

# Trends in health surveillance and joint service delivery for pastoralists in West and Central Africa

M.F. Abakar <sup>(1, 2, 3)\*</sup>, E. Schelling <sup>(2, 3)</sup>, M. Béchir <sup>(4)</sup>, B.N. Ngandolo <sup>(1)</sup>, K. Pfister <sup>(5)</sup>, I.O. Alfaroukh <sup>(1)</sup>, H.M. Hassane <sup>(1)</sup> & J. Zinsstag <sup>(2, 3)</sup>

(1) Institut de Recherche en Élevage pour le Développement (IRED), P.O. Box 433, N'Djamena, Chad

(2) Swiss Tropical and Public Health Institute (Swiss TPH), Socinstrasse 57, 4002, Basel, Switzerland

(3) University of Basel, Basel, Switzerland

(4) Association Sahélienne de Recherches Appliquées pour le Développement Durable (ASRADD), P.O. Box 2449, N'Djamena, Chad

(5) Institute of Comparative Tropical Medicine and Parasitology, Ludwig-Maximilians-Universität, Munich, Germany

\*Corresponding author: fayiz.abakar@unibas.ch

## Summary

In most sub-Saharan African countries, pastoralism represents an important economic resource and contributes significantly to national growth; however, challenges remain, particularly in providing social services to pastoralists (especially health and education) and in avoiding conflict with local sedentary communities and local authorities. All of this takes place while pastoralists try to maintain their mobile lifestyle within a rapidly changing ecosystem. Transdisciplinary approaches, such as 'One Health', which covers both human and animal health, have proven effective in delivering services and reaching mobile pastoralists in remote areas. The pastoralist way of life could be described as being linked to both their livestock and their environment, which makes social science an important element when researching the delivery and adaptation of social services to pastoralists.

Early or pre-diagnostic detection of emerging and endemic infectious disease remains a vital aspect of health surveillance targeted at preventing further transmission and spread. Community-based syndromic surveillance, coupled with visual mobile phone technology, adapted to the high levels of illiteracy among nomads, could offer an alternative to existing health surveillance systems. Such an approach could contribute to accelerated reporting, which could in turn lead to targeted intervention among mobile pastoralists in sub-Saharan Africa.

Although considerable efforts have been made towards integrating mobile pastoralists into social services, obstacles remain to the adoption of a clear, specific and sustainable policy on pastoralism in sub-Saharan Africa.

## Keywords

Central Africa – Health surveillance – One Health – Pastoralism – Public engagement – Service delivery – Sub-Saharan Africa – Syndromic surveillance – West Africa.

## Background

Pastoralism is an extensive farming method based on the exploitation of natural vegetation and often dependent on mobility. It is the dominant economic activity in arid and semi-arid regions of Africa. Pastoral and agro-pastoral systems account for over 80% of the supply of animal products in the Sahel and West Africa, where – in countries that include Mali, Chad, Uganda, Ethiopia and Kenya – animals represent up to 70% of the agricultural gross domestic product (GDP) (1).

According to World Bank estimates, the rural population in sub-Saharan Africa is approximately 587 million (2). In the West and Central African regions alone, an estimated 90 million people live in rural areas. They depend on agriculture and livestock, but have limited access to health and other social services, given the unequal distribution of good-quality services between urban and rural areas (3). Earlier studies in rural areas of Africa have shown high frequencies of fever-related illness, anaemia, and respiratory and gastrointestinal illness, which still have no aetiologic diagnosis and confirmation (4, 5, 6). Small-scale studies among pastoralists, who may be the most vulnerable to

exclusion from social services, such as health and education, have demonstrated the feasibility of mobile communication for health and demographic surveillance (7).

The main objective of this paper is to illustrate and discuss the integrated delivery of human and animal health services to pastoralists, and its added value. Moreover, the paper emphasises the potential of integrated syndromic surveillance among rural populations; notably pastoralists, who tend to have even higher levels of illiteracy and be harder to reach than other communities in rural areas of sub-Saharan Africa. The authors wish to present ways in which appropriate integrated surveillance systems, combined with mobile technology, could improve early detection of both human and animal health abnormalities and thus enable prompt corrective measures. Such an early syndromic surveillance system could also lead to more timely aetiological diagnosis and a targeted response. In addition, the paper highlights the importance of public engagement and discusses how transdisciplinary participatory decision-making could have a huge impact on the well-being and health of these communities.

## One Health and transdisciplinary approaches

Although it is well known that human and animal health are inextricably linked, under the increasing influence of specialisation, human and veterinary medicine have diverged, often failing to communicate, despite a shared interest in the same zoonotic diseases. For example, during a recent outbreak of Q fever in the Netherlands, public health authorities were not informed by veterinary authorities about a wave of abortions in goats (8). Similarly, outbreaks of Rift Valley fever in humans in Mauritania were mistakenly identified as yellow fever and were only correctly diagnosed after public health services contacted livestock services and learned that there had been a number of abortions in cattle (9, 10). Examples such as these show that collaboration between the human and animal health sectors still falls short, particularly in low-income countries, which harbour important reservoirs of potentially emerging zoonotic diseases. In recent years the collaboration of human and animal health services, under the coined phrase 'One Health' (11), has gained momentum. Closer cooperation between the two health services was fostered during the recent avian influenza pandemic, with new partnerships being developed at the political, institutional and technical levels (8). The One Health approach can be defined as the added value – in terms of improved human and animal health, financial savings or environmental services – resulting from the closer cooperation of both health sectors (12, 13). It is also the intersectoral, collaborative approach to preventing,

detecting and controlling diseases among animals and humans, and includes collaboration among the institutions and systems that support such prevention, detection and control (14). Engaging communities and authorities in all research and actions through iterative participatory stakeholder processes has demonstrated that joint human and animal preventive health interventions are feasible. Moreover, in countries such as Chad, they can provide health care to previously hard-to-reach communities while also saving resources (15).

## Health service delivery to pastoralists

Pastoralists have difficulty in accessing health services. But we should not forget that many of these difficulties and barriers are shared with remote rural populations in general. Mobility, the quality of health services, gender disparities, high maternal mortality rates and child health care are particularly poorly addressed in health policies for pastoral people. Barriers to health services can be classified as geographical, economic, cultural, technical, social or political (16). In pastoral and remote rural zones there is hardly any institutional framework adapted to pastoral needs (17). Mobility and a lack of conflict management are sometimes regarded as major barriers. For mobile populations, the geographical dispersion of groups and their distance from each other and from health services interact with other factors linked to everyday constraints.

Studies show that, rather than taking a traditional approach – i.e. initially serving those who are easiest to reach – approaches designed to first increase coverage among disadvantaged groups provide the most progress towards universal health coverage (18). However, better access to the governmental health system alone, without any political improvement in the situation of a marginalised population, may not have the expected positive impact on health. Even with efficient fixed or mobile clinics in pastoral zones, significant barriers to service delivery may still exist. Pastoralists have had contact with modern (Western or international) medicine for many decades, including through the Veterinary Services, but information on good performance at health facilities must spread more efficiently along their communication networks. The pastoralist way of life is closely related to their livestock and their environment. Research on adapted social services (e.g. health and education) requires the recruitment of social scientists.

The ability of health and veterinary systems to deliver services is constrained by a number of factors: declining

public-sector budgets; loss of confidence by the community as a result of unmet demand; a severe shortage of human resources, especially qualified personnel; inadequate infrastructure and equipment; and weak monitoring and information systems (19). Because they occupy remote areas with difficult access, pastoral communities are also at risk from criminal, contraband and terrorist activities. For example, the southern shores of Lake Chad and the commune (administrative district) of Ber in North Mali are exposed to Islamist terrorist groups.

Another constraint is that veterinarians are not allowed to treat human patients, and para-professionals are often not allowed to handle certain human and animal drugs or to perform simple interventions. These restrictions also apply in remote areas, where neither physicians nor veterinarians are available. With a proper legal framework and appropriate training, however, certain selected public health activities could be shared – for instance, surveillance. Patient care would, of course, remain the sole responsibility of the human health agents (20, 21). While the animal health sector lacks institutional focus – for example, the establishment of long-term community animal health systems – the human health sector lacks participatory rural appraisal methods to increase community involvement (22).

Pastoralist communities often demand more health information, but although service providers understand how to communicate health matters effectively and how to conduct social marketing campaigns to influence behaviour (23), this is often not done because of poor resourcing or concerns about how to provide understandable concepts to low-literacy populations. Anthropological studies on diseases that occur in livestock-keeping communities, particularly pastoralist communities, are still scarce and tend to be limited to better targeting of good health messages.

Community health and community animal health workers (CAHWs) can provide primary health care in remote zones. After initial training, the key activities for the long-term provision of both human and animal health community services include continued exchanges concerning quality services and supervision by the health systems, as well as patient referral systems (20, 24). The advantage of community workers is that they are more accessible to pastoralist community members who may face difficulties in accessing services that are further away. In addition, strong producer organisations or farmer cooperatives can sometimes deliver human and animal health services, although care is needed, because mixing marketing and services may lead to an undesirable confusion of the functions and responsibilities of the public versus the private sector. The authors believe that all stakeholders, including non-governmental organisations, should be included in the

discussion to identify opportunities for closer cooperation, which may lead to synergies in health service delivery.

In pastoralist communities in developing countries, livestock often contribute to multiple livelihood objectives and are not kept solely for food production, so focusing on Western technology to maximise individual animal production is an inappropriate solution (and one that is too often given precedence) (25) and a dual Western-style structure of service delivery is not suitable. McCorkle (26) argues that, especially for remote or rural people in developing countries, an intersectoral approach, partly modelled along the lines of traditional models for joint human and animal health service delivery, would be more feasible (26). Formal and informal and traditional and modern medical sectors could be combined if traditional/local practitioners are included. Effective ethno-medical practices and traditional healthcare networks could be an integral part of such a delivery system (27). However, the issue of how to integrate the two systems of medicine without the complete structural and cultural subordination of traditional medicines remains unresolved (26). Public health and veterinary programmes should more widely share their knowledge and their different approaches – and explore local priorities and perceived needs. They can then develop joint arrangements to implement and improve services to remote and rural communities. Different authors have proposed combining veterinary and public health services to increase the level of coverage to communities in remote zones (reviewed in 28). When pastoral and other livestock-keeping families in remote zones can be reached, maximum use should be made of each visit (29). In conflict situations, animal health services are sometimes still active when health services have already broken down (B. Peterhans, personal communication). Organisations such as the International Committee of the Red Cross have – in situations of humanitarian crisis, such as drought or armed conflict – implemented joint human and livestock vaccinations. However, such approaches are rarely documented. Based on findings from a simultaneous assessment of human and animal health needs in Chad, broad agreement was reached with the national and local authorities, as well as local communities, to test joint human and animal vaccination services. Sharing transport and equipment between physicians and veterinarians reduced total costs (saving 15% of the public health sector budget) (15, 30). In its Expanded Programme on Immunization, Chad's Ministry of Health, together with the country's Veterinary Services, continues to implement such joint vaccination campaigns in priority zones, particularly in regions with frequent cross-border pastoralist movements, representing ~20% of all pastoralist zones in Chad.

## Integrated syndromic surveillance and the use of mobile phones to spread public health information

Early detection of emerging disease, in particular infectious disease, is a key element in health surveillance and is aimed at a rapid response to prevent further spread, thereby reducing morbidity and mortality. Different terms have been used to describe public health surveillance systems for the early detection of outbreaks. 'Syndromic surveillance' is the term that has persisted for both humans and animals (31). It can be defined as the regular collection, analysis and interpretation of real-time and near-real-time indicators of disease and outbreaks by public health organisations (32). Syndromic surveillance methods have been developed as a complement to traditional health data analyses to allow the early detection of unusual health events with clearly identifiable syndromes (33). In the animal health sector, syndromic surveillance has been used in Europe mainly for cattle (34), goats and wildlife (33).

Syndromic surveillance in Africa is in its infancy. A systematic review, released in 2014, revealed that mobile-phone-based surveillance projects in sub-Saharan African countries are on a small scale, fragmented and not well documented (35). It has been applied in Sierra Leone for peste des petits ruminants. Health and demographic surveillance networks, such as the INDEPTH consortium, are still underutilised for surveillance of emerging diseases ([www.indepth-network.org](http://www.indepth-network.org)), but they spearhead the use of mobile communication technologies for health surveillance. Mobile phones offer a useful tool for consistent demographic and health surveillance of mobile pastoralists and their animals (7). Mobile devices and Web-based applications have revolutionised disease surveillance and health interventions (mHealth) in low- and middle-income countries. They cover, among other things:

- client education and changing behaviour
- sensors and point-of-care diagnostics, data collection and reporting, and
- supply chain management (36).

Collecting integrated human and animal health data through mobile phones in two health districts in Tanzania for a period of more than five months has shown an improvement from 50% to 89% for data completeness and timeliness (37).

However, while mobile communication coverage rapidly expands into remote areas, local communities still have low rates of literacy and require visual supports for education and communication for syndromic surveillance. In fact, the high illiteracy rate among pastoralists in sub-Saharan Africa is a motivation for finding other ways to include them within a community-based surveillance system, as is the value of their local observations and perceptions of most human and animal diseases. Therefore, appropriate syndromic surveillance among pastoralists, using the potential of mobile communication and visual technology, is a better alternative in trying to extend surveillance in these hard-to-reach populations and including them in national health services.

## Public engagement and its impact on the future of pastoralism: Chad case study

In most African countries, pastoralist communities live in vulnerable situations with limited access to social services. In general, national policies do not propose adapted solutions and the scarce existing legislation is either narrowed to specific conditions or not updated. In Chad, for example, a pastoralist legal framework (pastoralist code) and customary law were published in 1959 and 1967, respectively (Law No. 4, 31 October 1959 and Law No. 24 in July 1967). Both are now outdated (38). More recently, at the beginning of 2014, a pastoralist code was adopted by Parliament and sent to the government for endorsement. Between adoption and promulgation, the code was subject to huge political debate and polemics until its rejection by the President in December of the same year. This step back shows the complexity of the pastoralist issue, especially with regard to the continuous conflict between mobile pastoralists and farmers which, most of the time, is exacerbated to serve local political interests.

Moreover, some other decisions of the Chad government have had negative impacts on pastoralist communities and their livestock. The recent decision to close the borders with the Central African Republic, due to a political crisis, led to a high concentration of pastoralists on the Chad side of the border. Elsewhere in rural areas, the low level of information provided on the government's policy of decentralisation meant that pastoralists were unable to participate effectively in the decision-making process to protect their interests.

Non-governmental organisations, such as the Centre de Support en Santé Internationale and the Swiss Tropical and Public Health Institute, have supported the Chad government since 1998 in undertaking research and

interventions to provide specific services, using a combined One Health approach. It is important to go beyond these programmes and develop such joint interventions in remote and mobile pastoralist areas, to reach vulnerable communities (39, 40). Much reflection and advocacy have taken place, with the aim of ensuring that the health issues of remote and mobile communities are taken into account by government policy (41). A milestone was reached with the creation of the Governmental Nomadic and Islander Community Health programme: Decision No. 227 MSPASSN/SE/SG/DGRP/2014. More sharing of information with neighbouring countries is envisaged to establish cross-border vaccination campaigns, such as the continuing project, 'Reaching the hard-to-reach mobile pastoralists with the most appropriate vaccination scheme in Central Africa', funded by Pfizer.

## Conclusion

To date, few documented studies exist that illustrate the feasibility, acceptability and potential savings (through sharing resources and personnel) of health and surveillance systems adapted to the pastoralist way of life. The inclusion of various stakeholders in the conceptual and planning phase is crucial, as it increases a feeling of ownership among the populations and authorities concerned (42). As far as possible, we must avoid establishing parallel structures and

instead make use of existing health systems, infrastructure and human resources that are well integrated into the service provision systems of the countries involved. Moreover, any integrated service should try to meet the health priorities of the communities that it serves.

An increasing use of mobile technology may be a way forward. Even though signal strength is highly variable, and the platforms, hardware and operating systems available change rapidly, the rate of mobile communication use is rapidly increasing in Africa and mobile technology is reaching remote areas. The main challenge is how to develop culturally adapted, robust, low-cost and efficient phone-based applications as a key element for near-real-time disease surveillance in remote locations. Such a system needs to be able to function in settings with high levels of illiteracy in communities and low levels of education among health and veterinary staff. To ensure that a surveillance system remains effective, it must be coupled with the capacity to respond, whether via individual emergency referral or with rapid mass interventions, such as ring vaccination around outbreaks. Like surveillance systems, responses to disease will benefit from new technologies if such technologies are well embedded in the prevailing socio-cultural context. ■

## Tendances de la surveillance sanitaire et de la prestation de services intégrés dans le cadre du pastoralisme en Afrique de l'Ouest et centrale

M.F. Abakar, E. Schelling, M. Béchir, B.N. Ngandolo, K. Pfister, I.O. Alfaroukh, H.M. Hassan & J. Zinsstag

### Résumé

Bien que le pastoralisme constitue une ressource économique majeure dans la plupart des pays d'Afrique subsaharienne et qu'il contribue significativement à la croissance des économies nationales, il se heurte encore à de nombreuses difficultés liées notamment à l'accès aux services sociaux, en particulier dans les domaines de la santé et de l'éducation, et à la prévention des conflits avec les communautés sédentaires et les autorités locales. Ce constat intervient à un moment où les pasteurs eux-mêmes essayent de préserver leur mode de vie nomade au sein d'un écosystème soumis à de rapides transformations. Les approches transdisciplinaires, en particulier celles relevant du concept « Une seule santé » qui recouvre à la fois la santé humaine et la santé animale

ont fait leurs preuves pour améliorer la fourniture de services et la couverture des pasteurs nomades dans les régions éloignées. Le mode de vie des pasteurs pouvant se définir comme entretenant à la fois des relations avec le bétail et avec leur environnement, les sciences sociales ont un rôle important à jouer pour étudier les modalités de fourniture de services sociaux et leur adaptation aux communautés pastorales.

La capacité de procéder à la détection précoce (pré-diagnostic) des maladies émergentes ou endémiques demeure un aspect crucial de la surveillance sanitaire visant à prévenir les risques de transmission et de propagation. L'exercice d'une surveillance syndromique par les communautés, en recourant aux technologies de l'imagerie transmise par téléphonie mobile selon des modalités adaptées à cette population majoritairement illettrée constitue une alternative prometteuse aux systèmes actuels de surveillance sanitaire. Une telle approche permettrait d'accélérer le rythme des notifications et donc de cibler les interventions à destination des pasteurs nomades en Afrique subsaharienne.

Bien que des efforts considérables aient été déployés pour faire bénéficier les pasteurs nomades des services sociaux, nombre d'obstacles s'opposent encore à la mise en place d'une politique claire, spécifique et durable en faveur du pastoralisme en Afrique subsaharienne.

#### **Mots-clés**

Afrique centrale – Afrique de l'Ouest – Afrique subsaharienne – Participation du public – Pastoralisme – Prestation de services – Surveillance sanitaire – Surveillance syndromique – Une seule santé.



## **Tendencias en cuanto a vigilancia sanitaria y prestación integrada de servicios para las sociedades pastorales de África Occidental y Central**

M.F. Abakar, E. Schelling, M. Béchir, B.N. Ngandolo, K. Pfister, I.O. Alfaroukh, H.M. Hassan & J. Zinsstag

#### **Resumen**

Aunque en la mayoría de los países del África subsahariana el pastoreo constituye un importante recurso económico y contribuye sensiblemente al crecimiento nacional, quedan aún problemas por resolver, sobre todo a la hora de prestar servicios sociales a las comunidades de pastores, en particular de salud y educación, y de evitar situaciones de conflicto con las comunidades sedentarias y administraciones locales. Todo ello sucede mientras las sociedades pastorales tratan de preservar su modo de vida nómada dentro de un ecosistema sujeto a rápidas transformaciones. Se ha comprobado que los planteamientos transdisciplinarios, como el de «Una sola salud», que abarca a la vez la salud humana y la sanidad animal, resultan eficaces para prestar servicios y llegar a las comunidades de pastores nómadas de zonas aisladas. Cabría describir el pastoreo como un modo de vida vinculado a la vez al ganado y al medio natural, lo que hace de las ciencias sociales un elemento importante a la hora de investigar la prestación y adaptación de servicios sociales a estas poblaciones.

La detección pronta o previa al diagnóstico de enfermedades infecciosas emergentes o endémicas sigue siendo un aspecto central de la vigilancia sanitaria, destinado a impedir que el agente pueda transmitirse o propagarse. La vigilancia sindrómica a escala comunitaria, combinada con la tecnología de la telefonía móvil visual, perfectamente adaptada a los elevados niveles de analfabetismo existentes entre los nómadas, podría ofrecer una alternativa a los sistemas vigentes de vigilancia sanitaria. Semejante método podría ayudar a comunicar con mayor presteza episodios sanitarios, lo que a su vez podría traducirse en intervenciones específicas entre los pastores nómadas del África subsahariana.

Aunque se han hecho considerables esfuerzos para integrar en los servicios sociales a las comunidades pastorales móviles, subsisten obstáculos que dificultan la adopción en el África subsahariana de una política clara, específica y sostenible con respecto al pastoreo.

#### Palabras clave

África Central – África Occidental – África subsahariana – Participación pública – Pastoreo – Prestación de servicios – Una sola salud – Vigilancia sanitaria – Vigilancia sindrómica.



## References

- Hatfield R. & Davies J. (2006). – Global review of the economics of pastoralism, Nairobi, Kenya. International Union for the Conservation of Nature, Nairobi. Available at: [www.iucn.org/wisp/resources/publications/economics\\_of\\_pastoralism/review\\_on\\_the\\_economics\\_of\\_pastoralism/?1955/Report-Global-Review-of-the-Economics-of-Pastoralism](http://www.iucn.org/wisp/resources/publications/economics_of_pastoralism/review_on_the_economics_of_pastoralism/?1955/Report-Global-Review-of-the-Economics-of-Pastoralism) (accessed in May 2016).
- World Bank (WB) (2013). – Rural population. WB, Washington, DC. Available at: <http://data.worldbank.org/indicator/SPRUR.TOTL> (accessed in May 2016).
- United Nations Development Programme (UNDP) (2013). – Human Development Report. UNDP, New York. Available at: <http://hdr.undp.org/en/2013-report> (accessed on 28 July 2016).
- Daugla D.M., Daoud S., Tanner M., Zinsstag J. & Schelling E. (2004). – Morbidity patterns in three nomadic communities in Chari-Baguirmi and Kanem, Chad [in French]. *Méd. Trop.*, **64** (5), 469–473.
- Béchir M., Schelling E., Bonfoh B., Seydi M., Wade S., Moto D.D., Tanner M. & Zinsstag J. (2010). – Seasonal variations in the nutritional status of nomad and sedentary children less than 5 years of age living in the Sahel in Chad [in French]. *Méd. Trop.*, **70** (4), 353–358.
- Béchir M., Schelling E., Hamit M.A., Tanner M. & Zinsstag J. (2012). – Parasitic infections, anemia and malnutrition among rural settled and mobile pastoralist mothers and their children in Chad. *Ecohealth*, **9** (2), 122–131. doi:10.1007/s10393-011-0727-5.
- Jean-Richard V., Crump L., Moto Daugla D., Hattendorf J., Schelling E. & Zinsstag J. (2014). – The use of mobile phones for demographic surveillance of mobile pastoralists and their animals in Chad: proof of principle. *Glob. Hlth Action*, **7**, 23209. doi:10.3402/gha.v7.23209.
- Enserink M. (2010). – Infectious diseases. Humans, animals – it's one health. Or is it? *Science*, **327** (5963), 266–267. doi:10.1126/science.327.5963.266-b.
- Digoutte J.P. (1999). – Present status of an arbovirus infection: yellow fever, its natural history of hemorrhagic fever, Rift Valley fever [in French]. *Bull. Soc. Pathol. Exot.*, **92** (5), 343–348.
- Zinsstag J., Schelling E., Roth F., Bonfoh B., de Savigny D. & Tanner M. (2007). – Human benefits of animal interventions for zoonosis control. *Emerg. Infect. Dis.*, **13** (4), 527–531. doi:10.3201/eid1304.060381.
- Zinsstag J., Schelling E., Wyss K. & Mahamat M.B. (2005). – Potential of cooperation between human and animal health to strengthen health systems. *Lancet*, **366** (9503), 2142–2145. doi:10.1016/S0140-6736(05)67731-8.
- Zinsstag J., Schelling E., Waltner-Toews D., Whittaker M. & Tanner M. (2015). – One Health: the added value of integrated health approaches. CABI, Wallingford, Oxfordshire, UK.
- Greter H., Jean-Richard V., Crump L., Béchir M., Alfaroukh I.O., Schelling E., Bonfoh B. & Zinsstag J. (2014). – The benefits of 'One Health' for pastoralists in Africa. *Onderstepoort J. Vet. Res.*, **81** (2), E1–E3. doi:10.4102/ojvr.v81i2.726.

14. Glynn M.K. & Brink N. (2014). – Perspectives on One Health: a survey of national Delegates to the World Organisation for Animal Health, 2012. *In* One Health (W.B. Karesh, ed.). *Rev. Sci. Tech. Off. Int. Epiz.*, **33** (2), 433–441. doi:10.20506/rst.33.2.2296.
15. Schelling E., Béchir M., Ahmed M.A., Wyss K., Randolph T.F. & Zinsstag J. (2007). – Human and animal vaccination delivery to remote nomadic families, Chad. *Emerg. Infect. Dis.*, **13** (3), 373–379. doi:10.3201/eid1303.060391.
16. Wiese M. (2004). – Health vulnerability in a complex crisis situation: implications for providing health care to nomadic people in Chad. Verlag für Entwicklungspolitik Saarbrücken GmbH, Saarbrücken, Germany, 436.
17. Fokou G., Haller T. & Zinsstag J. (2004). – A la recherche des déterminants institutionnels du bien-être des populations sédentaires et nomades dans la plaine du Waza-Logone de la frontière camerounaise et tchadienne. *Méd. Trop.*, **64** (5), 464–468.
18. Gwatkin D.R. & Ergo A. (2011). – Universal health coverage: friend or foe of health equity? *Lancet*, **377** (9784), 2160–2161. doi:10.1016/S0140-6736(10)62058-2.
19. Schelling E., Grace D., Willingham A.L. & Randolph T. (2007). – Research approaches for improved pro-poor control of zoonoses. *Food Nutr. Bull.*, **28** (2), S345–S356. doi:10.1177/15648265070282S214.
20. Catley A., Leyland T., Mariner J.C., Akabwai D.M., Admassu B., Asfaw W., Bekele G. & Hassan H.S. (2004). – Para-veterinary professionals and the development of quality, self-sustaining community-based services. *In* Veterinary institutions in the developing world: current status and future needs (C. de Haan, ed.). *Rev. Sci. Tech. Off. Int. Epiz.*, **23** (1), 225–252. doi:10.20506/rst.23.1.1476.
21. Kahn L.H., Kaplan B. & Steele J.H. (2007). – Confronting zoonoses through closer collaboration between medicine and veterinary medicine (as ‘One Medicine’). *Vet. Ital.*, **43** (1), 5–19.
22. Riviere-Cinamond A. (2005). – Animal health policy and practice: scaling-up community-based animal health systems, lessons from human health. PPLPI Working Paper No. 22. Pro-Poor Livestock Policy Initiative (PPLPI), Food and Agriculture Organization of the United Nations, Rome.
23. Maibach E.W., Abroms L.C. & Marosits M. (2007). – Communication and marketing as tools to cultivate the public’s health: a proposed ‘people and places’ framework. *BMC Public Hlth*, **7**, 88. doi:10.1186/1471-2458-7-88.
24. Jaskiewicz W. & Tulenko K. (2012). – Increasing community health worker productivity and effectiveness: a review of the influence of the work environment. *Hum. Res. Hlth*, **10** (1), 38. doi:10.1186/1478-4491-10-38.
25. Randolph T.F., Schelling E., Grace D., Nicholson C.F., Leroy J.L., Cole D.C., Demment M.W., Omoro A., Zinsstag J. & Ruel M. (2007). – Invited review: role of livestock in human nutrition and health for poverty reduction in developing countries. *J. Anim. Sci.*, **85** (11), 2788–2800. doi:10.2527/jas.2007-0467.
26. McCorkle C. (1996). – Intersectoral healthcare delivery. *In* The ecology of health (J. Chesworth, ed.). Sage Publications, Thousand Oaks, California, 187–200.
27. Last M. (1990). – Professionalization of indigenous healers. *In* Medical anthropology: contemporary theory and method (T.M. Johnson & C.F. Sargent, eds). Praeger, New York, 349–366.
28. Swift J., Toulmin C. & Chatting S. (1990). – Providing services to nomadic people. A review of the literature and annotated bibliography. UNICEF Staff Working Papers No. 8. United Nations Children’s Emergency Fund (UNICEF), New York.
29. Majok A.A. & Schwabe C.W. (1996). – Development among Africa’s migratory pastoralists. Greenwood Publishing Group, Westport, Connecticut.
30. Schelling E., Béchir M., Zinsstag J. & Tanner M. (2015). – Integrated One Health services. *In* One Health: the theory and practice of integrated health approaches (J. Zinsstag, E. Schelling, D. Waltner-Toews, M. Whittaker & M. Tanner, eds). CABI, Wallingford, Oxfordshire, UK. doi:10.1079/9781780643410.0230.
31. Henning K.J. (2004). – What is syndromic surveillance? *MMWR*, **53** (Suppl.), 5–11.
32. Fricker R.D. Jr, Hegler B.L. & Dunfee D.A. (2008). – Comparing syndromic surveillance detection methods: EARS’ versus a CUSUM-based methodology. *Stats Med.*, **27** (17), 3407–3429. doi:10.1002/sim.3197.
33. Warns-Petit E., Morignat E., Artois M. & Calavas D. (2010). – Unsupervised clustering of wildlife necropsy data for syndromic surveillance. *BMC Vet. Res.*, **6**, 56. doi:10.1186/1746-6148-6-56.
34. Hyder K., Vidal-Diez A., Lawes J., Sayers A.R., Milnes A., Hoinville L. & Cook A.J. (2011). – Use of spatiotemporal analysis of laboratory submission data to identify potential outbreaks of new or emerging diseases in cattle in Great Britain. *BMC Vet. Res.*, **7**, 14. doi:10.1186/1746-6148-7-14.
35. Brinkel J., Kramer A., Krumkamp R., May J. & Fobil J. (2014). – Mobile phone-based mHealth approaches for public health surveillance in sub-Saharan Africa: a systematic review. *Int. J. Environ. Res. Public Hlth*, **11** (11), 11559–11582. doi:10.3390/ijerph111111559.
36. Hall C.S., Fottrell E., Wilkinson S. & Byass P. (2014). – Assessing the impact of mHealth interventions in low- and middle-income countries: what has been shown to work? *Glob. Hlth Action*, **7**, 1–12. doi:10.3402/gha.v7.25606.



37. Pascoe L., Kaasbøll J. & Koleleni I. (2012). – Collecting integrated disease surveillance and response data through mobile phones. *In Proc. IST–Africa 2012 Conference* (P.C.A.M. Cunningham, ed.), 9–11 May, Dar es Salaam, Tanzania. International Information Management Corporation, Dar es Salaam, Tanzania.
38. Béchir M., Zinsstag J., Tidjani A., Schelling E., Ibrahim A., Bonfoh B. & Tanner M. (2013). – Food security and resilience among mobile pastoral and settled community around Lake Chad in the Sahel: an overview. *In Advances in food science and nutrition* (Y. Srivastava, ed.). Queens College of Food Technology & Research Foundation, Aurangabad, India, 97–112.
39. Montavon A., Jean-Richard V., Béchir M., Daugla D.M., Abdoulaye M., Bongo Naré R.N., Diguimbaye-Djaibé C., Alfarouk I.O., Schelling E., Wyss K., Tanner M. & Zinsstag J. (2013). – Health of mobile pastoralists in the Sahel: assessment of 15 years of research and development. *Trop. Med. Int. Hlth*, **18** (9), 1044–1052. doi:10.1111/tmi.12147.
40. Schelling E., Wyss K., Diguimbaye C., Béchir M., Taleb M.O., Bonfoh B., Tanner M. & Zinsstag J. (2007). – Toward integrated and adapted health services for nomadic pastoralists and their animals: a North-South partnership. *In Handbook of transdisciplinary research. A proposition by the Swiss Academies of Arts and Sciences* (G. Hirsch Hadorn, H. Hoffmann-Reim, S. Biber-Klemm, W. Grossenbacher, D. Joye, C. Pohl, U. Wiesmann & E. Zemp, eds). Springer, Heidelberg, Germany, 277–291.
41. Béchir M., Zinsstag J., Mahamat A., Schelling E., Kessely H., Fokou G., Moto Daugla D., Bonfoh B. & Tanner M. (2012). – Social services for mobile pastoralists: cross-sector strategy based on 'One Health'. *Sociol. Stud.*, **2** (9), 705–714.
42. Schelling E. & Zinsstag J. (2015). – Transdisciplinary research and One Health. *In One Health: the theory and practice of integrated health approaches* (J. Zinsstag, E. Schelling, D. Waltner-Toews, M. Whittaker & M. Tanner, eds). CABI, Wallingford, Oxfordshire, UK. doi:10.1079/9781780643410.0366.
-

