

**DIGITAL PHARMACY AND PHARMACOVIGILANCE ECOSYSTEM IN AFRICA:
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ABSTRACT

Background: The evolving digital pharmacy and pharmacovigilance is a game changer in pharmacy services and practices in many spheres globally. The article highlights future opportunities in digital pharmacy services and pharmacovigilance and assesses evolving drawbacks and issues in emerging field practices and population perceptions in Africa. **Methods:** A systematic web-based survey of peer-reviewed publications on PubMed, Google Scholar, Scopus, Embase, Web of Science databases and other acknowledged scientific internet based sources were assessed and analysed. **Results:** Our findings provide insights into advances and future transformation in digital pharmacy services and market expansion, infrastructure improvements and participatory treatment offers to consolidate and maximize on innovative and exciting scientific, medical, technological and care delivery breakthroughs. It also highlight challenges and issues not only its adoption and integration, innovative options in overhauling health systems and improving real time pharmacy practices and care support systems, but also in enhancing monitoring of adverse drug reactions and safety profile prospects that promote healthier community resilience. It also offers new multiple opportunities to stakeholders, business development and real time innovative community pharmacy practices. **Conclusion:** Digital pharmacy is an emerging field that will promote the development and integration of digital health rights and shared responsibility. Also support the strengthening of effective collaboration between pharmacist and their community services, enhances accessible, coherent and participatory medication prescription, dispensing and treatment adherence. Moreover, insights into auctionable and sustainable strategies in emerging digital healthcare connectivity in contemporary lifestyle adaptations, quality care interventions and outcomes in Africa.

KEYWORDS: Digital health, pharmacy, e-pharmacy, pharmacovigilance, prescription, medication.**INTRODUCTION**

In recent decades, the increasing demands for healthcare demands and the rising cost of care delivery services.^[1] These have been accentuated with the rising double burden of non-communicable and communicable diseases, health transition, urbanization and globalization driven health needs.^[2, 3] Moving from the traditional paper-based and single dispensing software monopoly to digital pharmacy community health service and practices provides a paradigm shift in effective transformation of primary healthcare delivery systems, patient-pharmacist evolving engagement and resilience.^[4]

Digitalization of pharmacy business process and pharmacy networking between pharmaceutical and biotechnologies applications and devices procurement to chain supply management.^[5] As well real time monitoring safety profile of medicines combined with health information indications and tracking reporting systems in revolutionizing perennial drug shortage and counterfeiting, operational errors. Yet, there is a dearth lack of community pharmacy services and practices and increasing illegal drug stores (chemists), medicine counterfeiting and mobile merchants in most Africa countries.^[6,7]

This emerging Digital health pharmacy services and market expansion, infrastructure improvements and participatory treatment offers to consolidate and maximize on innovative and exciting scientific, medical, technological and care delivery breakthroughs much needed in improving population health and wellbeing worldwide especially in Africa.^[8,9]

The systematic review article highlights future opportunities in digital pharmacy services and pharmacovigilance and assesses evolving drawbacks and issues in emerging field practices and population perceptions in Africa.

METHODS

A systematic web-based systematic survey of peer-reviewed publications on PubMed, Google Scholar, Scopus, Embase, Web of Science databases and other acknowledged scientific internet based sources. Also search manual and web-based on national or regional annual original reports related to digital pharmacy, mobile pharmacy (m-pharmacy) and electronic pharmacy (e-pharmacy), xenosurveillance/pharmacovigilance (PV) or adverse drug reactions (ADR) or side effects of medication as well as Food and Drug Administration regulatory authority reports across African countries. These were scrutinized based on set inclusion criteria directly or indirectly linked to title key and related terms and analysed.

All data and information were further assessment for quality of information related to digital pharmacy, mobile pharmacy (m-pharmacy) and electronic pharmacy (e-pharmacy) and pharmacovigilance and gathered into Microsoft Excel Spread sheet and analysed.

RESULTS AND DISCUSSIONS

Digital pharmacy ecosystems in Africa

Digital pharmacy ecosystems offers new capabilities and incredible opportunities and present the importance of using massive data and information sources for a variety of purposes in pharmacy and pharmaceutical business.^[10] As well in monitoring public health, participatory learning, interactive exchanges approach and responsibilities by intersectorial and multidisciplinary actors including the community.^[10,11] The role of pharmacists, policy makers and legislators, researchers, academia, institutions and private stakeholders on the new healthcare shift, prescription and dispensing services delivery and education to other health-related tasks is imperative.

Digital health pharmacy political commitment and financial investment are vital in promoting the adoption and integration of the field in the public health systems. Particularly implementation of digital community pharmacy in strengthening health systems and community resilience in drug and devices procurement and chain supply management, prescription and medication adherence to community education and

patient empowerment.^[12] Digital health pharmacy policy and commitment due to the increasing urbanization, sedentary lifestyles, changing diets, rising obesity levels and widespread availability of tobacco products leading to health systems inefficiencies, cancer, obesity, diabetes, heart disease, mental disorders, HIV/AIDS and malaria maternal and child mortality as well as emerging diseases.^[10,12,13]

Digital health pharmacy new information technology infrastructure and facilities are needed to revamp the paradigm shift in pharmacy services and practices. Such expanded duties from examination, observations, screening and interpretation for evidence based interventions prescription and recommendations in enhancing good community pharmacy practices and combating substandard and counterfeiting medicines.^[14] Digital health pharmacy capacity development guarantee improved and innovative such efforts should be directed by institutions and pharmacist association in building and instituting new education programs, graduate specialised fields and new curriculum in digital pharmacy, e-pharmacy and digital health community pharmacy services.^[15] Also organising training courses and workshops in these areas in building and conducting quality pharmacy research, healthcare prescription, dispensing, electronic procurement and chain supply logistics, use novel sensors and wearable digital devices in screening and diagnostic, develop capacity in merging and analysing multiple metadata sources and interpretation. In addition, timely point of care treatment/response including counselling, advice, prescribing and medication management and patient follow up, improved continuous professional development. But also understand the responsibilities and implications of pharm and biotech companies in care and community pharmacy best practices.^[16]

Digital pharmacy offers effective opportunity in embracing participatory quality prescribing and dispensing practices by all professional pharmacists, improved formulation of patient care plan. Also in enhancing implementation of medication adherence, tackling the counter medication and fake medicine, shortage drug supply and qualified staff, management plan and interactive patient assessment.^[15] Digital health pharmacy metadata combining health, genetics, genomics, manufacturing information and protocols and community socio-demographic data and information could be complex and misleading, hence adequate education, training and skills on data management and mining is needed to equip pharmacists with the new era of digital and suitable to the needs and individual patient characteristics.^[16,17] Digital health personalised and/or community pharmacy services and practices is essential as personal genomics and quantified self-information have shown that genomics and genetic variability, environmental factors play an important role of the pharmacologic and non-pharmacologic drug response and outcomes.^[18] Hence, there is a need to revisit

pharmacy structures, process and guidance in the new arena in fundamental integration in community needs services and outcomes from public hospital or private clinics, drug procurement and chain supply management, import/export and distribution. But also in pricing regulation, inventory-related activity, tendering, quality assurance and control to device storage in improving pharmacy care services performance and effectiveness.^[19] Moving forward into effective digital community pharmacy empowerment and services delivery in rural and remotes communities in Africa requires digital health pharmacy dynamics and evidence-based deployment of applications, products and devices in services delivery. It is also a game changer in strategic community pharmacy services practices in achieving the Sustainable Development Goals (SDGs) and sustainable economic growth across Africa and elsewhere.

Digital health influence on pharmaceutical and biotechnologies companies

Recent digital health revolution in digital pharmacy and pharmacovigilance transformative power has the potential to continuously provide new platforms and innovative opportunities in pharmacy business needs and demands. But also to mount pressure on pharmaceutical and biotechnologies companies in terms of responsibility, accountable and transparent health manufacturers and provider's organisations. Importantly in improving health development patient health care and community coverage, quality fitness and reducing health systems expenditures or long term health allocation reduction and gains.^[19,20]

Critically ensuring and monitoring quality assurance, clinical rails and post-marketing assessments, products and logistics in chain supply management. Potential expansion of governments, medicines and international agencies (FDA, WHO), product or drug or vaccine manufacturers new marketing forums, supply and pharmacovigilance to detect, prevent and report and manage exposure to outcomes.^[21] Also digital health regulatory authorities have the urgent and huge responsibilities to define the ethical, legal and regulations policies and guidelines in guiding digital standards operating procedures, compliance and quality assurance, good pharmacy practices and quality health outcomes.^[19,22] Moreover researchers and others stakeholders should provide support in generating the minimum and effective set of evidence and contextual purposive information and knowledge for decision making and translation of digital health-related networks including the community in uplifting pharmaceutical and biotechnologies engagement, business commitment and benefits.

Digital community pharmacy practices

Digital community pharmacy requires considerable changes in meeting the need of the type of community setting and pharmacy services in providing pharmaceutical care and expansion of community

medication use optimisation in prevention and management of diseases or condition.^[2,10,22] It requires resources and new training, new infrastructures and facilities, new dispensing prescription medication environment, interactive platforms to gather and manage wider patients /community datasets and improved pharmacy practices.^[1,3] It must endeavour to define a clear framework and consistent programs and objectives with budget allocation in providing pharmaceutical products, clinical services and management in promoting and maintaining community health, in improving outcomes and optimal use public resources responsibly at all levels.^[22,23] Community pharmacy-based should also aim at providing continuing pharmacy professional development and engagement in meeting community health need, fostering behavioural changes and lifestyle adaptations. This is essential in providing early information to consumers and also in examining the contextual community challenges in clinical or non-clinical prescription medication and in optimizing the impact medication through effective regimen adherence, elucidation and education and monitoring of patient progress towards the therapeutic or immunization goals or community pharmacy-based medication programs. Such programs may include but not limited to community health screening, immunizations, awareness and outreach on diabetes or obesity management to smoking cessation.^[110,12] However these services are dearth and not common practices in Africa.^[7,24] Some funded organisations, NGOs or community engagement during larger multicentre pilot projects or few government projects often conducted limited and targeted activities that may include community pharmacy related to measure and gauge the capacity and impact of such project. Community pharmacy outreach programs can partners with local or international organizations, NGOs, groups or association to deliver programs or activities to specific community or group of individual on how to manage a condition or the safe and effective use of medication, counselling or advice on over the counter drugs, vitamins and supplements.

Digital pharmacovigilance and communicating systems in Africa

Traditional pharmacovigilance (PV) reporting, unstructured primary health systems and distrust in most Africa countries offer little opportunity to ADR documentation and reporting. Also PV patient support programs have been the major challenges in gathering and generating evidence based, transparent formal process of active drug or vaccine safety efficacy and monitoring information, archiving and dissemination.^[25] Over the counter prescription, proliferation of illegal mobile pharmaceutical products vendors in most African communities, counterfeit drug have become "monnaie courante" or common.^[7,24]

The search for novelty, innovative and effective approach in improving on existing PV has been provide with the real time, online social media and web base and

mobile wider subscribers and users reporting. The digital health information and communication technology coupled with genetics and genomics revolutions offer great opportunity in intensifying accessibility and availability and expanding new frontiers in PV services, ADR reporting practices and education. Turning post online, web-based reporting ADR into big data that can be mining into high quality useful data and information on ADR signal threshold definition on pre-clinical, clinical trials to post marketing ADR reports compilation for licensure and proof of early safety signals of pharmaceutical companies, regulators or legislators, patients, local and global community vital evidence knowledge and decision making.^[23,25] However further investigation, safety and security precautions and awareness are needed in maintaining the medicine safety profile, improving drug or vaccine bioavailability or reducing of drug toxicity, monitoring the impact of new digital integrated multi-channels and devices, marketing strategies and networks of opportunities such as m-pharmacy or e-pharmacy on health and well-being.

Real time PV patient forums, blogs, social media information communication in monitoring drug safety indications, safety profiling of medicines, tracking all new drugs has provided a changing paradigm in PV in terms of compliance and adherence to electronic prescription and medication (e-prescription or e-medicine) regimen regulations, safety information and literacy and safety surveillance.^[1,3,26] Furthermore it tends to improve innovative strategy in pharmacy services and practices, pharmaceutical and biotechnologies industries role and responsibilities, integrated quality standard of practices and valuable participatory engagement and benefits.

Contemporary pharmacy and pharmacovigilance drawbacks and issues in Africa

Within Africa, pharmacy and pharmacovigilance remain challenged by weak and lack of uniformity of pharmacy practices probably due to the diversity and complexity of poverty related diseases but also lack of aware of the existence of a national pharmacovigilance system and capacity development. In addition, inefficiencies in health systems in terms of poor services to practices innovations, shortage of pharmacy in remotes and most vulnerable settings and community pharmacists, inadequate knowledge and practice by health professionals, underutilization of facilities in referral and provincial hospitals, and weak standardization of pharmacy documentation of practices and weak interdisciplinary networks in improving in prescription, medication, services and safety measures monitoring.^[3, 7, 27, 28, 29] Lack or little use of automated systems in monitoring of public health in most decentralized management with fragile or weak health systems infrastructures and facilities, persisting “old models education and practices pharmacists” dispensing software monopoly and monitoring of malpractice to ADR have been very porous across African health

systems and communities.^[28,29,30,31] Lack real time capabilities and little connection with healthcare centers with few financial incentives, to little shared of common information, on specific medication, lack of local, national to regional pharmacy practices surveillance systems.^[32,33] This is pervasive with other confounding variables including diverse population cultural and structure, genetic variability, weak professional satisfactions of pharmacists, lack of standardization and optimization of ADR across African population, linguistics and literacy challenges in reporting side effects.^[29,33]

Transforming pharmacy practices require innovative approach such as digital health pharmacy that offers shared information, proactive and resilient actions for equal opportunities to the population at all levels can provide valuable and comprehensive insights for patients, enhanced hospital and community services and health-related companies sustained revolutions in shaping the future beyond the existing traditional approaches.^[1,5]

The urgent need to prioritize on advantage of real time, automated and online implementation of digital pharmacy and pharmacovigilance practices is beneficial to pharmacy, patient and pharmacist services and practices, health and pharmaceutical and biotechnologies companies services provided the establishment of good political support and investment.^[1,34] But also in addressing previous challenges in impacting care through the use of smart, cost effective, accountability and transparency new medication and drug distribution mechanisms, shared information and risk communication, tracking and new payment or investment schemes in promoting digital pharmacy leadership, voices and practices landmarks.

Benefits of digital pharmacy and pharmacovigilance community services and practices

Harnessing the applications of digital health in pharmacy practices and community services have the potential in changing and uplifting pharmacy and pharmacovigilance challenges by opening new opportunities to new in real time and prompt interconnectivity in speedy ordering channels for drug or devices chain supply management, partnership and collaborations to care solutions. But also in transforming traditional pharmacy services delivery and practices, medical insurance companies business and built applications development.^[1,23,35,36]

Entrenching the digitalization of pharmacy services, pharmaceutical business process and pharmacovigilance, new partnership, collaboration and networking of all stakeholders. Drug and devices manufacturers’ quality assurance and control is essential component in drug supply and storage management to innovative marketing strategies, disease and/or adverse reactions prevention and care through monitoring and evaluation of performance and practical outcomes.^[1,4,15] This new

paradigm offers real time essential data in medicines and medication digital chain supply management system, pharmaceutical compliance, increase the relationship between patient, community-pharmacists participatory digital pharmacy services approach and exchanges landscape.^[2,4,6,33,36]

Promoting accessibility and delivery of customized and personalised or precision digital pharmacy and medication education, services. For example “click here to call or consult your pharmacist” can enhance adherence to prescriptions through online pharmacy counselling and consultation services in saving time, cost and engaged patient in digital health pharmacy platforms. As well as tracking and strengthening pharmacovigilance essential functions and use of digital health technologies in collecting and reporting key performance indicators and effectiveness of digital pharmacy services, even in remotes patient, health centers and communities.^[1,37,38] Moreover increasing efficiency in automated ADR and other operational errors reporting and significant reduction in medication errors, simplify and streamline medication delivery process to Food and Drug alters and post marketing manufacturers regular update to promote brand and awareness through healthy interactive conversation.^[1,2,4,6] Increasing transparency, speed or timeliness, and accountability both the pharmaceutical, pharmacy services delivery to accurate digital records and reports but still requires further research in standardization and optimization of lexicons and knowledge-based approaches, applications and tools.^[1,2,4,13] Embracing the power of digital pharmacy and pharmacovigilance metadata implementation (e.g.: SIDER, FDA AERS, UMLS, CHV, RxWiki, etc.) in the healthcare systems offers comprehensive raw data, content and tools needed in algorithms transformation into useful knowledge and information to refine and improve existing prescription and dispensing practices, and safety practices.

CONCLUSIONS

Digital pharmacy is a new field that provides new resources and opportunities as an attractive foundation for innovative actionable pharmacy business and health landscape. It promotes real time and continuous participatory partnership of patient/community-pharmacist in quality care service delivery, mutual empowerment and resilience in monitoring and evaluation of services delivery performance and practical outcomes. It also enables rapid accessibility, convenient health education, timely and reliable approach in community pharmacy services and practices. Moreover, it is set to improve management of safety profile of medicines, devices, services and much needed comprehensive transformation of healthcare systems through participatory care decision making policy process, quality services delivery and better outcomes.

Competing interest

Author declares no conflict of interest.

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ET conceived the concept, designed, gathered the data. ET analysed and wrote the primary draft of this manuscript. ET, TAA, AM, AAA, JYN critically revised and provided evidence insights. All authors read and approved the final version.

REFERENCES

- Freifeld CC, Brownstein JS, Menone CM et al. Digital drug safety surveillance: monitoring pharmaceutical products in Twitter. *Drug Safety*, 2014; 37: 343–350.
- Ming Yang, Melody Kiang, Wei Shang. Filtering big data from social media – Building an early warning system for adverse drug reactions *J Biomedical Informatics*, 2015; 54(3): 230–240.
- Abed Sarker, Graciela Gonzalez Portable automatic text classification for adverse drug reaction detection via multi-corpus training. *J Biomedical Informatics*, 2015; 53(2): 196–207.
- Marie Dupuch, Natalia Grabar Semantic distance-based creation of clusters of pharmacovigilance terms and their evaluation. *J Biomedical Informatics*, 2015; 54(2): 174–185.
- V. Kumar. Challenges and future considerations for pharmacovigilance. *J Pharmacovigilance*, 2013; 1(1): 1–3.
- Maigetter K, Pollock AM, Kadam A, Ward K, Weiss MG. Pharmacovigilance in India, Uganda and South Africa with reference to WHO's minimum requirements. *Int J Health Policy Manag.*, 2015; 4(5): 295-305.
- Binagwaho A, Bate R, Gasana M, Karema C, Mucyo Y, Mwesigye JP, Biziyaremye F, Nutt CT, Wagner CM, Jensen P, Attaran A. Combatting substandard and falsified medicines: a view from Rwanda. *PLoS Med.*, 2013; 10(7): e1001476.
- R. Harpaz, W. DuMouchel, N.H. Shah, D. Madigan, P. Ryan, C. Friedman Novel data-mining methodologies for adverse drug event discovery and analysis *Clin Pharmacol Ther.*, 2012; 91(3): 1010–1021.
- Kajungu DK, Erhart A, Talisuna AO, Bassat Q, Karema C, Nabasumba C, Nambozi M, Tinto H, Kremesner P, Meremikwu M, D'Alessandro U, Speybroeck N. Paediatric pharmacovigilance: use of pharmacovigilance data mining algorithms for signal detection in a safety dataset of a paediatric clinical study conducted in seven African countries. *PLoS One.*, 2014; 9(5): e96388.
- J. Lazarou, B.H. Pomeranz, P.N. Corey Incidence of adverse drug reactions in hospitalized patients: a meta-analysis of prospective studies. *JAMA*, 1998; 279(15): 1200–1205.
- Dodoo A, Hugman B. Risk perception and communication in sub-Saharan Africa. *Drug Saf.*, 2012; 35(11): 1041-52.
- Nde F, Fah AB, Simo FA, Wouessidjewe D. State of knowledge of Cameroonian drug prescribers on pharmacovigilance. *Pan Afr Med J.*, 2015; 20: 70.

13. Kabore L, Millet P, Fofana S, Berdai D, Adam C, Haramburu F. Pharmacovigilance systems in developing countries: an evaluative case study in Burkina Faso. *Drug Saf.*, 2013; 36(5): 349-58.
14. Thiam S, Ndiaye JL, Diallo I, Gatonga P, Fall FB, Diallo NE, Faye B, Diouf ML, Ndiop M, Diouf MB, Gaye O, Thior M. Safety monitoring of artemisinin combination therapy through a national pharmacovigilance system in an endemic malaria setting. *Malar J.*, 2013; 12: 54. doi: 10.1186/1475-2875-12-54.
15. R. Xu, Q. Wang. Large-scale combining signals from both biomedical literature and FDA adverse event reporting system (FAERS) to improve post-marketing drug safety signal detection *BMC Bioinform*, 2014; 15(17).
16. C.C. Yang, H. Yang, L. Jiang. Postmarketing drug safety surveillance using publicly available health-consumer-contributed content in social media. *ACM Trans Manage Inform Syst.*, 2014; 5(1): 2:1-2:21
17. A.J. Forster, A. Jennings, C. Chow, C. Leeder, C. van Walraven. A systematic review to evaluate the accuracy of electronic adverse drug event detection. *JAMIA*, 2011; 19: 31-38.
18. I.R. Edwards, M. Lindquist. Social media and networks in pharmacovigilance: boon or bane. *Drug Saf.*, 2011; 34(4): 267-271.
19. W. ying Sylvia Chou, Y.M. Hunt, E.B. Beckjord, R.P. Moser, B.W. Hesse. Social media use in the United States: implications for health communication. *J Med Internet Res.*, 2009; 11(4): e48.
20. Yang CC, Yang H, Jiang L, Zhang M. Social media mining for drug safety signal detection. In: *Proceedings of the 2012 International workshop on smart health and wellbeing*, 2012; 33-44.
21. A Nikfarjam, A. Sarker, K. O'Connor, R. Ginn, G. Gonzalez. Pharmacovigilance from social media: mining adverse drug reaction mentions using sequence labeling with word embedding cluster features. *J Am Med Inform Assoc.*, 2015; 22(2).
22. C.D. Corley, D.J. Cook, A.R. Mikler, K.P. Singh. *Advances in computational biology-chapter using Web and Social Media for Influenza Surveillance*, Springer, New York, 2010; 559-64.
23. A Abbasi, D. Adjeroh. Social media analytics for smart health. *Intell Syst.*, 2014; 60-80.
24. Ginn R, Pimpalkhute P, Nikfarjam A, Patki A, O'Connor K, Sarker A, et al. Mining Twitter for adverse drug reaction mentions: a corpus and classification benchmark. In: *Proceedings of the fourth workshop on building and evaluating resources for health and biomedical text processing*, 2014.
25. Chee BW, Berlin R, Schatz B. Predicting adverse drug events from personal health messages. In: *Proceedings of the American medical informatics association (AMIA) annual symposium*, 2011; 217-26.
26. Sarker A, Gonzalez G. Portable automatic text classification for adverse drug reaction detection via multi-corpus training. *J Biomed Inform.*, 2015; 53: 196-207.
27. Hadzi-Puric J, Grmusa J. Automatic drug adverse reaction discovery from parenting websites using disproportionality methods. In: *IEEE/ACM conference on advances in social networks analysis and mining*, 2012; 792-7.
28. H. Gurulingappa, A. Mateen-Rajput, L. Toldo. Extraction of potential adverse drug event from medical case reports. *J Biomed Semantics*, 2012; 3(15): 122-26.
29. Diomandé FV, Yaméogo TM, Vannice KS, Preziosi MP, Viviani S, Ouandaogo CR, Keita M, Djingarey MH, Mbakuliyemo N, Akanmori BD, Sow SO, Zuber PL. Lessons Learned From Enhancing Vaccine Pharmacovigilance Activities During PsA-TT Introduction in African Countries, 2010-2013. *Clin Infect Dis.*, 2015; 61(5): S459-66.
30. Swamy S, Mourya M, Kadhe G, Mane A, Sawant S. Safety reporting through a comprehensive and pragmatic pharmacovigilance process for India and emerging markets: an industry perspective. *Expert Opin Drug Saf.*, 2015; 14(9): 1409-20.
31. Suku CK, Hill G, Sabblah G, Darko M, Muthuri G, Abwao E, Pandit J, Osakwe AI, Elagbaje C, Nyambayo P, Khoza S, Dodoo AN, Pal SN. Experiences and Lessons From Implementing Cohort Event Monitoring Programmes for Antimalarials in Four African Countries: Results of a Questionnaire-Based Survey. *Drug Saf.*, 2015; 38(11): 1115-26.
32. Skalli S, Bencheikh RS. Pharmacovigilance of herbal medicines in Africa: Questionnaire study. *J Ethnopharmacol*, 2015; 171: 99-108.
33. Masenyetse LJ, Manda SO, Mwambi HG. An assessment of adverse drug reactions among HIV positive patients receiving antiretroviral treatment in South Africa. *AIDS Res Ther.*, 2015; 12: 6. doi: 10.1186/s12981-015-0044-0. eCollection 2015.
34. Oreagba IA, Usman SO, Olayemi SO, Oshikoya KA, Opanuga O, Adeyemo TA, Lesi OA, Dodoo AN, Akanmu AS. Pharmacoepidemiology of antiretroviral drugs in a teaching hospital in Lagos, Nigeria. *Ghana Med J.*, 2014; 48(4): 194-203.
35. Mouton JP, Mehta U, Parrish AG, Wilson DP, Stewart A, Njuguna CW, Kramer N, Maartens G, Blockman M, Cohen K. Mortality from adverse drug reactions in adult medical inpatients at four hospitals in South Africa: a cross-sectional survey. *Br J Clin Pharmacol.*, 2015; 80(4): 818-26.
36. Ateudjieu J, Stoll B, Nguefack-Tsague G, Tchangou C, Genton B. Vaccines safety; effect of supervision or SMS on reporting rates of adverse events following immunization (AEFI) with meningitis vaccine (MenAfriVac™): a randomized controlled trial. *Vaccine.*, 2014; 29; 32(43): 5662-8.
37. Osakwe A, Oreagba I, Adewunmi AJ, Adekoya A, Fajolu I. Impact of training on Nigerian healthcare

- professionals' knowledge and practice of pharmacovigilance. *Int J Risk Saf Med.*, 2013; 25(4): 219-27.
38. Mehta U, Dheda M, Steel G, Blockman M, Ntilivamunda A, Maartens G, Pillay Y, Cohen K. Strengthening pharmacovigilance in South Africa. *S Afr Med J.*, 2014; 104(2): 104-6.