taking into consideration that this ethnic group occupies a restricted area of the desert in cohabitation with different domestic animals (dogs, cats, sheep, goats, camels) another serological research was performed on echinococcosis and toxoplasmosis. No echinococcosis was revealed in humans but adult worms were found in dogs and cysts in camels (Poglayen, personal communication). Concerning *Toxoplasma*, a positivity rate (IgG) of 32% was recorded with an higher level in female in the age class 5-10 years. This data would be worthy of further study but the scarcity of funding has drastically reduced activities. Even the 12.5 % of recent infections (IgM) would have deserved further investigation [8].

In recent past, Veterinary Medicine has focused its interest on involving wild animals non only as single head fenced in captivity and therefore clinically similar to domestic one, but also as free-living populations. All these are meant to protect biodiversity and curtail the possible spread of pathogens and zoonotic disease. These preliminary considerations suggest transferring the clinical approach proposed by Bologna [9] and more recently by Cambridge Academy [10] simplifying and adapting them to wild ruminants in game preserves of South Africa. These are wild farms suitable for the conservation, including breeding of species of local wildlife particularly valuable, from economic, touristic or endangered point of view. Their management is quite particular: wild ruminants are fenced on many hectares of land and continuosly exchanged with other preserves. Considering that from this wild farm parasitological information are lacking and also domestic ruminants are raised close the wild ones, we suggested transferring the clinical approach cited adapting them to wild ruminants by a visual system for scoring body condition (telediagnosis). Body Condition Score (BCS) is an index of an animal's health [11]. An increase or decrease in Body Conditions could mean a change in quality of management or environment in which an animal lives. The wildlife BCS should be linked to the presence of gastrointestinal parasites that should be recognized, counted and statistically evaluated. Another purpose to study the parasitism of wild ruminants should be to help their management by rangers. Our survey was done in 6 preserves in the Eastern region of Garden Route, Republic of South Africa during February 2016. Overall, we had the opportunity to work with 103 animals belonging to 15 different ruminant species. To evaluate the BCS the animals were identified through an optical instrument (field glass Olympus 10X50) at dropping time and subsequently photographed. Fecal samples were collected from each animal, parasitological exams were performed and the results statistically evaluated. The 83.5% of samples resulted positive for gastrointestinal strongyles (GIS) and 21.85% were also positive for coccidia. Scarce BCS values resulted linked to the higher parasite presence, same animals

should be treated avoiding its loss. The present paper is full part of the limited experiences of telediagnosis in a conservation perspective. The preserves owners were enthusiastic about our work and the management advice that emerged from it. For our part we can affirm that only with their collaboration we have been able to obtain transferable results even in situations of complete freedom of the animals as happens in national parks [12].

The great helpful and collaboration on the part of the managers, colleagues and rangers of the Krugher National Park have offered us the opportunity to report, for the first time in the world, *E. equinus* in the white rhinoceros (*Ceratotherium simum simum*). The animal was killed by poachers, but rangers and vets arrived shortly after the lions that had spared the thoracic cavity were was possible to find four cysts in the lungs. The cysts were fertile with many protoscolices inside and subjected to PCR allowing to define the strain *E. equinus*, the same genotype present in zebras of the area. This strain is not tansmissible to man and the local definitive carnivorous host is unknown and we are searching for it [13].

The activity of Vet for Africa NGO, supported by the Bologna University in Tanzania allowed us to collect disease information at Songea slaughtherhouse (South Tanzania). With the collaboration of official veterinarians, we wanted to investigate further the parasite presence with particular attention to zoonotic ones deepening inspective diagnosis by means of parasitological and histological investigations on tissue samples. Overall the slaughter data of 614 animals were reported. In most cases slaugthered cattle belonged to local breeds and came from Mbeya region. Fasciolosis (diagnosed in 44.6 % of animals) was the most frequent condition, followed by respiratory diseases (24.4%), aortic onchocerciasis (6.5%), hydatidosis (5.5%) and bovine cysticercosis. Laboratory analysis identified *Fasciola gigantica* as the species involved in hepatic distomatosis in this area; In an attempt to identify the cause of this high prevalence, we found that all the cattle were taken to local rivers to drink every morning and evening, where they inevitably came into contact with the intermediate host snail.. Cases macroscopically ascribed to cysticercosis turned out to be a muscular form of onchocerchiasis (by *Onchocerca dukey*), a neglected and unrecognised parasitic disease in Tanzania, questioning the real frequence of a zoonosis that causes primarily major economic losses. Pulmonary cysts, referred as hydatidosis at visual inspection, were histologically identified ad haemal nodes, lymphoid organs common in ruminants, but described in cattle lungs for the first time in the present research. Slaugtherhouse demonstated to be an important epidemiological observatory, especially for neglected parasitoses. The possibility of having basic laboratory diagnostic as an aid to visual inspection can ensure greater efficiency of veterinary service in the control of important livestock disease and zoonoses in the frame of a One Health perspective [14].

Cystic echinococcosis (CE) is included in WHO (World Health Organization) list of the most frequent Neglected Zoonotic Diseases (NZDs) and is a major problem in rural areas where hygienic measures are poor. Prevalence of the disease in humans is often underestimated given the challenges in carrying out studies in resource-poor communities

in remote and isolated geographic areas. A prevalence and genotyping study was conducted in the Limpopo National Park (LNP), Gaza province (Mozambique), to evaluate the effects of this parasitic disease on liverstock production, wildlife health and possible public health risk in this human-wildlife interface conservation area. A total of 204 cattle were inspected in the Massingir slaughterouse which is the focal point for all animals reared in the LNP and its buffer zone. Inspection detected 25 animals with cystic-like lesions in various organs, of which 22 were microscopically confirmed as *Echinococcus granulosus* s.l., representing a prevalence of 10.8%. Subsequent molecular analysis confirmed that the samples belonged to strain G5, now reclassified as *E. ortleppi*, one of the known zoonotic *Echinococcus* species. Due to the poor attention observed by local technicians during inspection procedures on the occasion of the visit of the European Cooperation Inspectors we prepared a poster on the veterinarian importance during animal inspection to be displayed in the slaughterhouses and schools in the area (Figure 1) [15].

At the end of this brief review of our activity on the African continent we would like to highlight that a modest knowledge gap was also completed also with the support of local colleagues and above all it was possible to scientifically demonstrate the cooperation's activity, which is quite rare.

Figure 1. Poster prepared to illustrate the main livestock diseases that can be found at slaughter in the context of the research activity conducted in Mozambique.

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Female Genital Mutilation (FGM): a theological reflection on islamic and evangelical christianity practises in Ethiopia

by Mohammed Worku Hailemariam*

khafḍ or *khifaḍ* (Arabic): reduce
gizrat or *girzat* (Amharic): cutting. [1]

Abstract
Female Genital Mutilation (FGM) is an ongoing problem here in Ethiopia and elsewhere. There are plans, projects, and initiatives implemented here and there to stop FGM which is harmful traditional practise s in limited time frames 1-5 years down the road. A great deal of results has been achieved over the years among Muslims and Evangelical Christians. However, efforts towards the planned goal remained challenged and at times discouraged, and seeing the slow process is common in reaching the targeted goals. In this brief reflection, the author of this piece will focus on the theological bases and religious practises of Islam and Evangelical Christians. On the one hand, Islam is promoting FGM traditionally as part of obligatory religious practises. In the early days of Islam, FGM was practised with the knowledge of the leaders of Islam including Prophet Muhammed himself as traditional and religious purification order which seemed obligatory action. On the other hand, Evangelical Christianity also practises FGM as part of culturally accepted traditions considered as part and parcel of spiritual purification. Though both sides have observed significant progress over the past two decades or so, formulating theological direction and condemning FGM again in a louder voice must be promoted and remembered now and then. The issue of FGM is highly interwoven and justified with traditional and religious practises. Some practical actions will be recommended to revisit the prevalence of FGM and protection of women from FGM will-be offered at the end of this brief article considering Islamic and Evangelical Christian theology. Ethiopians are a religious community, eager to listen and follow their religious leaders and orders. The purpose of this piece is to offer a call to revisit the FGM practise in Ethiopia amongst the religious circles in general and within Islam and Evangelical Christianity in particular.

Keywords
Female Genital Mutilation, Ethiopia, Religion, Anthropology, Traditional Practices.

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1. Introduction

Ethiopia is a country located in Eastern Africa and placed at the Horn of Africa with a population size of over 120 million and 88+ people and language groups with long history of practicing Christianity and Islam as well as indigenous traditions, with estimated percentages of Christians in general 63%, Muslims 35%, others 2%. 28 people and language groups are excepted, including the Hamer, Bunna, Mursi, and the Me'en from FGM. FGM has been an issue and might continue to be an issue with the rest of 60+ people and language groups in Ethiopia. FGM, due to the nature of the problem which is highly interwoven with both traditional and religious practises, it won't be easy to eradicate as quickly as possible. This traditional and religious practise is generally performed to control female sexuality and has lifelong consequences for both the woman and also for men or partner. Female Genital Mutilation, Cutting, Circumcision is practised in many cultures around the world and cause untold medical harm and unnecessary pain to women. It is a procedure that is usually performed as traditional and religious practise to control a woman's sexuality. Once done, it is permanent and has lifelong consequences for a woman and her husband.

Traditional and religious practises are interconnected in the Ethiopians beliefs and practises. So, the religious part should be addressed accordingly using their authoritative scriptures like the Quran, Hadith, and Bible considering their science of interpretation (*tafsir, exegesis*). The author of this piece will do his best to tackle few scriptural passages from Islam and Evangelical Christianity.

Let me begin by a quote from Ayaan Hirsi Ali's speech [2]:

> I was born in Somalia, I spent my formative years there, in Saudi Arabia, Ethiopia, and Kenya [...] I was part of a clan culture, where the blood line matter about everything else. [...] No escape from a clan.. I was raised as a Muslim girl, I attended Quran school, in according to my clan and my village. [...] I, like the majority of other Somali girls underwent through female genital mutilation, [FGM] purification as it was described.

It is not a surprise to see that Female Genital Mutilation (FGM) is considered as religious purification and practises in both Islam and Evangelical Christianity, at least in Ethiopia. It has been there for centuries and might continue for sometimes in the years ahead.

2. Islamic theology on FGM

Historical records confirmed that FGM was practiced before Islam introduced it as a religion in Africa or elsewhere. In Islamic theology, there is not a clear theological reflection about FGM. However, some practised it, mainly those who inclined with the Shafi'a school of thought and by others like Hanafi, Malik, and Hanbali are less practised though not forbidden. Views on FGM in the authoritative books of Islam and practises including the Quran, Hadith, and Ijma/Qiyas.

2.1. *Quran*

The Quran is void of any reference to FGM. FGM is praised in a few hadith (sayings attributed to Muhammad) as noble but not required. Though the authenticity of these hadith has been questioned, practicing

FGM amongst Muslim communities is continued with a significant decrease. So, no base for FGM from the main authoritative text, which is the Quran, but a few Hadith excepted.

2.2. *Hadith or Sunna (traditions according to prophet Muhammed)*

FGM is neither discouraged nor encouraged in the reliable (*sahih*) Hadith/Sunna. However, Muhammad said to a woman used to perform circumcision in Medina: "Do not cut severely as that is better for a woman and more desirable for a husband". It is worth noting that, in Islam, Muhammad is considered as uninspired Prophet with inspired sayings. So, from this hadith, we can draw a conclusion of that FGM is permitted in a way of practising with less severity in order to full fill the desire of the husbands. Practising FGM in any of the forms is dangerous, although the level of pain and consequences differ from person to person. The Islamic communities practising FGM in a massive way, but the dilemma in interpreting the authoritative passages like the Hadith/Sunna of Muhammad is always tricky. One of the arguments could be: stop FGM, because there no evidence that Muhammad gave strong blessing or there is no evidence that Muhammad practised FGM towards his daughters. I argue that making an interpretation (*tafsir*) to Muhammad's saying, better to stop it in order to full fill the desire of the husbands which in Islam have a great deal of making your husbands happy.

2.3. *Ijma' or Qiyas (consensus or analogy)*

Dr Kermani writes at a symposium in Arusha Tanzania, in August 2000: "We understand that female circumcision is not an Islamic tradition or a religious obligation. Moreover, in its most severe form it is considered as an anti-Islamic act. In fact, performing or not performing such an action should depend on medical instructions that in the case of necessity and being of interest and not as a tradition Practised by all individuals. Therefore, performing this action in Islam is not prohibited, and neither is it emphasised; however, it is left to circumstances and necessities" (Inter-African Committee – AIC, 2000, p. 82).

According to most forms of Islam and fatwas have been issued the decision to parents but advising against it. However, FGM was introduced in Ethiopia through the spread of Shafi'a School of thought which is one of the Sunni Islamic Jurisprudence which considers the practise as obligatory.

On the contrary, FGM is a distortion of God's creation by cutting and inflicting pain on a woman. The Prophet banned such alteration and is said to have cursed those who introduce any change in the creation of Allah. It is the most famous Hadith in which it is related that a woman called Om Atteya performed circumcision in Medina and that the Prophet told her: "Do not cut severely as that is better for a woman and more desirable for a husband" (Sunna Abu Dawd 5271-43 General Behaviour [Kitab Al-Adab] 180 Chapter: Regarding circumcision) [3].

Based on this tradition, it is difficult to conclude that Islam is allowed FGM or even strictly prohibited such practise as it is mentioned as the weak parts of saying of the Prophet Muhammed. Muhammed himself admitted the causing pain on a woman due to such unhealthy practise of the Muslim society.

3. Evangelical theology

3.1. *Bible*

The Old Testament in Psalm Chapter 139 verses 13-15: David, the Psalmist writes "You created me in my inmost being: You knit me together in my mother's womb. I praise you because I am fearfully and wonderfully made. Your works are wonderful, I know that full well. My frame was not hidden from you when I was made in the secret place. When I was woven together in the depth of the earth, your eyes saw my unformed body". Reading this passage will inform us to preserve all parts of our body whether that are little or hidden; outside or inside of our bodies, all parts of our body need proper respect and admiration and of course a very great reason to praise the creator God.

The New Testament in 1 *Corinthians* 6:19, it is stated, "Do you not know that your bodies are temples of the Holy Spirit, who is in you, whom you have received from God? You are not your own". This means that our bodies are not our own but of God, and that is why it should be clear and pure of unnecessary impurities. Based on this verse, I can argue that FGM is one of the unnecessary impurities which deny God given pleasure and brings pain instead. So it should be stopped in order to bring honour to human beings and glory to God.

3.2. *Evangelical theologians/ scholars in the field of FGM*

Scholars suggest that FGM is supported by people who are more inclined to traditional and cultural than practises biblical rather than biblical basis. FGM is not mentioned anywhere in the Bible, and it goes against many of the Christian beliefs around protecting, respecting and not altering the body God built for you. So, this is the popular view supported by the majority of evangelical scholars if not all.

3.3. *Current trends, practises, and ground realities*

Current Trends and Practises suggest biblically unfounded and unhealthy misconceptions with regard FGM. Some of the misconceptions are: i) FGM preserve the girl's virginity and keep her for her husband. ii) It will keep the girl 'cool' and make her sex drive less. iii) The women must be passive so that she will be well behaved and listen to her husband and fight. iv) if the girl is not circumcised, she will not get a good bride price. Her father will suffer economically. These practises are still going around among Muslims and Evangelical Christians with baseless religious scriptures. FGM practises is decreasing significantly in urban areas but slow in the rural setup. FGM is taking place underground or in a hidden form due to the consideration of criminal law. Since 2004, FGM is a violation of human rights and has been prohibited in the Ethiopian criminal law.

4. Conclusion and recommendations

FGM is Practised in most parts of Ethiopia in general, hugely in the eastern parts of the country in particular, mainly in the Somali Region. That's why I started my introduction by mentioning a Somali born Ayaan Hirsi Ali who is one of the leading activists in criticising Islamic Extremism and harmful traditional practise in this piece of writing. The ongoing research on FGM in Ethiopia [4] shows that 82.2% of Muslim women aged 15-49 have undergone FGM/C,

compared to 65.8% of protestant women. The interesting part of these data is both religions are trying and explaining the practise as bad and dangerous, but they found themselves doing it hugely, particularly Muslims.

FGM is now firmly on the global development agenda, most prominently through its inclusion in Sustainable Development Goal (SDG) target which aims to eliminate the practice by 2030. Ethiopia should not be out of this plan. As indicated in the UNICEF FGM Country Profile on Ethiopia (2020) [5], the country is "home to 25 million girls and women who have experienced FGM" (Female Genital Mutilation/Cutting), the largest absolute number in Eastern and Southern Africa.

Though there are initiatives and programmes by UNFPA-UNICEF and the like within Ethiopia to stop the FGM in the coming 5 years or so, the practise is continued as religious obligations. The United Nations General Assembly passed The Girl Child Resolution (A/RES/51/76), Recognising female genital mutilation as a form of "discrimination against the girl child and the violation of the rights of the girl child". It is also prohibited in the Ethiopian law: "FGM is a violation of human rights and has been prohibited in Ethiopia's criminal code since 2004".

Female Genital Mutilation, Cutting, Circumcision is practised in many cultures in the world and cause untold medical harm and unnecessary pain to women. It is a procedure that is usually performed as traditional and religious practise to control a woman's sexuality. Once done, it is permanent and has lifelong consequences for a woman and her husband.

According to the DHS 2005, the prevalence of FGM among women aged 15-49 in Ethiopia is 74.3%. Prevalence has decreased from 79.9% in 2000, a statistically significant decrease of 5.6 percentage points over five years. The EGLDAM data shows a decrease from 73% in 1997 to 57% in 2007, a decrease of 16 percentage points over 10 years. The DHS data shows a general trend towards a lower prevalence in younger women, also suggesting that the practise is declining. UNICEF calculates that 23.8 million women and girls in Ethiopia have undergone FGM. In terms of absolute numbers, this is one of the highest numbers of girls and women who have undergone FGM in Africa, second only to Egypt 37.7% of women with at least one living daughter have a daughter who has undergone FGM.

UNFPA-UNICEF Joint Programme on the elimination of Female Genital Mutilation (FGM) in Ethiopia contributes to the national commitment to end FGM and child marriage by 2025, and to achieve SDG target 5.3 by 2030. The programme is led by the Ministry of Women and Social Affairs. It also plays catalytic role via the National Alliance to End FGM and Child Marriage, which engages over 60 memberships from other ministries, civil society, non-governmental organizations and UN entities. The programme envisions to implement the national costed roadmap and accelerate institutional, individual and community level efforts as to end FGM by 2030, the country requires to progress eight times faster than what has been observed in the past 15 years.

I the author of this piece highly recommend to scholars of Islam and Evangelical Christianity should work very closely in order to tackle FGM practises in Ethiopia with a huge voice which bring impact to

not only minimise significantly but to stop forever. Violations of God's command is strictly forbidden by both religious circles. On the Friday's preaching (*khutbah*) in the mosques, 'stop FGM' must be part and parcel of the talk and the teachings for those days. The same should be done on Sundays preaching in the churches, 'stop FGM' must be on the top of the preaching agenda to bring honour to humans and glory to the almighty God. FGM MUST BE CURSED not only as unhealthy and harmful practises but as a great sin which hinder the believers to enter to the kingdom of God which both sides are longing too.

Appendix I: stories and type of FGM

Story 1

"Some time ago I went to visit a friend who gave birth to a baby girl. We praised the Lord for His provision. Accidentally [Unintentionally], we raised the issue of female 'circumcision'. I asked my friend what her plan was regarding her baby. She immediately responded that she would get her circumcised after 80 days. I was shocked.

The discussion grew wild. There was division in the house. The mother insisted that if girls are not circumcised, the clitoris, (which in fact dose not grow more than a pea-head), would grow big in size and would cover the vaginal entrance. With surprise, I asked if she was serious. She again affirmed it to be true. I was indeed upset by the belief of these ladies. Why did God create the clitoris if it was to grow and cover the entrance to the vagina? God does not play games with our bodies. In fact, it was a sad to hear such false information from an 'educated' mother. The mother also thought she should make some type of circumcision covenant relationship with God. But God does not mention anything regarding Female Genital Mutilation or Female 'Circumcision'. I felt sad for the innocent girls who are made victims for nothing but wrong beliefs".

Story 2

A 15 year-old Oromo girl cam into a clinic in agony because she had been unable to urinate for more than 24 hours. The health worker drained her bladder and sent her home. She was soon back with a full bladder. This time the nurse noticed that her pelvic (perineal) area was swollen. Suspecting that the woman had undergone FGM, the nurse asked if the patient had started her monthly bleeding [menstruation]. The answer was 'no'. A physical examination revealed that the vaginal opening was completely closed as a result of FGM. Once the vagina was re-opened, foul-smelling, dried blood pored out. Swelling caused by menstrual blood that could not escape, had squeezed against the urinary passage, preventing the flow of urine.

Story 3

A group of church elders [leaders] met and decided that FGM was wrong and that Christians should not do this to their children. After this group decision every one of the elders who had a daughter officiated over his daughter's 'circumcision'.

A group of women at a Bible school received teaching on the subject of FGM and acknowledged that it is not a biblical practise and that it should be stopped. They were asked to spend thirty minutes in groups coming up with a strategy to bring about change in their home areas. Their response was that if they were not circumcised or if they did not have

their daughters circumcised then they would have no hope of getting married and having children.

Appendix II: types of FGM (taken from *Cut Flowers: Female Genital Mutilation and a Biblical Response,* by Sandy Willcox with Arina Short, pp. 6-7)

The World Health Organisation (WHO) has categorized of Female Genitals into four types. It is worth noting that one type being done by different people and language groups. Larger people groups, for instance, the Oromo, or Amhara, or Somali have a variety of traditions relating to FGM within their people groups.

Type 1

Excision of the prepuce (hood) with or without excision of the entire clitoris or part of it.

Removal of the clitoral hood. Practised in many parts of Africa and called it Sunna, according to Islamic tradition.

Removal of all or part of the clitoris. Done in West, East, North, and Central Africa. In Ethiopia it is done by Jeberti, Tigrayans and others.

Removal of part of the labia minora (small lips) without touching the clitoris. Amhara and Agew [Awi] of Ethiopia (NCTPE survey, p. 56).

Type 2

Excision of the prepuce and clitoris together with partial or total excision of the labia minora (small lips). Practised in Ethiopia by the Gurage, Tigrigna of Tigris, and the Amhara of Gondar and Oromo.

Type 3

Excision of all or part of the external genitalia and stitching/narrowing of the vaginal opening (infibulation). Practised by some groups in Djibouti, Mali, Nigeria, Mauritania, Egypt, Chad, Kenya, and Somalia. In Ethiopia [and Eritrea] it is practised among the [Somali people], Kotu, Benja, Erbore, Affar, Bellen, Tigre, Rashaida, and Saho.

Type 4

Unclassified:

- Introcision. A very extreme form of mutilation involving the external and internal genital organs is practised by the Pitta-Patta of Australia.
- Pricking, piercing, and incision of the clitoris and labia.
- Stretching of the clitoris or labia, e.g. in Ruanda.
- Cauterisation by burning. The insertion of substances to the vagina to cause bleeding and subsequent narrowing of the vagina.

Notes and References

1. Circumcision is valid for both men and women, though it is said only for men. If a girl is not circumcised, her breast will not be mature, famous, and the greatest. Circumcision is the reason why the of the book of philosophers has said, the main reason to see bigger, swelling, and blowing breast, is circumcision (FGM). *Amharic Dictionary*, p. 320.

2. Ayaan Hirsi Ali's speech, entitled *The Escape from Islamic Extremism* she is also known by Women's rights advocacy, criticism of female genital mutilation, criticism of religion, criticism of Islam, criticism of Islamism, honour killing, opposing forced marriage, and opposing child marriage.

3. Narrated Umm Atiyyah al-Ansariyyah: A woman used to perform circumcision in Medina. The Prophet (ﷺ) said to her: Do not cut severely as that is better for a woman and more desirable for a husband. Abu Dawud said: It has been transmitted by 'Ubaid Allah b. 'Amr from 'Abd al-Malik to the same effect through a different chain. Abu Dawud said: It is not a strong tradition. It has been transmitted in mursal form (missing the link of the Companions) Abu Dawud said: Muhammad b. Hasan is obscure, and this tradition is weak.

4. FGM/C is practised across all regions, religions and ethnic groups in Ethiopia. FGM/C among women aged 15-49 is more prevalent in the east of the country, and the region with the highest prevalence is Somali, at 98.5%. The lowest prevalence is in Tigray, at 24.2%. It should be noted that small sample sizes were used in many of the regions, and figures therefore may not be accurate. Women who live in rural areas are more likely to be cut (68.4% of women aged 15-49) than women who live in urban areas (53.9%). The Somali are the ethnic group with the highest prevalence of FGM/C among women aged 15-49, at 98.5%, followed by the Affar at 98.4% (however, once again, the small sample size makes this figure potentially unreliable). The ethnic group with the lowest prevalence is the Tigray, at 23%. https://www.fgmcri.org/country/ethiopia/.

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Architectural design strategies for infection prevention and control in resource-limited rural healthcare facilities in developing countries: bridging the gap with context-sensitive design

by Cecilia Ceccarelli, Alessandra Ciccozzi, Marta Giovanetti, Francesco Branda, Laura Elena Pacifici Noja, Fabio Scarpa, Massimo Ciccozzi, Giancarlo Ceccarelli*

Abstract

Infectious diseases pose a significant threat to public health, particularly in developing countries where access to healthcare is often limited. This challenge is further exacerbated in rural areas, where resource constraints and infrastructural limitations hinder the implementation of effective infection prevention and control measures. Architectural design plays a crucial role in mitigating these challenges by creating healthcare environments that inherently minimize the risk of infection transmission. This paper explores context-sensitive architectural design strategies for rural primary healthcare facilities in developing countries, focusing on maximizing IPC efficacy within extremely resource-limited settings. Recognizing that conventional, high-tech solutions are often impractical in these contexts, we emphasize low-cost, culturally appropriate, and sustainable design interventions. By adopting a holistic and context-sensitive approach to architectural design, we can create rural healthcare facilities that are not only functional but also act as frontline defenses against infectious diseases, ultimately contributing to improved health outcomes in resource-limited settings.

Keywords

Architecture, Development, Infection Control, Low-Resources, Limited Resources, Developing Countries, Strategies, Prevention.

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1. Introduction

The Sustainable Development Goals (SDGs) have set a broad agenda to advance health and achieve equity by 2030. However, promoting healthy lives and well-being for all remains a challenge in resource-limited settings [1]. Many areas in developing countries still suffer from significant socio-economic imbalances and inequalities in access to healthcare resources and quality medical care. Infection prevention and control (IPC) is particularly challenging in rural areas where health resources are often extremely limited [2,4]. Simultaneously, infectious diseases heavily burden population health outcomes and present a formidable challenge for public health. According to the World Health Organization, a high burden of communicable diseases such as malaria, tuberculosis, and HIV/AIDS puts considerable pressure on healthcare systems in developing countries [5]. Access to care in qualified centres is difficult for a large portion of the population in these areas, and as a result, the SDGs for reducing infection-related mortality rates remain unmet (fig 1) [6].

Given these challenges, the availability of healthcare facilities capable of effectively responding to needs in safe and highly sustainable spaces is a key priority for individual and public health, especially in extremely resource-limited rural areas.

2. Infection prevention and control in developing countries

IPC represents a fundamental, evidence-based approach aimed at safeguarding patients and healthcare workers from avoidable infections. It influences every aspect of

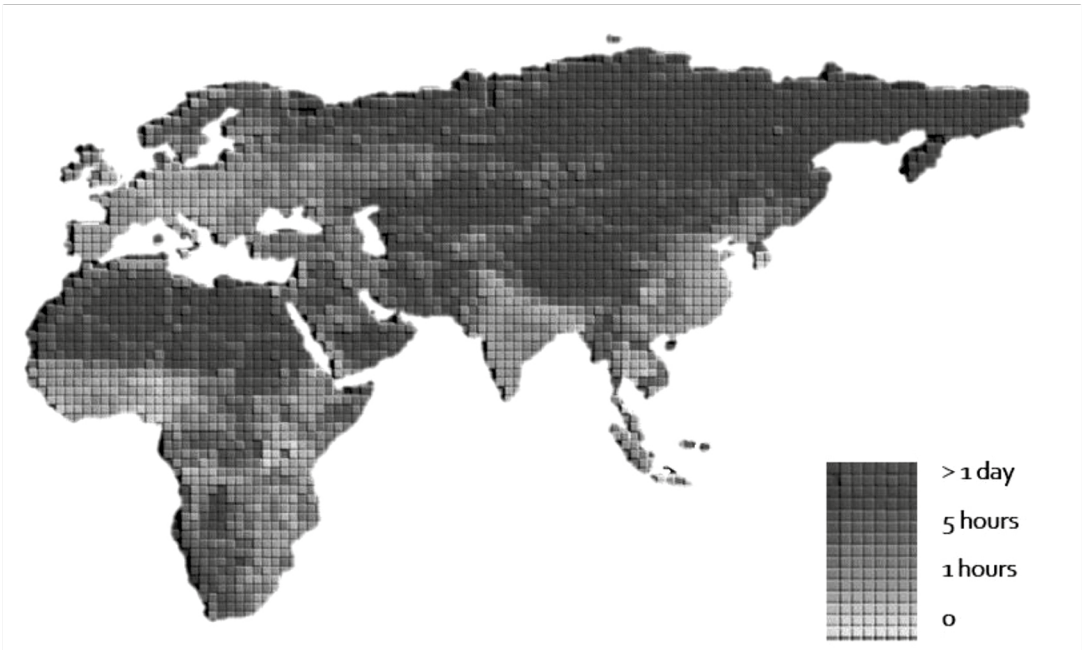

Figure 1. The walking travel time map (Africa, Europe and Asia) to Healthcare Facilities (inspired by Weiss, DJ, *et al.* Global maps of travel time to healthcare facilities. *Nat Med* 2020).

healthcare, including hand hygiene, prevention of surgical site infections, injection safety, antimicrobial resistance, and hospital operations during both emergencies and routine care [4,7-9]. IPC is unique in the realm of patient safety and quality care as it is universally relevant to every healthcare interaction, involving every patient and health worker (fig 2). Achieving effective IPC is a priority in any care programme and requires continuous efforts at all levels of the healthcare system, from policymakers and facility managers to healthcare workers and patients. Supportive IPC programmes are particularly vital in low- and middle-income countries, where healthcare delivery and hygiene standards are often compromised by secondary infections [7-9]. The World Health Organization states that the risk of healthcare-associated infections (HAIs) in developing countries is two to twenty times higher than in industrialised nations. This is due to a combination of factors: limited resources, infrastructural constraints, knowledge gaps, and socio-economic and political factors [10].

Developing countries often face shortages of essential resources such as clean water, sanitation facilities, personal protective equipment, disinfectants, and trained healthcare workers. Overcrowding in hospitals, inadequate ventilation systems, and poor waste management practices can contribute to the spread of infections. The lack of awareness and training on proper IPC practices among healthcare workers can hinder effective implementation. Moreover, poverty, malnutrition, and limited access to healthcare can increase patient susceptibility to infections.

Improving IPC in developing countries requires a multifaceted approach. Strong political will and investment in healthcare infrastructure, resources, and training pro-

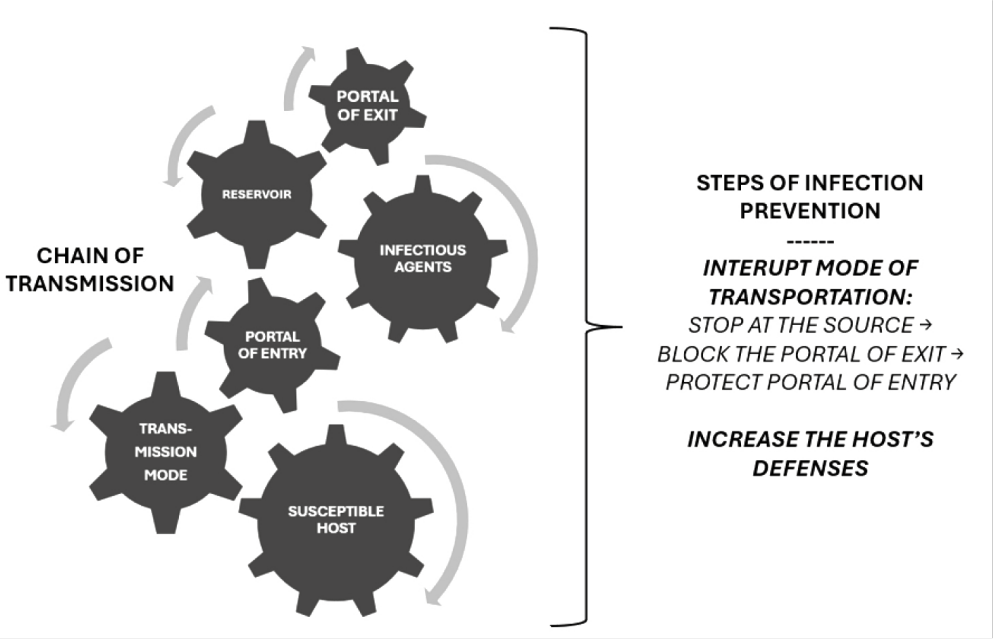

Figure 2. The chain of infection.

grammes are essential. Providing healthcare workers with the necessary resources, training, and support to implement IPC guidelines is crucial. Engaging communities in IPC efforts and promoting health education can lead to sustainable behavior change [11]. Sharing knowledge, best practices, and resources between developed and developing countries can accelerate progress. However, in under-resourced and remote rural settings, where access to high-quality healthcare infrastructure is limited, the challenge of adhering to IPC guidelines is even greater [12]. These areas often face not only high burdens of communicable diseases but also significant geographical and climatic obstacles, combined with unique social, cultural, and spiritual beliefs that collectively contribute to the difficulty of infection control [13]. The presence of small healthcare centres in these regions is crucial for safeguarding public health, yet the challenging environmental conditions prevalent in these areas often lead to minimal adherence to IPC standards. Despite the daunting challenge, there are proven strategies to improve IPC even in resource-limited settings. Key IPC strategies can be summarized in seven main points: hand hygiene, environmental cleaning and disinfection, safe injection practices, waste management, isolation precautions, antimicrobial stewardship, and education and training. Addressing these challenges and implementing effective IPC strategies can create safer healthcare environments and improve health outcomes for all, regardless of where they live [12]. A less explored yet critically important aspect of IPC application is the contribution that targeted hospital space design can make. Architectural resources and strategies can substantially enhance IPC standards even under extreme conditions and at minimal cost. Epidemiologically, the healthcare environment is considered one of the extrinsic factors that affect the infectious agent and the opportunity for exposure. Although the relationship between the healthcare environment and infectious disease prevention and control is gaining recognition, developing the knowledge of efficiently adopting design strategies for infectious disease control remains a significant challenge in developing countries [11,14].

2. Architectural design contributions to infection prevention and control in extremely resource-limited settings: passive design strategies

Architectural design can significantly contribute to infection prevention and control in healthcare facilities, even in resource-constrained settings. Even small design choices can have a big impact on IPC. By focusing on affordability, sustainability, and local context, architects can make a real difference in creating safer healthcare environments in developing countries. By embracing safe and sustainable design strategies, healthcare facilities in developing countries can move towards a more environmentally responsible, cost-effective, and resilient model of care, ultimately benefiting both present and future generations [15,16]. Finally, by engaging with local communities to understand their needs and practices related to hygiene and healthcare, policy makers and architects can organize and design healthcare facilities culturally appropriate and accepted by the community [17].

Some key strategies are reported in table 1.

Table 1. Architectural strategies for IPC.

IPC Strategies	IPC Concepts	Design Strategies
Optimizing Natural Ventilation	*Reduces Airborne Pathogens*: Good airflow naturally flushes out airborne bacteria and viruses, lowering the risk of transmission. *Cost-Effective*: Relies on natural forces, reducing the need for energy-intensive HVAC systems and their maintenance.	*Orientation*: Position the building to take advantage of prevailing winds. *Window Placement*: High and low windows create a "stack effect," drawing fresh air in and pushing stale air out. *Ventilation Shafts*: Vertical shafts can enhance natural airflow through the building. *Courtyards*: Open spaces within the facility can promote air circulation.
Optimizing Natural Lighting	*Disinfection*: Sunlight has natural germicidal properties, killing some bacteria and viruses on surfaces. *Improves Visibility*: Better visibility for cleaning staff to identify and address potential hygiene issues.	*Large Windows*: Maximize the amount of natural light entering the building. *Skylights*: Introduce sunlight into deeper areas of the facility. *Light Wells*: Reflect sunlight into interior spaces. *Light Shelves*: Horizontal surfaces that bounce daylight deeper into rooms.
Simple and Easy-to-Clean Layouts	A – Surface Porosity and Cleanability: *Prioritize Non-Porous Materials*: non-porous materials and solid surfaces are less likely to harbor microorganisms and are easier to clean and disinfect effectively. This reduces the risk of cross-contamination. *Minimize Grout Lines and Seams*: Seamless surfaces are crucial. Where seams are unavoidable, use antimicrobial sealants and ensure they are properly maintained to prevent germ accumulation. B – High-Touch Surface Considerations: *Frequent Disinfection*: Identify high-touch surfaces (door handles, bedrails, light switches, call buttons) and select materials that can withstand frequent disinfection with hospital-grade cleaners without degrading.	1 – Materials Selection: *Seamless Surfaces:* Opt for materials that create smooth, continuous surfaces with minimal grout lines, seams, or crevices where dirt and germs can accumulate. Examples include: • Solid surfacing materials (e.g., Corian, Avonite) for countertops and sinks. • Seamless flooring options like sheet vinyl, poured epoxy, or rubber flooring. • Large-format wall panels made of materials like high-pressure laminate or glass. *Non-Porous Materials:* Choose materials that are resistant to moisture and stains, making them easy to clean and disinfect. Examples include: • Metal (e.g., stainless steel) for equipment, fixtures, and furniture. • Glass for partitions, doors, and wall coverings. • Solid surface materials for countertops and sinks.

C – Design for Accessibility and Thorough Cleaning:

Easy Access for Cleaning: Ensure adequate space around equipment and furniture for easy cleaning and disinfection. Avoid tight corners or hard-to-reach areas that can be missed during routine cleaning.

Wall and Floor Junctions: Use coved baseboards or integral floor-wall transitions to eliminate dirt traps and facilitate thorough cleaning.

***

Note: Surface Properties Compliant With IPC And Job Security

VOC Emissions:

- *Low-VOC Materials*: Choose materials with low or no volatile organic compound emissions to maintain good indoor air quality and minimize potential health risks. Look for products certified by reputable organizations like Greenguard or FloorScore.

Fire Safety:

- *Fire-Resistant Materials*: Ensure all materials meet fire safety standards and building codes. Use fire-resistant materials, especially in areas with high fire risks.

Sustainability:

- *Environmentally Friendly Materials*: Consider using sustainable and recycled materials whenever possible to minimize the environmental impact of construction. Look for products with certifications like LEED or Cradle to Cradle.

Durable Finishes: Select materials with durable finishes that can withstand frequent cleaning and disinfection without degrading. Look for finishes that are:

- Moisture-resistant
  – Ceramic Tiles: With antimicrobial grout.
  – Moisture-Resistant Wall Panels: Solid phenolic, fiberglass-reinforced plastic.
- Stain-resistant
- Scratch-resistant
- Chemical-resistant

Antimicrobial Options: Consider using materials with antimicrobial properties, such as copper alloys, which can continuously kill bacteria on contact, providing an added layer of protection.

2 – Design Details:

Coved Corners: Design coved (rounded) corners where walls meet floors and ceilings. This eliminates sharp angles that are difficult to clean and can harbor dust and germs.

Integrated Features: Integrate sinks, countertops, and backsplashes seamlessly to minimize joints and crevices.

Minimal Trim and Molding: Reduce the use of decorative trim and molding, which can collect dust and make cleaning more time-consuming.

Recessed Features: Consider recessed soap dispensers, paper towel dispensers, and hand sanitizer dispensers to create a smoother wall surface.

Easy-Access Panels: Design access panels for plumbing and electrical systems that are easy to remove and clean.

3 – Additional Considerations:

Color Selection: Light-colored surfaces can make it easier to spot dirt and spills, while darker colors may show scratches and wear more easily.

Lighting Design: Adequate lighting is essential for effective cleaning. Ensure that all areas are well-lit, paying attention to corners and under furniture.

Maintenance Planning: Consider the long-term maintenance requirements of different materials and finishes when making design decisions.

Decentralized Handwashing Stations	*Strategic Locations*: Position stations in high-traffic areas and points of care, such as near room entrances, patient beds, medication preparation areas, and outside restrooms. *Visibility*: Ensure stations are easily visible and clearly marked to encourage frequent use. *Universal Design*: Design stations to be accessible to people of all abilities, considering wheelchair users, those with limited mobility, and children. *Splash Reduction*: Design sinks and faucets to minimize splashing, which can spread contaminants.	*Integrated Design*: Incorporate handwashing stations seamlessly into the overall design of the facility, rather than treating them as afterthoughts. *Space Planning*: Allocate sufficient space around stations to allow for comfortable use and to avoid crowding. *Lighting*: Provide adequate lighting to ensure visibility and promote proper hand hygiene. *Signage and Education*: Use clear signage to indicate the location of stations and reinforce proper handwashing techniques. *Flexibility and Adaptability*: Design stations to be modular or adaptable to accommodate future changes in needs or technology. *Water Conservation*: Explore water-saving features like low-flow faucets and automatic shut-off valves.
Spatial Separation and Zoning	A – Risk Stratification and Separation: *Identify Risk Levels*: Assess different areas of the facility and categorize them based on the risk of infection transmission (e.g., high-risk areas like operating rooms and isolation rooms, moderate-risk areas like patient wards, low-risk areas like administrative offices). *Physical Barriers*: Use walls, partitions, doors, and corridors to create physical separation between areas of different risk levels. This helps contain potential outbreaks and prevents the spread of infectious agents. *Air Pressure Control:* Employ air pressure differentials to control airflow between zones. For example, maintain negative pressure in isolation rooms to prevent airborne pathogens from escaping. B – Zoning for Infection Control: *Functional Zones:* Divide the facility into distinct zones based on their function (e.g., patient care zones, staff zones, public zones). This helps minimize unnecessary traffic and potential cross-contamination between different user groups.	*Flexible Design*: Incorporate flexible design elements, such as movable partitions or adaptable rooms, to easily modify zoning layouts in response to changing needs or outbreaks. *Visibility and Natural Light*: Design spaces with good visibility to promote observation and natural surveillance. Maximize natural light to create a more pleasant and healthier environment. *Outdoor Spaces*: Integrate outdoor spaces, such as courtyards or gardens, to provide opportunities for fresh air and respite for patients, staff, and visitors. *Technology Integration*: Consider incorporating technology, such as real-time location systems or digital signage, to monitor and manage traffic flow and communicate zoning protocols effectively. Additional Considerations: • *Cultural Sensitivity:* Be mindful of cultural norms and practices when designing for spatial separation and zoning. • *Staff Training:* Provide comprehensive training to staff on infection control protocols and the rationale behind zoning strategies.

	Clean vs. Dirty Workflows: Establish clear pathways for the movement of people, equipment, and materials to separate "clean" and "dirty" workflows. This helps prevent the spread of contaminants from contaminated areas to clean areas. C – Traffic Flow and Wayfinding: *Minimize Cross-Traffic:* Design circulation routes to minimize the intersection of staff, patients, and visitors from different risk zones. Use separate entrances, hallways, or elevators for different user groups. *Clear Signage:* Implement clear and intuitive signage to guide people through the facility and reinforce zoning protocols. *Visual Cues:* Use color-coding, floor markings, or other visual cues to differentiate between zones and guide traffic flow.	• *Regular Evaluation:* Regularly evaluate and adjust zoning plans based on infection control data, staff feedback, and best practices
Waste Management	A – Waste Segregation at Source: *Clearly Defined Categories*: Implement a color-coded system with clearly labeled containers for different waste streams: • General Waste: Non-hazardous waste. • Infectious Waste: Waste contaminated with blood, body fluids, or potentially infectious materials. • Sharps Waste: Needles, scalpels, and other sharp objects. • Pharmaceutical Waste: Expired or unused medications. • Recyclable Waste: Paper, plastic, glass. *Strategically Placed Containers:* Position waste containers in convenient locations near the point of waste generation to encourage proper segregation. B – Waste Minimization: *Reduce, Reuse, Recycle:* Implement strategies to reduce waste generation, such as using reusable items whenever possible and exploring recycling options for appropriate materials. *Inventory Control:* Manage medical supplies effectively to minimize expiration and waste.	*Dedicated Waste Rooms*: Designate dedicated, well-ventilated rooms with handwashing stations for waste storage and sorting. *Chutes and Conveyors*: Incorporate chutes or automated conveyor systems to safely and efficiently transport waste from upper floors to designated collection areas. *Access Control*: Limit access to waste storage areas to authorized personnel only. *Durable and Easy-to-Clean Surfaces*: Use materials for walls, floors, and fixtures that are durable, moisture-resistant, and easy to clean and disinfect. *Signage and Training*: Provide clear signage to indicate waste segregation procedures and provide comprehensive training to all staff on proper waste management protocols. Additional Considerations: • *Risk Assessment*: Conduct regular risk assessments to identify potential hazards and areas for improvement in waste management practices.

C – Safe Handling and Transport:

Closed Containers: Use leak-proof and puncture-resistant containers with lids for all waste streams, especially infectious waste.

Minimize Handling: Design workflows to minimize the number of times waste is handled to reduce the risk of exposure.

D – Waste Treatment and Disposal:

Consider on-site treatment options for certain waste streams, such as autoclaving for infectious waste, to reduce the volume and hazard level before disposal.

- *Emergency Preparedness*: Develop contingency plans for waste management during emergencies or disasters.
- *Sustainability*: Incorporate sustainable waste management practices, such as composting for organic waste, whenever feasible.

Passive design strategies involve a suite of sustainable architectural techniques that harness natural resources to optimize a building's performance, comfort, and energy efficiency. Unlike active design systems that depend on mechanical interventions, passive strategies exploit the inherent characteristics of a site to regulate heating, cooling, lighting, and ventilation (fig. 3).

Essential elements such as solar orientation, wind patterns, thermal mass, local material availability, and geological features play a pivotal role in determining the passive strategies for a healthcare facility project [17]. Therefore, it is imperative for architects working on the design of low-resource rural clinics and hospitals in developing countries to explore passive design strategies that minimize environmental and climate impact, and reduce both construction and maintenance costs.

3. Examples of passive design strategies to enhance natural ventilation and lighting

From an architectural perspective, natural ventilation leverages differences in air pressure, temperature, and wind to ventilate buildings without the need for mechanical systems [18-23]. This method includes various techniques such as stack ventilation, wind towers, and courtyard effects. Stack ventilation utilizes temperature differences to expel warm air from tall rooms or structures. Wind towers cool incoming air through evaporation before distributing it indoors (fig. 4) [24]. Courtyards facilitate the rise of warm air, which is then replaced by cooler air entering at lower levels (fig. 5) [25]. Optimal natural airflow can be achieved through proper building orientation, strategic openings, cross ventilation, and tall structures. While natural ventilation provides cost-free ventilation, it offers less control over air quality compared to mechanical systems.

Prioritize designs that maximize natural ventilation and sunlight is a key resource for the projects of rural healthcare facilities. As previously reported, good airflow helps to remove airborne pathogens, and sunlight has natural disinfectant properties. Natural ventilation and lighting

are valuable and integrated tools for infection control, especially in limited-resource settings where mechanical systems might be expensive or unreliable. By thoughtfully integrating natural ventilation and lighting, architects can create healthcare environments that are healthier, more sustainable, and better suited for resource-constrained settings. This can be achieved through strategically placed windows, courtyards, and building orientation [6-7]. Key architectural considerations are that:

1. design should be tailored to the local climate to ensure comfort and effectiveness;

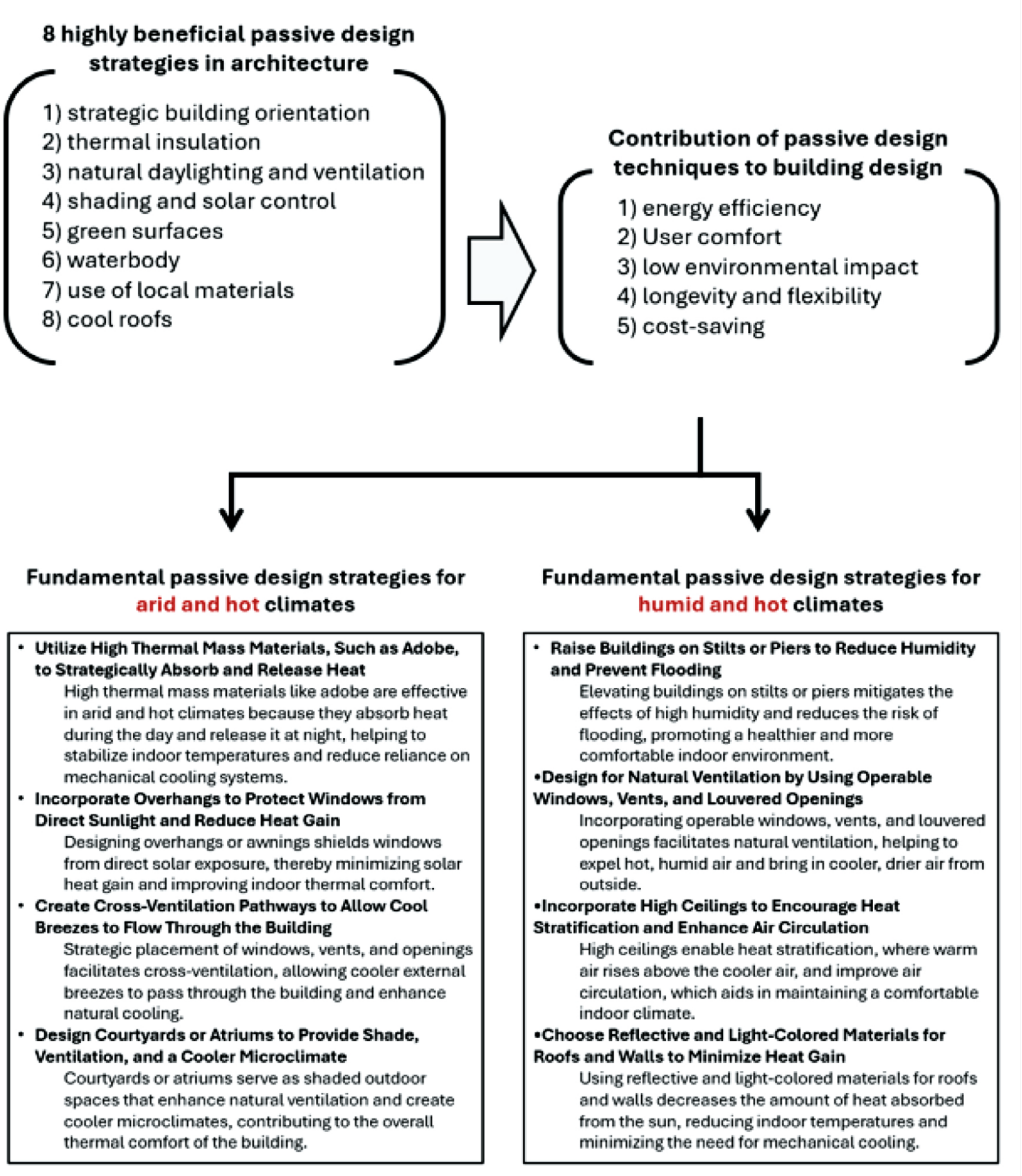

Figure 3. Passive design strategies and climate.

2. cultural preferences and practices related to ventilation and light should be strictly considered for the acceptability of the healthcare users;
3. natural ventilation should be balanced with infection control measures, such as appropriate spatial separation, to prevent cross-contamination.

Integrating natural ventilation and lighting in healthcare facilities in developing countries contributes to a more sustainable and resilient healthcare infrastructure in several ways. Firstly, this architectonic strategy **r**educes environmental impact by decreasing reliance on energy-intensive HVAC systems and artificial lighting, natural alternatives significantly lower a facility's carbon footprint and operational costs. Natural ventilation and lighting systems are less susceptible to power outages or mechanical failures, making them more resilient in the face of natural disasters or infrastructure challenges often faced in developing countries. The reduced reliance on mechanical systems translates

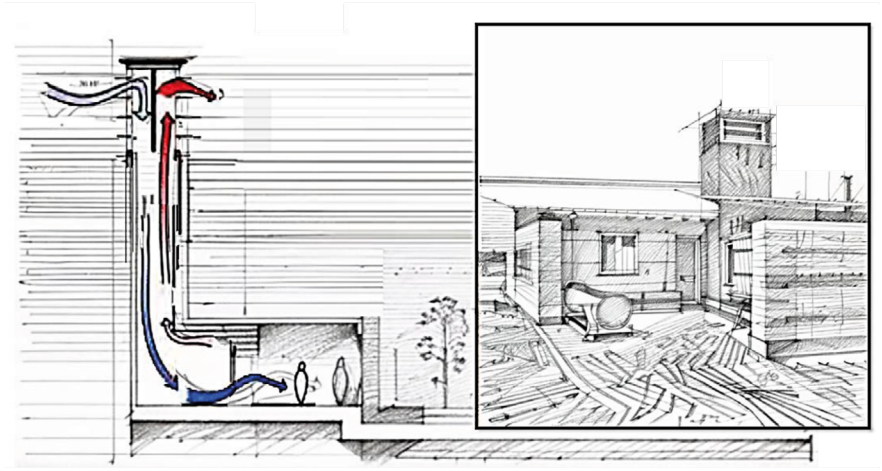

Figure 4. Model of natural ventilation generated by the stack effect in a vernacular windcatcher. The box contains a sketch of the Windcatcher House (Architect: Build-BLUFF/University of Colorado, Denver, Utah, 2010).

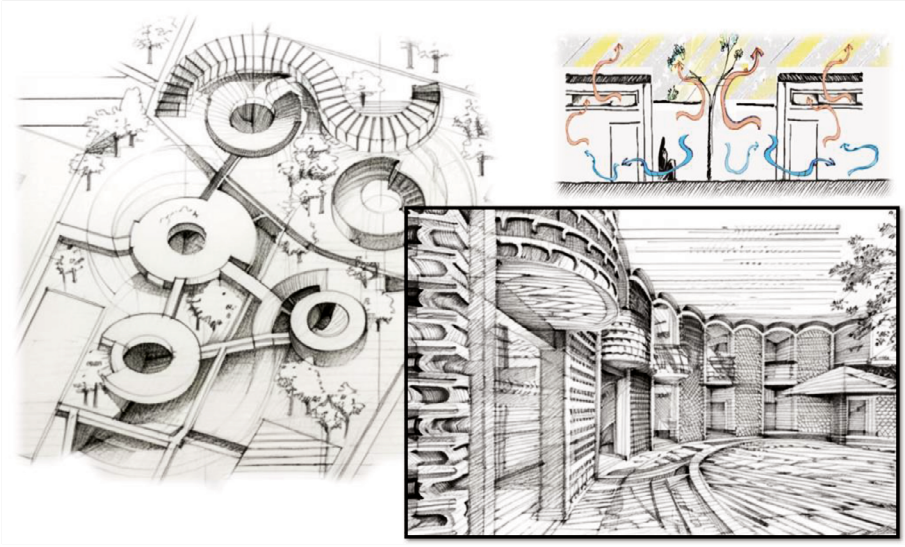

Figure 5. Model of natural ventilation generated by the courtyard effect and the building plan of Tambacounda Pediatric and Maternity Hospital, Senegal (Architect: Manuel Herz Architects, Basel, 2021). The box contains a sketch of the Tambacounda Hospital courtyard, Senegal.

to significant cost savings on energy bills and maintenance, freeing up resources for other critical healthcare needs. This is particularly impactful in regions with unreliable electricity grids or limited resources. Moreover, by improving indoor air quality and providing natural light, these strategies can contribute to a healthier healing environment, potentially reducing the spread of infections and improving patient recovery times [8]. Natural ventilation and lighting can create a more comfortable and pleasant environment for patients, staff, and visitors, potentially reducing stress and improving overall well-being. Finally, utilizing readily available resources like sunlight and wind can empower local communities to participate in the construction and maintenance of their healthcare facilities, fostering a sense of ownership and sustainability.

4. Perspectives: strategies to achieve net zero healthcare facilities in developing countries

The drive towards sustainability in the built environment has increasingly centered on achieving net-zero energy consumption, especially in the context of workplace design [25]. The net-zero workplace design framework goes beyond the basic goal of environmental impact reduction. It offers a holistic approach that addresses both environmental sustainability and the well-being of occupants. This design philosophy incorporates natural ventilation, maximizes daylight exposure, and fosters the creation of inspiring work environments, all of which play a vital role in enhancing the quality of life for patients and workers [26-28]. It is important to understand that achieving a net-zero workplace involves a comprehensive approach that includes several critical components. At the core of this endeavor is the principle of energy efficiency, which focuses on reducing energy consumption through the implementation of advanced systems and practices designed to minimize waste and optimize the use of resources. This involves adopting measures such as high-efficiency lighting, advanced HVAC systems, and energy-saving building designs. In addition to enhancing energy efficiency, another fundamental aspect of creating a net-zero workplace is the incorporation of renewable energy sources. This involves integrating clean energy solutions like solar panels, wind turbines, or geothermal systems to meet the workplace's energy demands. By relying on these renewable sources, businesses can significantly reduce their dependence on fossil fuels and move towards a more sustainable energy future [27]. However, achieving net-zero energy consumption also requires addressing any remaining carbon emissions through carbon offsetting. This final step involves compensating for residual emissions by engaging in activities such as tree planting or investing in carbon offset projects. These efforts help to balance out the carbon footprint of the workplace, thereby contributing to the broader goal of environmental sustainability. Together, these components – energy efficiency, renewable energy, and carbon offsetting – form the foundation of a net-zero workplace strategy. Each element plays a crucial role in not only reducing the environmental impact of workplace operations but also in fostering a more sustainable and responsible approach to energy use and carbon management [26-28].

To achieve a fair and effective transition to net-zero

healthcare, strategies must be progressive rather than uniform, addressing population dynamics and essential needs, and ensuring that the most significant polluters reach net-zero emissions sooner to create opportunities for others. Accelerating the net-zero healthcare agenda can not only reduce the climate impact of healthcare practices but also drive the societal transformation essential for meeting the Paris Agreement's climate objectives. In this decisive decade for climate action, the health sector must play an active and leading role.

5. Conclusions

One of the key challenges for scientists is health-care innovation in developing nations. Creating a low-cost innovation to address a global health problem is not easy. Scaling it up, securing financing, ensuring distribution, achieving cultural acceptance, and actual utilization are even more challenging. Success depends on understanding the conditions and resources of the local community. Working side by side, integrating diverse disciplines and expertise, even when they seem vastly different and distant, is the only path to achieving widespread and global health.

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Telepathology: a great opportunity for improving cancer diagnostics in Sub-Saharan African countries

by Matteo Botteghi, Vincenzo Stracca, Miriam Martinelli, Mario Alessandro Bochicchio, Caterina Martinotti, Elena Toniato, Stefano Martinotti and the Pathoxphere Consortium*

Abstract
According to the World Health Organization (WHO), deaths from non-communicable diseases (NCDs) are increasing globally, with the largest increase being on the African continent. Projections have indicated that deaths from NCDs will exceed all combined communicable, maternal, perinatal and nutritional diseases as the most common causes of death by 2030 in Africa. Hence, the importance of a functional and improved approach to Pathology in the diagnosis of cancer cannot be debated. How can we deliver a better and more acceptable quality of healthcare within the limits of current resources? WaidX telemedicine platform application to Virtual Telepathology tries to give valid answers to this urgent requirement.

Keywords
Telepathology, Digital Pathology, WaidX, Telemedicine, Developing Countries, Virtual Microscopy, Virtual Slide.

1. Introduction

Africa is a continent of opportunities for growth, undergoing a rapid economic transformation, which, however, will result in an increase of noncommunicable diseases (NCDs). Estimates in 2015 suggested that the annual number of new cases over the next 5 years will grow to above 1 million. Predicted deaths from NCDs over the next 10 years will also increase globally by 17%, the greatest increase being in Africa (27% or 28 million

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deaths) [1,2,3]. Data updated to 2020 confirms the accuracy of these estimates [4].

The ability to provide early diagnosis, treatments, and follow-up care has a large impact on care efficacy and patient survival. The importance of pathology in correct diagnostics and further adequate cancer treatments cannot be emphasized enough. There are currently still a high number of African countries in which pathology services are struggling with a limited number of available pathologists, inadequate infrastructure and with severely restricted budgets from the governments, although in recent years several developing countries are facing the challenge of introducing modern approaches to oncology. At the same time, pathology unarguably remains the backbone of the success of the cancer care.

The challenges facing pathology diagnostics, training and oncology research in Africa, are multiple and daunting. They include the lack of or inadequate infrastructure and personnel, both pathologists and technical personnel; limited opportunities for professional education or training; 'brain drain' following many years of mismanagement of the health-care services; a lack of or insufficient funding for basic laboratory materials such as reagents.

While we acknowledge these challenges, custodians of African pathology and clinical oncology are asking new and pragmatic questions, for example: how can we deliver a better and more acceptable quality of services within the limits of current resources? The 'game plan' must address the following, immediately and in a sustained way:

- define ways for updating the knowledge base of practicing pathologists, addressing the enhancement of training for pathologists and technical staff;
- explore the need for continuous capacity building and quality improvement;
- develop new models based on modern digital health technologies.

2. Telepathology in developing countries

Telemedicine consists in many services and applications such as VoIP and web conferencing, teleconsulting, remote tumor board, medical records software, digital imaging, e-learning and several others. The World Wide Web (WWW) and the Information & Communications Technology (ICT) play a pivotal role in telemedicine diffusion.

Telepathology is the practice of pathology at a distance. It uses ICT to facilitate the transfer of image-rich pathology data between distant locations for the purposes of diagnosis, education, and research [5,6]. Performance of Telepathology requires that a pathologist selects the video images for analysis and the rendering of diagnoses[7].

Despite the term "Telepathology" was defined more than 30 years ago, Telepathology practice largely remains a privilege of high-income countries. Digital Divide, the economic and social inequality of peoples in their access, use or knowledge of ICT, plays a determining role in curbing the spread of Telepathology, such as the lack of solutions tailored for the developing countries needs.

The divide is hugely remarkable between developing and developed countries in terms of technological gap, social engagement, information poverty, and Internet access diffusion.

However, other "divides" exist: Sub-Saharan African Countries suffer a dramatic shortage of medical pathologists, in the range of 1 to 10 pathologists per 10 million people.

During the last two decades, Pathology has benefited from the rapid progress of image scanning technology. Progress in improving this technology has led to the creation of slide scanners that are capable of producing digital images of a complete histological cut, that can be exploited by image viewers in a manner comparable to the conventional microscope, with considerable comfort for pathologists compared to viewing on a traditional microscope. When the slide is digitally scanned in its entirety in high resolution (Whole-Slide Imaging), the resulting digital image is called "virtual slide".

Although the capture of photos of microscopic views opened the road to "static Telepathology" based on store-and-forward model, Telepathology based on virtual slides sharing offers a much more effective means to view an entirely digitized slide, allowing the remote browsing of the slide by running image management software on a standard web browser [8].

File size of the virtual slides usually ranges from a few hundred Megabytes to several Gigabytes, which routinely address storage and image management challenges in daily clinical practice.

Virtual slides are used in pathology for educational purposes, diagnostics (clinical-pathological meetings, consultations, reviews, panels, and increasingly for remote diagnostics), research and archiving. Digitisation of slides provides several advantages, but the diffusion of Digital Pathology in developing countries opens new challenging issues to be faced including costs for virtual slide scanning, accessibility limitations imposed by local Internet Service Providers (ISPs), management of huge sized files, security for sensitive data.

3. The Mwanza cancer project and WaidX

"Associazione Vittorio Tison ONLUS" is an Italian no-profit organization devoted to develop the Clinical Oncology facility of the Bugando Medical Centre (BMC) in Mwanza, one of the main cities of Tanzania, according to a long-term capacity building program that took into account all the main aspects of the oncology discipline[9]. Amazing achievements were growing in a scenario characterized by the resource poverty and a strong digital divide issue, with a dramatic impact on the efficacy of the effort put by project managers and volunteers coming from Italy.

This scenario stimulated out team in undertaking the design of an intercontinental telematic platform oriented to oncology and its related branches, able to interconnect BMC Oncology and Pathology Departments with the Istituto Scientifico Romagnolo per lo Studio e la Cura dei Tumori (IRST IRCCS) – Italy, to allow for:

- conference calling and remote tumor boards between the institutes' teams;
- second opinion, e-learning and quality control;
- sharing of clinical data on the IRST medical records software;
- remote control of medical equipment;
- carry out GCP clinical trials through data collection, monitoring and evaluation;
- activate a Telepathology

facility for simultaneous counselling sharing microscopy images.

After a long development phase and an accurate fine tuning of the platform, we launched the novel telemedicine platform performing a complete demo of the system during the AORTIC East African Regional Meeting hosted at BMC (25-26 June 2015).

From this pioneeristic experience, the WaidX – World Aid Exchange project was founded, with the aim of consolidating and prosecute the development of the original telemedicine platform through the implementation of new applications, giving valid answer at the different requests we were rapidly collecting.

WaidX consists in a global telematics platform devoted to the remotization of healthcare process, resulting in a critical enhancement of the transmission performance between facilities sited in developed and developing countries, using low cost and poor quality connections, overcoming the accessibility problems induced by local ISPs, introducing many benefits like an high level of service continuity, privacy for sensitive data, a strong integration of concurrent IT applications on a converged global network, all this oriented to promoting the development of Digital Health applications based on cost-effective resources. WaidX core is based on an Italian Computer-Telephony Integration (CTI) technology, appropriately customized for the telemedicine purposes.

4. APOF NGO

The Mwanza oncology project led by Tison Association started in 1999 with the establishment of the anatomic pathology laboratory at BMC, with sponsoring the training of a pathologist, a medical oncologist and four oncology nurses. Soon after that, the Oncology Department was started and BMC became a specialized hospital in north-west Tanzania. The hospital has 850-bed capacity for a catchment population of 20 million, equivalent to one-third of the population of Tanzania. The histopathology laboratory, whose staff currently includes different pathologists, has the capacity to perform more than 10,000 histological analyses and about 3,000 cytological diagnosis per year.

This prodromic arm of the Mwanza project gave birth to Associazione Patologi Oltre Frontiera NGO – APOF (Pathologists Beyond Borders NGO). The main aim given to the newborn NGO was to promote the growth of Pathological Anatomy in developing countries, implementing projects for preventive medicine and cancer diagnostics.

The following APOF projects focus on the diffusion of histological and cytological diagnostics, through the training of technical and medical personnel, the direct engagement in the reporting of biopsy and surgical cases, the support to cancer prevention programs, the construction or upgrading of laboratories, the introduction of digital technologies, in order to achieve the full autonomy of the patronized facilities in a long-term perspective. Furthermore, the supported facilities are offered the possibility of accessing the global Telepathology network based on WaidX, continuing the capacity building process.

During its first decade of activity, APOF took up the challenge of new technologies introducing static Telepathology contributions to support the remote diagnostic. This experience has reached its peak thanks to the first "Zambia

project", designed with the objective of inspecting the potential of Telepathology for assisting surgical and cytologic pathology in developing countries[10]. The results demonstrate a high correlation between Telepathology and traditional microscopy and indicate that the project may be repeated similarly in other developing countries. Nevertheless, different factors restrain the spread of this model: high costs for satellite connections, limitation in transmission speed and quality combined with the asynchronous workflow for remote pathologists. It was clear that static Telepathology couldn't address all the open questions concerning the establishment of a diagnostics routine in such very poor contexts.

The large number of pending issues indicates the need of a more adequate and modern approach to deal with Telepathology requirements, so we decided to support APOF projects with the design of WaidX applications devoted to virtual dynamic Telepathology.

5. Telepathology in the Horn of Africa

The commitment of WaidX in favour of APOF takes shape on the "Horn of Africa" Project, towards the ambitious goal of creating a network of Pathology laboratories among different countries of the Greater Horn of Africa.

Since 2010 APOF patronized a project in the Hospital of Balbala, Republic of Djibouti, aimed to the institution and the development of the first Pathology Department of the country. At present this department is fully operative, with complete equipment, four well-trained technicians and two full time medical pathologists. Subsequently the second pathology department in Djibouti was created at the Djiboutian Military Hospital, equipped with the Digital Pathology facility since its inception.

In 2015 APOF received a request from the Hargeisa Group Hospital (HGH) of Hargeisa, Somaliland, concerning the institution of a Pathology Department. So, we started a project aimed to create a network of Pathology labs through the "Hub & Spoke" model, where the more equipped laboratories of Djibouti should act as hub of competencies for the Pathology lab of Hargeisa with no available pathologists at that time. To optimize the use of ICT resources, the virtual slide files should be stored in the production sites and made available for viewing and by browsing by remote pathologists.

In order to reach this goal, several hot points were identified:

- The technicians should be fully trained on the preparation not only of the biopsies but even of the surgical specimens.
- The slides should have an optimal preparation quality.
- The pathologists need to be trained for making diagnosis on remote virtual slides.
- A slide scanning system with a proper tropicalization and a powerful Telepathology platform is needed.

Since WaidX platform was ready to comply all Telepathology requirements enabling a good level access of remote pathologists to the virtual slides stored locally in their respective production sites, we ventured with the development of a Digital Pathology solution based on manual whole-slide scanning, adequate for the needs of a remote lab with a limited number of slides to be managed (few thousands per year) and no local pathologists. This goal has been firstly

reached through a system integration task, adopting the Microvisioneer software suite in association with the Olympus CX33 Microscope coupled with a Basler CCD camera, running on a basic HP workstation with an EIZO high resolution monitor. This set allows the whole slide image scanning through a manual process, performed by local lab technicians after a 3-hours training course. Once the virtual slides are saved on the workstation, the local operator can share them into the Telepathology collector with a simple drag & drop action, and remote pathologists can immediately access them through the telematic connections handled by WaidX.

We connected to WaidX the two Internet access lines previously serving the Hospital network, both provided by Djibouti Telecom: a WiMAX bridge with a download bandwidth of 3 Mbps and upload of 2.5 Mbps, and an ADSL line with a download bandwidth up to of 8 Mbps and upload of about 0.7 Mbps (tests performed on the national ISP's servers). The upload values were very weak and particularly impacted from a high frequency of transmission defects (packet loss, significant variance in data packet transmission latency), drawing a prohibitive framework in which we had to perform the live tasks of virtual Telepathology with the other concurrent telematics applications. To benefit from all its features, WaidX became as the border gateway for the entire Hospital network. We defined a set of policies concerning LAN-WAN traffic prioritization, link aggregation, UDP encapsulation of traffic on international routes, recovery of transmission defects and a redundant connection topology optimized to confer high availability to the telematics services. The outcome of adopting this design was the achievement of more than 5 Mbps of stable upload effective-bandwidth, allowing us to perform a good level Telepathology activity assuring the Internet service for the common needs of the Hospital network on the same two connections.

This model addresses the main issues involved in the Telepathology process: solidity and affordability of the local equipment, integration of the Telepathology platform in the existing IT infrastructure, accessibility for remote pathologists, efficacy and efficiency of the whole diagnostic process running on poor connections.

The first WaidX-based Digital Pathology facility within the "Horn of Africa" Project was put into operation in early 2018 at Balbala Hospital. The roadmap continued with the installation of the platform at the Djiboutian Military Hospital, and in 2021 in the HGH where an automatic slide scanning system manufactured by West Medica was installed. The laboratory nodes connected subsequently to the pilot installation in Balbala benefit from slightly better internet access, although without the use of WaidX it would not be possible to guarantee a routine telepathology activity.

The platform resulted easy-to-use, all sanitary operators involved in the solution testing find it friendly and effective. The virtual slides remotely viewed are fully compliant with the diagnostic requirements in terms of definition and magnification. The images browsing on the screen is fast and precise enough, professional operators evaluated the effectiveness of this solution equivalent to the use of the microscope and much more comfortable for the user.

We presented the first achievements at World Cancer Congress 2018, held in Malaysia, where we chaired a 90-minute session dedicated to Teleoncology and Telepathology [11,12]. The session was aimed at illustrating the potential of the ECHO e-learning project[13] and of remote oncology diagnostics in association with virtual Telepathology, relatively to developing countries requirements. After the presentations given by the speakers from the involved organizations, we moved to the discussion of a patient case via remote tumor board collecting different teams of medical oncologists and pathologists, spread over 4 continents (Malaysia, New York, Djibouti, Tanzania, Italy and San Marino). The session audience was very impressed by the powerful interaction gained by our telemedicine model, fueling an intense discussion during the final question time.

During 2018 the first database of virtual slides, related to clinical cases managed by the Balbala Pathology Department, has been digitized. In 2019 a quality control study on the whole Digital Pathology and Telepathology process was be carried out through review of diagnoses performed with double check of physical and virtual slides, confirming excellent diagnostic concordance.

This represents the first experience of a model involving exclusively African departments of pathology through Telepathology. The "Hub & Spoke" method is demonstrating its efficacy in allowing the optimization of the local resources and is being extended to other pathology departments of the Greater Horn of Africa.

6. Development scenarios

Our commitment to the development of Telepathology in favour of developing countries is an ongoing work in progress. To strengthen our action and broaden the range of our initiatives, in 2024 we founded the Pathoxphere consortium which brings together all the medical, scientific and industrial main partners who collaborate in various capacities on our projects.

One area of particular interest concerns the digitization of cytology. Cytologic examinations may be performed on body fluids or on material that is aspirated from the body. Cytology also involves examinations of preparations that are scraped from specific areas of the body. A common example of cytologic diagnostics is the evaluation of cervical smears. In order for cytologic evaluation to be carried out, in the classical approach the material to be examined is spread onto glass slides and stained. A pathologist then uses a microscope to examine the individual cells in the sample. Currently, PAP smears test represents the 50% of total cytology tests, such a figure is decreasing thanks to the primary screening switching to HPV. On the other side, non-gynaecological cytology is rapidly increasing.

Liquid-based thin layer cytology represents the set of methods that allow the production of monolayer cytological slides on which the cell fields are deposited on the same plane and hopefully clearly distinct from each other. Among the many advantages of this approach, thin layer slides can be digitized effectively unlike classical cytology slides. Hospitex International, a partner of the Pathoxphere consortium, has developed the cytological sample processing system CYTOfast, based on the innovative technology called Custom Density Monolayer – Liquid Based Cytol-

ogy. We can identify several strengths in the CYTOfast solution: the capability of optimal preparation of any cytological sample through this technology; the low cost of the system and sample preparation kit; the extreme simplicity of use of the equipment according to a semi-automatic preparation process, accessible even to less skilled operators; the possibility to store samples at room temperature for at least 60 days thanks to the CYTOfast fixative solution; after the preparation of the monolayer slide, the availability of a portion of the original fixed sample to perform further diagnostic continuation tests. Thanks to the integration of CYTOfast in our Digital Pathology model, we are offering healthcare organizations new diagnostic models that are easily scalable on large numbers of samples and patients, overcoming the typical limitations of conventional cytology diagnostics. Of particular importance is the implementation of screening programs on the population for the early diagnosis of different pathologies, targeted to obtain a high impact on tumor pathologies which represent the top killers for developing countries.

After over 10 years of presence of WaidX applications in Ethiopia, our activity in this country is intensifying thanks to the engagement of new Telepathology and laboratory implementation projects, developed with different Ethiopian healthcare institutions and university. Although the Ethiopian context presents several challenges, the implementation of digital health projects for cancer diagnostics represents a huge opportunity for expanding the access to healthcare for the population.

A development area of particular interest is the implementation of Pathomics algorithms dedicated to computerized diagnostic support in cytology. We are undertaking various initiatives to quickly obtain the first operational prototypes of pre-diagnostic software applicable to our Digital Pathology model.

Given the particular importance of ancillary diagnostics for obtaining a complete and effective laboratory medicine diagnosis, we have opened a research branch dedicated to the application of Telepathology in the related fields of clinical pathology, oncology and microbiology, with the scientific support of the University of Chieti – CAST institute and the Unit of Clinical Pathology and Microbiology in the Department of Medicine Free University of the Mediterranean LUM of Bari, affiliated to the Miulli Regional General Hospital in Acquaviva delle Fonti (Bari), institutions that also act as training centres for students coming from twinned project sites in developing countries. In addition to molecular and biochemical diagnostics, this area of investigation deals with immunophenotypic diagnostics, with particular reference to flow cytometric confirmation of myelogenic/lymphoid leukaemia and lymphoma. As a matter of fact, malignant lymphoproliferative diseases have historically been a widespread problem in sub-Saharan African populations.

7. Conclusions

Information and Communication Technologies are triggering stellar improvements in healthcare: the collaboration between remote specialists through Telepathology represents a virtuous capacity building model in order to support developing countries in providing an appropriate level of diagnostics to the whole population. The implemen-

tation of a digital pathology workflow based on WaidX for rapid remote diagnostics is an example of how technological innovation can act as a game changer, if conceived for the specific needs of contexts characterized by resource poverty.

This model is driven by a truly cooperative intent: switching the focus from the simple providing of laboratory equipment to developing countries and of diagnoses coming from abroad, to a vision strongly centred around a pervasive action of capacity building, knowledge transfer and interaction between the available local health specialists adequately supported, enhancing the diffusion of modern healthcare to the disadvantaged populations and averting new forms of scientific colonialism such as the so-called "helicopter science" [14].

Moreover, it shows how the development cooperation can be a challenging ecosystem for the growth of highly innovative solution like WaidX, increasing the diffusion of good health practices and boosting the use of modern technologies in developing countries.

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