IMAGE: A MAP OF THE STARS OF THE ORION CONSTELLATION

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Reduce, Reuse and Recycle: Associations of New 3D Technologies Focused on Improving Practical and Theoretical Veterinary Education

Luiz Felipe Souza de Lima

Universidade Federal de Mato Grosso

ABSTRACT

Practical training is essential for learning and mastering various medical approaches, being a differential for quality professional training. As a result, over the years, cadavers and live animals have been used for such execution, and these options are ethically questionable in several areas. Currently, there are emerging techniques that seek to offer an alternative to the use of animals in education in an economically viable and skillful way. Using computed tomography images, free software for tissue segmentation, polygon mesh editing and a 3D FDM printer with PLA filament to create biomodels that are biosafety, rigid to support orthopedic training, recyclable and biodegradable. With these tools it was possible to set up a virtual and physical database of canine and feline skeletal anatomy with direct application in academic teaching in veterinary medicine.

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Practical training is essential for learning and mastering various medical approaches, being a differential for quality professional training. As a result, over the years, cadavers and live animals have been used for such execution, and these options are ethically questionable in several areas. Currently, there are emerging techniques that seek to offer an alternative to the use of animals in education in an economically viable and skillful way. Using computed tomography images, free software for tissue segmentation, polygon mesh editing and a 3D FDM printer with PLA filament to create biomodels that are biosafety, rigid to support orthopedic training, recyclable and biodegradable. With these tools it was possible to set up a virtual and physical database of canine and feline skeletal anatomy with direct application in academic teaching in veterinary medicine.

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Author: Anna Julia Brandao Paes de Barros, Edson Moleta Colodel, Pedro Brandini Nespoli, Roberto Lopes de Souza. Universidade Federal de Mato Grosso - UFMT HOVET

I. INTRODUCTION

Corpses have always been a common choice in veterinary education over the years for training various clinical surgical techniques, however this option is always dependent on fresh specimens, free of infectious contagious pathogens, zoonotic and/or pathological dependent. Another option is the use of live animals, exposing the patient to an error rate on the part of unexpected candidates, which can generate irreversible injuries and even lead to death, conflicting with ethical issues. However, in recent years, there has been a growing trend in universal medical education to place more emphasis on the practical teaching of clinical and surgical procedures more commonly performed in private practice, thus requiring new means to achieve this goal of finding both physical and digital alternatives that are not harmful to animals for application in teaching (GRIFFON, 2000; KNIGHT, 2007; WARAN et al., 2013; REIS et al., 2017; MASHARI et al., 2018).

The use of Computed Tomography (CT) combined with the use of CAD software and the Rapid Prototyping (RP) technology has been a bold and innovative method to generate synthetic biomodels analogous to biological, and can be used easily with students and veterinary medical teams for several trainings. These techniques have been providing clinicians and surgeons with the planning and best approach for each situation encountered in the routine and which instruments to adopt to treat the patient in the most efficient and safe way (PLOCH et al., 2016; BORDELO et al., 2018).

Virtual biomodeling is the necessary step to obtain a digital model, which reproduces the morphological characteristics identical to that of a determined anatomical structure found in vivo. 3D modeling software uses images from CT, magnetic resonance exams or photogrammetry to build a replica of a structure in the polygon mesh language (FREDIEU et al., 2015; BORDELO et al., 2018). Prototyping, or physical biomodeling, is obtaining physical biomodels through 3D printing, building a model from scratch through the extrusion of melted material with overlapping layers on the Z axis, being the technique of Fused Deposition Modeling (FDM) the most

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economically accessible (SILVA & GAMARRA ROSADO, 2014). 3D printing is a unique tool when used with medical images, having a considerable positive impact in the fields of modern medicine. Pieces can be made to assist complex surgeries, training professionals in delicate surgeries, enabling the creation of personalized pieces, with high morphological realism of the anatomical structures, providing clarification for preoperative planning and their training in several areas (GRAUVOGEL et al., 2012; WARAN et al., 2013; PLOCH et al., 2016; SHI CHEN, 2017). Physical and digital anatomical models can be created in a short period of time according to the skill of the team involved or a professional facilitator, in addition to being able to use free digital editing software, reducing the cost of producing the models (HESPEL et al ., 2014; FREDIEU et al., 2015; BORDELO et al., 2018).

The availability of these materials reduces the need for biological or commercial anatomical models, being applied to an alternative form of study, promoting good assimilation and allowing students to move between the physical and virtual world in a dynamic and interactive way (SILVA & GAMARROROSADO, 2014; FREDIEU et al., 2015; REIS et al., 2017). It can also be applied to clarify tutors or guardians, exploring treatment options and approaches, performing simulations with the structures to be addressed. Alternative methodologies to animal studies is a necessity within the scientific community, with the 3Rs program (reduce, recycle and reuse), a goal to be achieved in research, and met through the use of biomodels created by RP (FREDIEU et al. , 2015; PLOCH et al., 2016; SINGHAL et al., 2016; BORDELO et al., 2018).

The accuracy of biomodels is suitable for orthopedic applications, enabling training and planning for both simple and complex surgeries such as total hip arthroplasty, for example, in addition to generating the opportunity to tangentially handle the model and make immediate comparisons (FREDIEU et al., 2015; GRAUVOGEL et al., 2012; MASHARI et al., 2018). The use of 3D FDM printers promotes low production costs and allows the generation of clinically identical replicas, with no distortions, providing dimensional accuracy compared to other PR technologies (HESPEL et al., 2014). This represents an advance in the accessibility of new technologies for use by surgeons in training prior to surgery, reducing the use of animals, valuable time and costs in the operating room (HARRYSSON, 2003; ASMA and EDDINE, 2014; MASHARI et al., 2018).

The objective of this study was to create a canine and feline bone bank, both physical and digital, for theoretical and practical educational purposes in the veterinary surgical clinical area in a fast, economically viable manner, with realistic quality and portability, helping to reduce the need for use of animals and corpses in veterinary orthopedic training.

II. ANIMAL MODEL

For this experiment, a cadaver of an adult dog and an adult cat without defined breed were used as experimental models, both obtained from ethical sources at the Veterinary Pathology sector of the Veterinary Hospital of the Universidade Federal de Mato Grosso-Cuiabá. The canine specimen had no bone fractures or deformity, the feline specimen had multiple complete fractures in its right pelvic limb due to the cause of death, being run over a car.

III. METHODS

The specimens were properly dissected by hand with a scalpel, removing all muscles and soft tissues, preserving only bone structures. The canine specimen was completely disarticulated, preserving the skull, pelvis and limbs. The feline specimen was dissected in two stages, dislocating the limbs and discarding the fractured one. In the first moment, the complete spine separated from the long bones was used, in the second moment the long bones were disjointed and isolated for further data capture.

The bones were scanned using the SOMATON Spirit Siemens® device in the Diagnostic Imaging sector at HOVET-UFMT Cuiabá, using the helical computed tomography technique, with the Kv and mAs values generated automatically by the

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equipment in each protocol adopted. In the first moment, the pelvic and thoracic limbs of the dog were scanned, using the Long Bones protocol, bone window with 1.5 mm spacing between the slices with 0.5 mm image overlap. In a second moment the dog's skull, jaw and pelvis was scanned under the Skull Bone protocol, bone window with 1.5 mm spacing and 0.5 mm overlap between slices. To capture the data of the felid the same protocols as that of the dog had been used, only alternating the arrangement of the parts for capture, making possible the capture in addition to the limbs, pelvis, skull and the fully articulated spine (Figure 1).

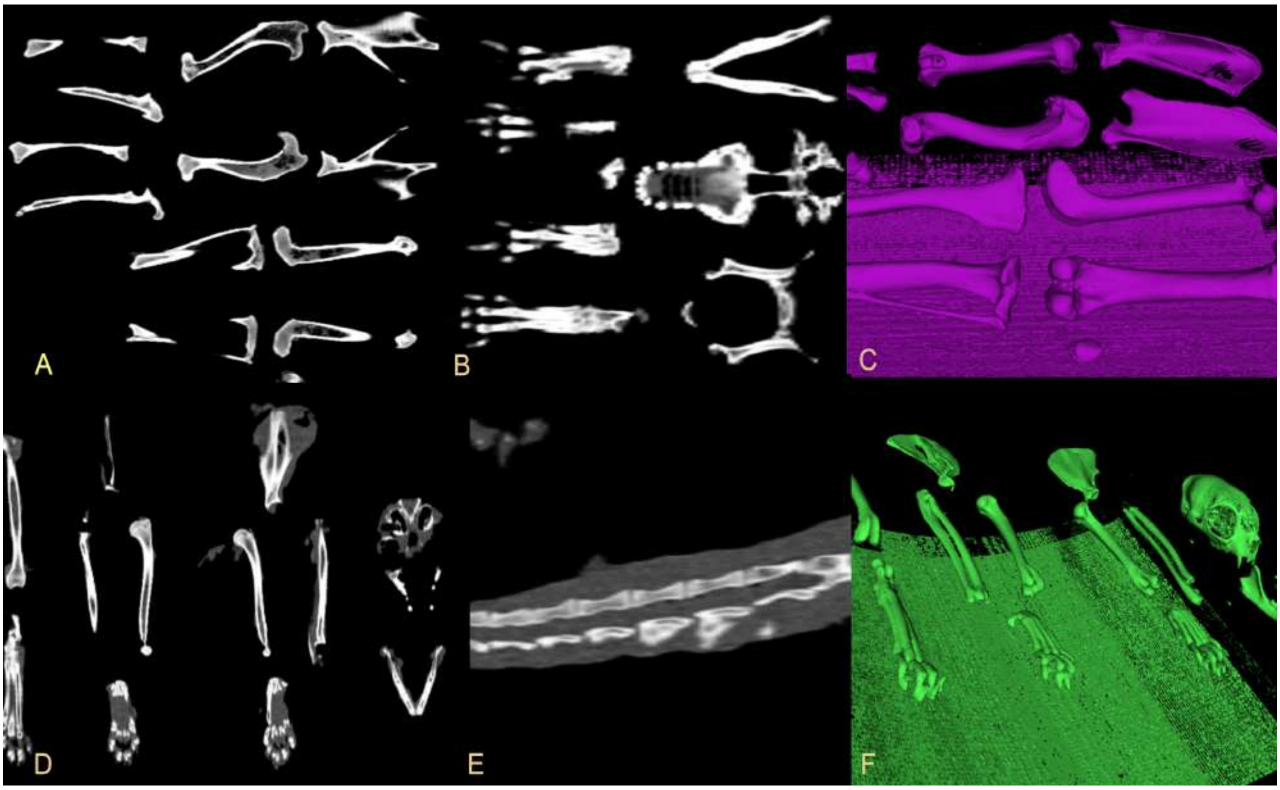

Figure 1: Tomographic projections analyzed in the InVesalius software. (A) Canine long bones in bone window with dorsoventral projection. (B) Dorsoventral projection with bony window of the skull, pelvis and canine paws. (C) With the Housted threshold applied, it is possible to create a 3D polygon mesh of the bone structures with the desired density. (D) Dorsoventral projection of uptake of long bones, skull, pelvis and feline paws. (E) Laterolateral projection of the spine showing the medullary canal in the healthy feline lumbar area. (F) 3D projection of feline feline polygon mesh exportable in .stl format.

All images were saved on CD-R in DICOM (Digital Imaging and Communications in Medicine) format and subsequently analyzed by the free software InVesalius®, allowing to view the tomographic images, apply image filters and also regulate the threshold value of the Hounsfield scale generating the segmentation of different types of tissues present in the exam. With the region of interest segmented, a polygon mask is generated creating an interactive 3D surface that allows it to be saved in an STL (Stereolithography) file.

Using the Meshmixer® educational version software, .stl files were imported allowing them to be isolated, smoothed, mirrored, transformed into solid objects and to fill in gaps when necessary. After completing the virtual biomodeling, a digital library was created where all the bones were saved separately in folders on the central computer of the operating room, with copies in external HD and cloud (Figure 2). With the stored virtual biomodels, it is possible to sequence the FDM RP using a 3D printer of the GTMax3D® Core A3v2 model. Each file was opened separately in the Simplify3D® software and previously stipulated

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the total size of the piece, its positioning, supports and infill. For all models, the 3DX® filament composed of Polylactic Acid (PLA) with 1.75 mm in diameter was used under the following protocol described by Lima (2019); automatic support, 40% filling, 3 layers of detailing, thickness between layers of 200 microns, heating the extruder nozzle to 195ºC with extrusion speed of 30 mm/s and nozzle displacement speed of 40 mm/s. After the print definition, the files were saved in .x3g format on an SD card and attached to the 3D printer to perform the PR. At the end of the 3D printing, each piece received a manual finish, with the support brackets removed with metal clamps followed by the finish with sandpaper for wood in the protruding areas, in order to generate greater smoothness and realism (Figure 3).

With a digital and physical bank of canine and feline bones assembled, undergraduate and graduate students at the UFMT School of Veterinary Medicine were able to use the biomodels in theoretical classes to understand the anatomy of the limbs and their classifications for fractures, followed by a practical class of orthopedics fractures using all the necessary equipment (drill, surgical forceps, saw, plates, drills, pins) to perform osteotomies in techniques with simple and blocked plates, external and cerclage fixation. The skulls, jaws, vertebral column with delimitation in the pelvic area were used to exemplify theoretical and practical classes of veterinary anesthesia about loco-regional block in the maxillary, mentonian, infraorbital, palatal and incisor pterygopalatine fossa. In the pelvis, an epidural block simulation was performed between the seventh lumbar and the first sacral, where students were able to train on the biomodel first, then on cadavers and later on routine patients at the hospital.

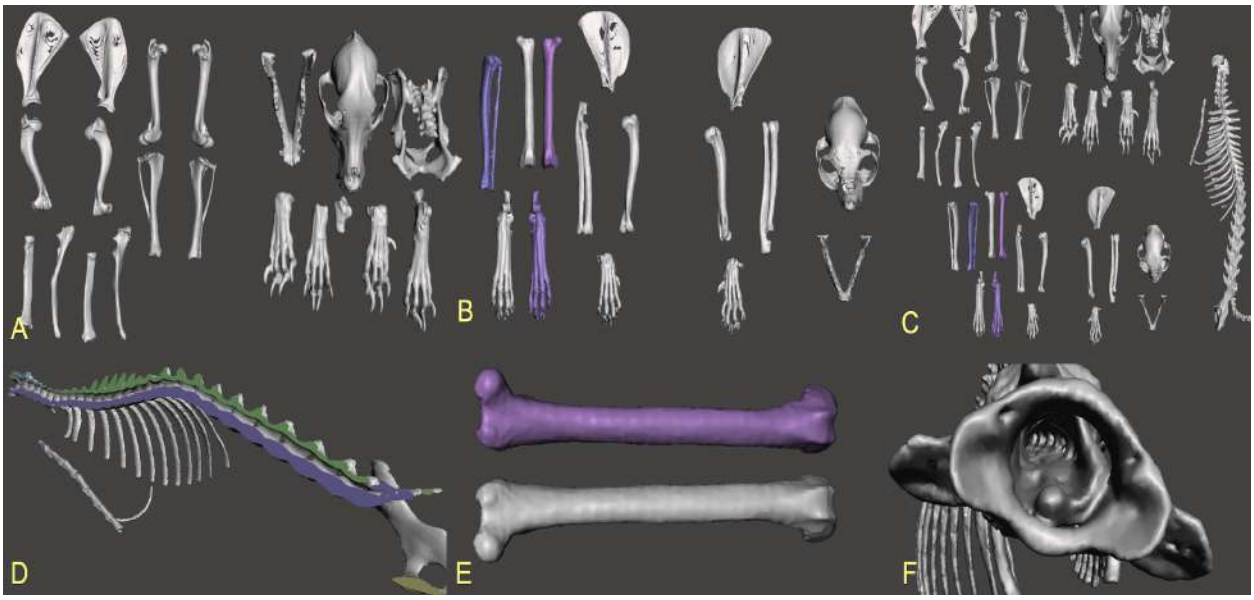

Figure 2: Interactive 3D data edited in the MeshMixer software forming the virtual database. (A) Canine bone bank. (B) Feline bone bank, including the digitally created right pelvic limb highlighted in cold tones. (C) Complete bone bank, including long bones, skull, pelvis, canine and feline limbs in addition to the feline spine. (D) Feline spine after digital dissection, showing the healthy spinal canal and nerve foramens, ideal to understand the points of anesthetic blocks loco regional. (E) Using the healthy part of the feline pelvic member, could mirror it creating the absent member analogous to the scanned, evidenced bone created in purple hue. (F) The 3D pieces allow virtual explorations of the anatomical details, in the image the medullary canal is highlighted, being seen craniodorsal through the base of the atlas and the exit of the nerve branches through the lateral foramina.

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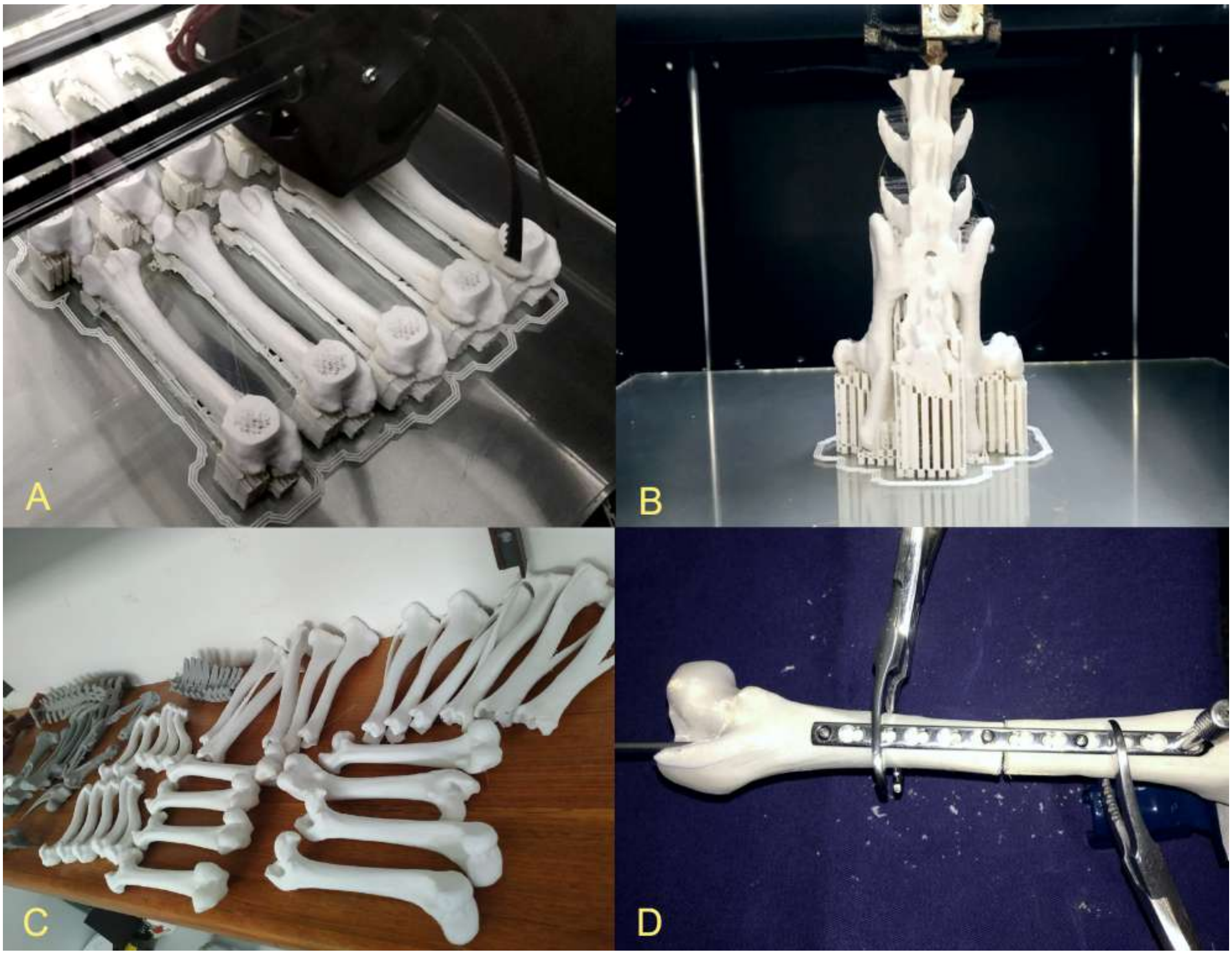

Figure 3: Physical biomodels bank created from 3D FDM printing with PLA filament. (A) Multiple biomodels being produced simultaneously to meet the demand of undergraduate classes. (B) Vertebral column in the pelvic portion being printed, the positioning of the piece is essential for a quality impression. (C) Bank of physical bones assembled for use in the medical school routine. (D) Orthopedic training of variable techniques using surgical tools required in the physical biomodels.

IV. RESULTS

The bank of digital and physical bones has refined the quality of theoretical-practical classes in anatomy, anesthesia, general veterinary orthopedics and orthopedic surgical training for undergraduate and graduate students. Because its content is digital and physical, students were able to access digital models on their smartphones before and during classes. Spatially understanding the patient's anatomy and the area of interest, in addition to being able to carry out practical training for various situations several times. Participants reported at the end of the school semester that they were much more confident to perform the surgery in vivo after having had multiple planning and training classes on synthetic biomodels.

The capture of the feline spine allowed those involved to understand the clinical anatomy and cases of spinal pathologies using sectional CT and 3D images. This prototype also ensured that students understand the minutiae of vertebral anatomy, visualizing the shape and diameter of the foramina and intervertebral spaces, understanding how to orient themselves between the spinous processes to designate the correct area and depth of anesthetic application as suggested by Mashari (2018). Guiding a practical theoretical epidural anesthetic blocking class without pressure before the class had contact with

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routine patients. The capture of the skulls and mandibles proved to be very satisfactory to reproduce via 3D printing the details of the bone structures and facial foramina, incorporating them also in anesthetic and surgical classes.

The various prototypes also provided simulations of specific fractures in regions of interest, as well as their correction using fixing plates, drills, pins and the technique of fracture reduction cerclage. The physical biomodels are resistant to support special orthopedic materials serving for training and surgical planning, allowing to elaborate the desired alteration and perform its practical surgical correction. Ensuring adequate training in orthopedics and also the verification of the procedure through simple radiographs in order to guarantee the integrity of the parts and the precision of the technique adopted (LIMA et al., 2019). The material used for printing guarantees to be biodegradable in case of disposal, promotes the biosafety of those involved because it is not of animal origin and is free of pathogenic agents, they are subject to sterilization, recycling, in some cases reuse.

V. DISCUSSION

The action of dismantling the limbs and removing the musculature is not related to an improvement in the technique of capturing images, but in the logistics of the experiment. Once the animal was prepared after the end of the routine necropsy and only scanned days later, making it impossible to keep them intact due to their maintenance, decomposition and storage process. The prepared pieces are more practical for such care and when image captures were performed, the fact that they were dissected provided that several bones were scanned at the same time, positioned at a distance from each other. The data when analyzed in the free software InVesalius® proved to be very efficient for segmentation, excluding the possibility of the bones leaving connected due to the presence of cartilage and approximation of structures when articulated. This is a technique recommended by us for the development of digital libraries with greater practicality, optimizing the time of 3D editing.

Even though the feline specimen did not have a viable pelvic limb, using the MeshMixer® software it was possible to choose healthy elements and create a mirrored copy of the bones. Ensuring that the database had both the left and right pelvic limbs. This proves to be an alternative for expanding the library when dealing with complex cases, rare pathologies, congenital malformations or anomalies.

The PLA physical biomodels derived from CT capture combined with virtual editing and 3D printing sequentially, are promising since they do not need supercomputers to perform all processes, have sufficient strength for practical training, use biodegradable and recyclable material. This technique guarantees accessibility and replicability of rapid prototyping endlessly on any 3D printer model over the years due to the file format (.stl) being compatible with different brands, printer models and materials. But to achieve this goal, it is necessary to have a specialized professional who assists in the entire process to ensure the excellence of the final product, being necessary to understand both imaging medicine, surgical clinic as well as having skills with 3D technology.

Corpses are commonly used in teaching over the years, but it is worth mentioning that even in corpses there is a lack of realism and physiological responses as well as synthetic biomodels. However, corpses are more complex to acquire, maintain, use and dispose of, adding costs to the process, the need for legal authorization and presenting ethical conflicts. Biomodels can be used for training and testing of new techniques, as well as in cadavers, however without restrictions and with the possibility of multiple attempts improving the skills of professionals and thus promoting shorter anesthesia time in a future patients, being the surgical time always a critical factor that should always be minimized (WARAN et al., 2013). A universal convention has been taking place in teaching and training techniques most commonly performed in professional practice, creating a demand for materials for clinical and surgical training, which can be resolved through the capture of biodata and 3D printing in the teaching institution itself. This

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being a practical and viable alternative for reducing animals in veterinary education, reducing the cost of acquiring new materials and optimizing logistics, improving the anatomical spatial perception and facilitating the understanding of the techniques in their approaches, promoting animal welfare, improving quality of life of the patient and the team for applying the 3R in teaching (GRIFFON, 2000; HARRYSSON, 2003; GRAUVOGEL et al., 2012; ASMA and EDDINE, 2014).

A limitation in the application of 3D printing in veterinary medical education

and also a significant cost factor is the availability of digital 3D models, usually acquired via computed tomography or magnetic resonance imaging (HESPEL et al., 2014). As an alternative to the use of photogrammetry in anatomical parts, however, this technique requires more effort from those involved and takes more time, a few days, to obtain the final product when compared to CT is just a few minutes. The printing time varies according to the piece size, quantity, speed and percentage of pre-fill adopted in the protocol. On average, each long bone took about 2 hours to be made while skulls and spine take more than twice the time to ensure the necessary detail (LIMA et al., 2019).

Currently, many tutors are committed to animals and are willing to do their utmost to help them, generating economic return and covering the costs for the creation of biomodels (HARRYSSON, 2003; FREDIEU et al., 2015). It is possible to refer patients to perform imaging exams in specialized centers outside the clinic or original teaching institution and return with the saved DICOM files, so that it is possible to work with such data and reproduce the biomodels via 3D printing. Since the cost of the printer and filament is low when compared to the tomography scanner, however, it is necessary to have a professional facilitator who performs the entire process from segmentation, biomodeling to finishing the materialized prototypes (HESPEL et al., 2014; FREDIEU et al., 2015).

This study considerably reduces the number of animals required for surgical training in an academic semester using alternative measures, helping to reduce the dependence of older methods on PR, promoting ethical teaching and increasing the useful life of natural resources (BOYD; CLARKSON ; MATHER, 2015; MASHARI et al., 2018). Certainly, the use of biomodels for simulation is very effective in the learning system of the anesthetic and interactive surgical clinic, it is extremely important for us to implement new technologies that protect the lives of animals and that also respect the integrity of cadavers (MASHARI et al., 2018). The use of alternative models is not intended to completely replace the use of animals in teaching and research, but to minimize and complement practical training in an ethical, accessible, ecologically correct, sustainable and efficient manner. The recognition of the animal's value and the ethics that surrounds it has been discussed, expanded and applied in common global interest the need to use the 3R principle more frequently in academic and scientific routine (ASMA and EDDINE, 2014; GRIFFON, 2000).

VI. CONCLUSION

With this experiment we can affirm that from a single cadaver of each species, canine and feline, it is possible to create a digital database with 2D images of the clinical anatomy of bone structures in different formats such as: DICOM, .png, .gif, .jpeg, .tif... As well as 3D models in .stl and .obj format that can be accessed dynamically, interactively and remotely on smartphones, tablets, notebooks and 3D printers. Making the material inclusive and accessible to those involved, in addition to the prospect of continuous and repeated use of these files as an embedded teaching tool in institutions, promoting the maintenance of natural resources in an ethical manner and applying the 3R principle.

The final product does not present a risk of biological contamination because it is entirely made of PLA, it is resistant to support special orthopedic materials serving for academic training and surgical planning, allowing the elaboration of the desired alteration and making

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its most appropriate surgical correction. Both the digital and physical databases can be used in surgical medical clinic, with tutors, students and professionals. Optimizing the understanding of the case and the approaches to be taken. When necessary, multiple prototypes can be made simultaneously to assist in the training and understanding of each case with large classes, assisting in the understanding and spatial dimensioning of the area of interest in an ethical, dynamic and biosafety manner.

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Autotransplantation for the Management of Impacted Maxillary Canines

Luigi Tagliatesta, Matteo Arcari, Marco Lorenzoni, Mattia Sanna & Luca Boschini

University of Milan

ABSTRACT

The impaction of maxillary canines is a spread condition, with a prevalence in females. The treatment necessity is mainly related to the aesthetic and functional roles played by these teeth, but also to the possible development of sequelae over time. The gold standard in pediatric patients is the interceptive treatment, but in adults, orthodontic treatment might not be indicated and autotransplantation, when possible, may provide the best solution.

Keywords: impacted canines, orthodontics, oral surgery, tooth autotransplantation.

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Luigi Tagliatesta[α], Matteo Arcari[σ], Marco Lorenzoni[ρ], Mattia Sanna[Ѡ] & Luca Boschini[¥]

ABSTRACT

The impaction of maxillary canines is a spread condition, with a prevalence in females. The treatment necessity is mainly related to the aesthetic and functional roles played by these teeth, but also to the possible development of sequelae over time. The gold standard in pediatric patients is the interceptive treatment, but in adults, orthodontic treatment might not be indicated and autotransplantation, when possible, may provide the best solution.

A 30-year-old female patient with bilateral upper canine impaction had interceptive and orthodontic treatment, succeeding only in rehabilitation of element 1.3, while 2.3 remained impacted. Due to the previous orthodontic failure, treatment times and costs, the autotransplantation was performed to manage the impacted canine.

In adult patients the management of upper canine impaction cannot always be finalized by orthodontic or surgical-orthodontic treatment. In such cases, autotransplantation represents a successful choice. It involves atraumatic surgical removal of the donor tooth from its impaction or ectopic site, the creation of the receiving socket, and the transplantation. Its success is determined by different factors, mainly the presence of healthy periodontal ligament cells on the root surface, the root formation stage and its splinting once replanted.

Autotransplantation of an impacted tooth is a well-documented and successful technique, which can be considered as a valid solution for both functional and aesthetic aspects for the management of impacted and, or ectopic maxillary canines when the orthodontic treatment is not practicable.

SUMMARY

Introduction: The impaction of maxillary canines is a spread condition, with a prevalence in females. The treatment necessity is mainly related to the aesthetic and functional roles played by these teeth, but also to the possible development of sequelae over time. The gold standard in pediatric patients is the interceptive treatment, but in adults, orthodontic treatment might not be indicated and autotransplantation, when possible, may provide the best solution.

Presentation of the case: A 30-year-old female patient with bilateral upper canine impaction had interceptive and orthodontic treatment, succeeding only in rehabilitation of element 1.3, while 2.3 remained impacted. Due to the previous orthodontic failure, treatment times and costs, the autotransplantation was performed to manage the impacted canine.

Discussion: In adult patients the management of upper canine impaction cannot always be finalized by orthodontic or surgical-orthodontic treatment. In such cases, autotransplantation represents a successful choice. It involves atraumatic surgical removal of the donor tooth from its impaction or ectopic site, the creation of the receiving socket, and the transplantation. Its success is determined by different factors, mainly the presence of healthy periodontal ligament cells on the root surface, the root formation stage and its splinting once replanted.

Conclusion: Autotransplantation of an impacted tooth is a well-documented and successful technique, which can be considered as a valid solution for both functional and aesthetic aspects for the management of impacted and, or ectopic maxillary canines when the orthodontic treatment is not practicable.

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Keywords: impacted canines, orthodontics, oral surgery, tooth autotransplantation.

α: DDS, Specialist in Oral Surgery, Department of Biomedical, Surgical and Dental Sciences, Unit of Pediatric Oral Surgery, Santi Paolo and Carlo Hospital, University of Milan, Milan, Italy.
σ ρ: Dentistry Student, Department of Biomedical, Surgical and Dental Sciences, Unit of Oral Surgery, Santi Paolo and Carlo Hospital, University of Milan, Milan, Italy.
Ѡ: Dentistry Student, Department of Biomedical, Surgical and Dental Sciences, Santi Paolo and Carlo Hospital, University of Milan, Milan, Italy.
¥: DDS, Private Practitioner, Rimini, Italy.
ORCID:
Luigi Taliatesta 0000-0002-1352-102X
Matteo Arcari 0000-0001-8482-8718
Marco Lorenzoni 0000-0002-2382-004X

I. INTRODUCTION

Impaction is a condition defined as the failed eruption of a permanent tooth with a completely developed root. The most commonly impacted teeth are, consecutively, third molars, maxillary canines, mandibular premolars and maxillary central incisors [Kaczor-Urbanowicz et al. 2016]. The prevalence of impacted maxillary canines ranges from 1% to 2.5% worldwide, with a prevalence in females. Upper canines can be impacted palatally (54%), buccally (32%) or in line with the dental arch (12%) [Merlini and Gallini 1991; Grybienė et al. 2019]. The etiology can be found into two theories: the *genetic* one declares that maxillary palatal impaction has familial and hereditary components and includes other associated dental anomalies, such as missing or small lateral incisors. The *guidance theory* explains that the canine erupts along the distal surface of the root of the lateral incisor, which acts as a guide. If this is absent or malformed, the canine might not erupt. In addition to these explanations, other factors causing the impaction may be physical obstacles (like supernumerary teeth, odontoma or cysts), crowding, trauma, long eruption path, or syndromes [Counihan et al. 2013; Kaczor-Urbanowicz et al. 2016].

According to the literature, the main reasons why patients and clinicians are concerned about this condition and look for treatment are the aesthetic and functional roles that they play, seen their importance in an ideal mutually protected occlusal scheme. An impacted tooth may also develop several sequelae over time, like migration of the neighboring teeth and loss of arch length, internal resorption and/or external root resorption of the impacted tooth or adjacent teeth, development of follicular cyst, infection and referred pain [Bishara 1992]. That is why it is required the earliest possible diagnosis and a rational treatment plan that allows recovery, while respecting the integrity of the supporting tissues.

Investigations may be carried out both clinically, with visual inspection of the canine bulge, and radiographically, involving the use of orthopantomography, parallax or cone beam computerized tomography (CBCT). The management of impacted canines usually involves up to five treatment options:

- No active treatment, leaving the elements in situ and monitoring radiographically for cyst formation or root resorption;
- Interceptive removal of the deciduous canine;
- Surgical exposure with or without orthodontic alignment;
- Surgical repositioning or autotransplantation;
- Extraction of the permanent canine for prosthetic or restorative treatment [Counihan et al. 2013].

Treating adult patients, the orthodontic appliance is sometimes impracticable, especially due to the position of the impacted tooth. On the other hand, the patients often refuse it because of the long time required, or for economic reasons. In such cases, autotransplantation might provide a valid alternative, if there is sufficient space for the transplanted tooth [Zufía et al. 2020]. This is nowadays a well-documented technique with a long-term success for both mature and immature teeth in the treatment of agenesia, impacted or ectopic teeth, traumatic tooth loss, loss of teeth due to tumors or iatrogenic causes, replacement of teeth with bad prognosis and/or dental

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development anomalies [Czochrowska et al. 2002; Boschini et al. 2018; Boschini et al. 2020].

The aim of this manuscript is to present a successful case of autotransplantation of an impacted maxillary canine to its physiological position in the upper dental arch, in an adult female patient.

II. CASE REPORT

The reported case concerns the management of an impacted maxillary canine.

A 30-year-old female came to our attention after an interceptive orthodontic treatment performed by another dentist for the management for a bilateral upper canine impaction. The orthodontic treatment was only successful with the tooth 1.3; the orthodontist was unable to align tooth 2.3 despite an apparently favorable position (Figures 1 and 2). The failure in the descent of the tooth could be justified by the presence of an obstacle, in fact the X-Rays showed a radiopacity compatible with a root of a deciduous tooth actually ankylosed (Figure 2). Because of the tooth impaction, the patient received a resin template as provisional restoration that she used for nearly twenty years.

Although a further orthodontic treatment was proposed, the patient refused, preferring to replace the tooth with implant supported prosthesis. The choice was conditioned to the past orthodontic failure and to the long treatment time. The dentist who made the first orthodontic treatment was also consulted and he advised against a further orthodontic attempt because he failed to achieve success even if the tooth was in an extremely favorable position.

After the clinical and radiological examination, an autotransplantation of the element 2.3 was proposed. The space available for the canine transplantation was less than necessary, but with a slightly rotated positioning it would still have allowed the tooth to be seated. The implant option was considered as a second choice in case of failure of the autotransplantation. The patient accepted the therapy and the surgery was planned.

Figure 1: Pre-operative image showing the absence of the permanent canine and the sufficient space for its descent

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Figure 2: Pre-operative x-ray showing the impaction of the canine. A radio-opacity is present distal to the canine, compatible with an ankylosed root

To decrease the intraoral bacterial load, the patient underwent an oral hygiene session a week before the surgery and 3 days before local antiseptic therapy (chlorexidine digluconate 0,2% mouth rinse, twice a day) was prescribed. Furthermore, prophylaxis with 2 g of amoxicillin + clavulanic acid was administered 1 hour before the surgery. After local anesthesia with arthicaine 4% + adrenaline 1:100.00, a mucoperiosteal triangular flap was performed (Figure 3); the two incision lines were in mid-crest position and mesial to the lateral incisor. The mid-crest incision allowed to preserve the keratinized mucosa that will be positioned buccal to the transplanted canine. After the flap elevation, the osteotomy for the canine exposition was performed using a micro-drill (KaVo Sonicflex®) (Figure 4). Then luxation and extraction were executed applying slight forces. In order to simplify the gingival healing and to thicken the soft tissue around the transplanted tooth, the pericoronal follicle of the canine was maintained and sutured to the flap edge (Figure 5). The donor canine was replanted coronally without bone remodeling of the receiving socket in line with the dental arch (Figures 5b and 6) and stabilized through semi-rigid splinting with orthodontic wire and polyamide suture (Figure 5d). The splinting was removed two weeks after surgery. According to pre-operative planning, the replanted tooth resulted slightly turned, but the patient was however satisfied with her smile.

Due to the age of the patient and to the complete formation of the donor canine root, the root canal treatment was performed 6 months after the surgery, a sufficient time for complete bone and periodontal ligament healing.

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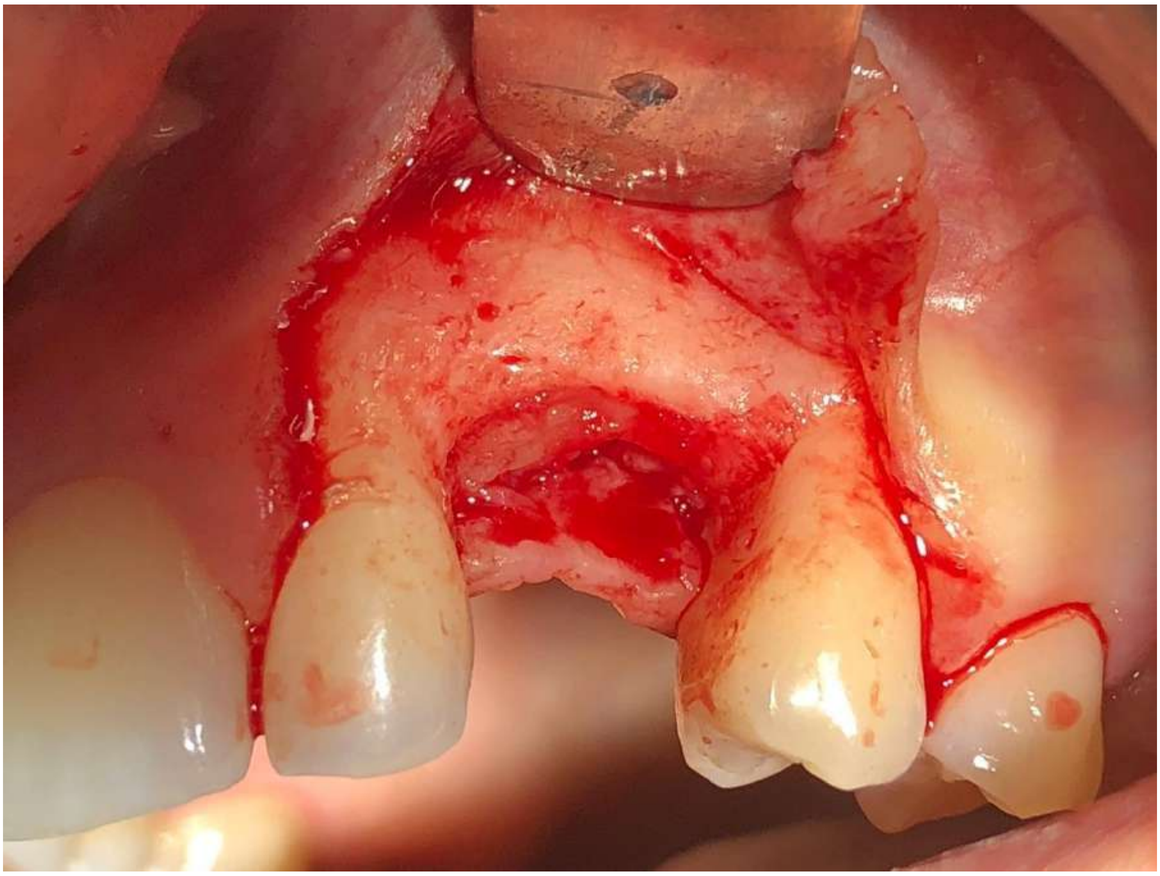

Figure 3: Elevation of the triangular flap

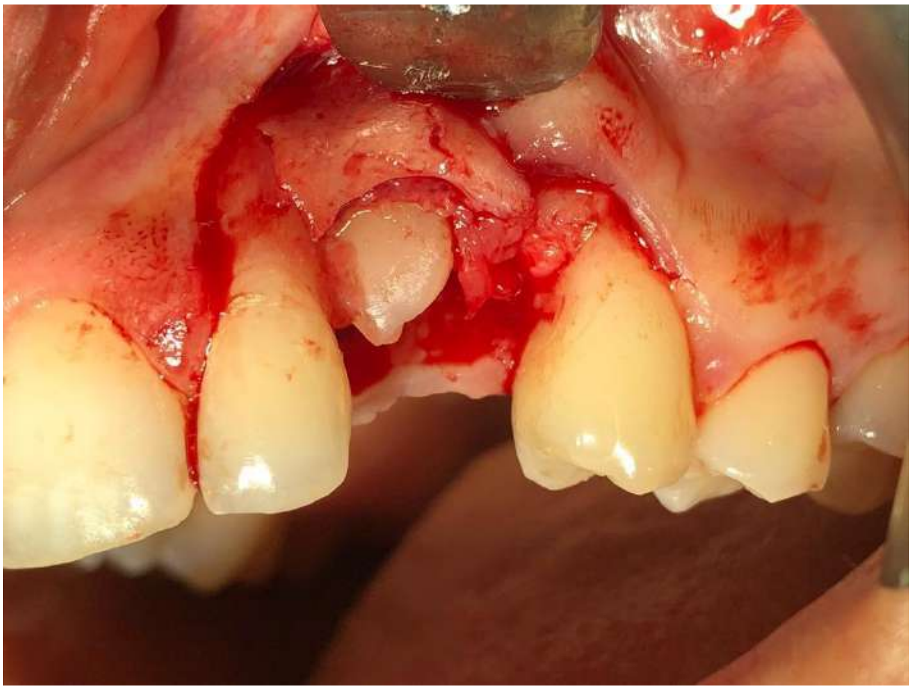

Figure 4: Crown of the impacted canine was exposed

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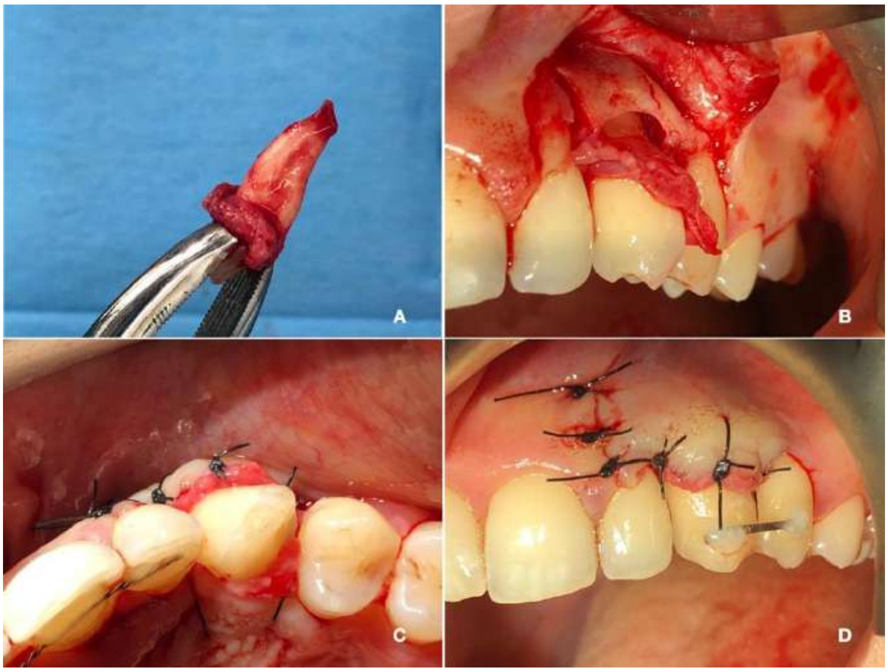

Figure 5: a) Donor tooth; b) Repositioning in line with the other teeth; c) Suture of the follicular cap with the gingival edge of the flap; d) Splinting

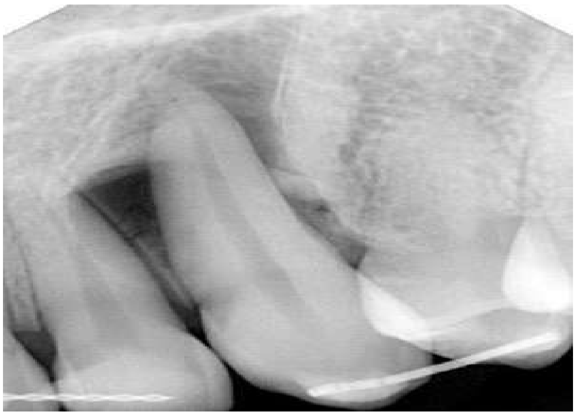

Figure 6: Immediate post-operative x-ray

The two-year follow-up shows soft tissues in a good condition (Figure 7), with a keratinized gingiva similar to that of the neighboring teeth. The X-ray shows bone reformation around the root with the presence of a black line compatible with the periodontal interspace and a fully healed lamina dura (Figure 8).

Figure 7: 2 Years clinical healing

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Figure 8: a) 6 Month x-ray follow up; B) 1 Year x-ray follow-up; C) 2 Years x-ray follow up

III. DISCUSSION

The management of the impaction of maxillary canines starts with interceptive treatment as the best long-term solution. This procedure usually allows the permanent tooth to become upright and erupt properly into the dental arch [Bedoya and Park 2009]. In fact, according to Ericson and Kurol, early extraction of primary maxillary canines may result in normal eruption of ectopically permanent corresponding elements. Particularly, extracting the primary canine before the patient is 11 years old would normalize the erupting position of the permanent element in 91% of the cases if the crown is distal to the midline of the lateral incisor root. This success rate decreases to 64% if the permanent canine crown is mesial to the midline of the lateral incisor root [Ericson and Kurol 1988a]. The degree of crowding, extent of overlap of the canine on the lateral or central incisor, angulation, and height of the canine are all important predictive factors for success, and these need to be taken into account before a treatment decision can be formulated [Ericson and Kurol 1988b; Patel et al. 2011].

Surgical exposure may be also considered as a solution alone or combined with orthodontic treatment: uncovering the tooth may encourage its autonomous eruption and, in addition, an eventual odontoma may be removed letting the canine arise. Access to the tooth may be provided for the later placement of an attachment and for the application of orthodontic traction. Excepting the very simplest forms of impaction, orthodontics will be necessary to properly resolve the impaction and then align the tooth. This being so, the dental arches need to be aligned and leveled and adequate space provided in the canine location: this preparatory step takes time, occasionally a year or more [Becker and Chaushu 2015]. When the root development stage is more favorable, orthodontic traction is planned in order to obtain ideal function and aesthetics through correct positioning of the impacted canine [Dalessandri et al. 2017]. Several potential complications may arise following surgical exposure and orthodontic forced eruption of the impacted maxillary canine, including root resorption, periodontal defects, poor esthetic outcome, and immobility [Chapokas et al. 2012].

The orthodontic treatment is not always accepted by patients, particularly senior ones, because it might last up to 2 or 3 years, depending on many factors like the canine position, aesthetic, and economical considerations. In adults, it might also be contraindicated because of some risks that can accompany the extrusion and the subsequent alignment, such as loss of vitality, loss of periodontal attachment, and root resorption of both the canine and adjacent teeth [Boschini et al. 2018].

In such cases, and with sufficient space, autotransplantation of the canine may be considered a good solution.

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Autotransplantation involves atraumatic surgical removal of a tooth from its impaction or ectopic site, the creation of a socket at the donor site, and then replantation of the tooth into the correct position within the alveolus [Patel et al. 2011].

According to the literature, autotransplantation success is determined by different factors, such as patient age, developmental stage of the transplanted tooth, type of tooth, surgical technique, and extra-alveolar time between the extraction and the replanting. The presence of healthy periodontal ligament cells on the root surface is a critical factor for healing and long-term success [Andreasen 1981], and the administration of a single prophylactic dose of antibiotics, combined with perioperative antiseptic local treatment, reduce the bacterial load minimizing the risk of initial infection.

Unlike an osseointegrated dental implant, in fact, tooth autotransplantation provides vital periodontium and continuous skeletal growth. The advantages of autotransplantation, compared to prosthetic rehabilitation, are improved aesthetics, function and mastication; in addition, the alveolar bone volume is preserved, due to maintained proprioception and physiological stimulation of the periodontal ligament. The prognosis of these elements is comparable to that with dental implants, even though proper complications may occur. Infection-related root resorption and ankylosis are reported frequently in cases of donor tooth with complete root formation [Czochrowska et al. 2002; Chung et al. 2014; Boschini et al. 2018].

Tooth autotransplantation can be the best option in case of pediatric patients in which dental implants are contraindicated because of the developing maxillary jaws. Moreover, the transplantation of a tooth implies also the maintenance of the proprioception, which is otherwise almost completely lost in case of implants [Boschini et al. 2020].

In agreement with the literature, the percentage of survival from individual studies ranged widely at 30 - 100%. The success must be found in the absence of root resorption or ankylosis, both obtained with atraumatic surgery procedure, maintenance of the periodontal ligament cells on the root surface, and gentle manipulation of the tooth. Significant predictors are the extra-oral time during transplantation, which has to be between 5 and 18 minutes, because the clonogenic capacity of the periodontal ligament cells will fall to nearly 3% after 30 min of extra-oral dry storage. Teeth with completely formed roots with no extra-oral storage have less risk of pulpal necrosis compared to those which are stored until transplantation. The success rate is higher for teeth with incomplete root formation, and the presence of an open apex is considered one of the key factors for clinical success [Andreasen et al. 1990; Boschini et al. 2018; Grisar et al. 2021]. The management of an incomplete formed root tooth appears to be different: while pulp regeneration is unpredictable for adult teeth, it is otherwise probable for young forming teeth. This aspect implies a mandatory root canal treatment of the former; conversely, root canal treatment may be optional for the latest. Finally, splinting stabilization should not exceed 14 days in order not to cause ankylosis. Suture splint or flexible titanium wire with composite splint should be considered, according to more recent evidence that highlights a 3.7 RR in favor of suture splinting [Chung et al. 2014; Boschini et al. 2020].

While the transplantation of immature teeth has always been viewed with optimism, especially in the orthodontic field, the transplantation of mature teeth is often considered with skepticism.

A recent study showed that even mature transplanted teeth have survival rates of 90% over 10 years, making dental transplantation a valid alternative in cases where it is applicable (Boschini et al. 2020). For this reason, dental transplantation is suitable as a therapeutic proposal in orthodontic cases of management of impacted teeth in adult patients. This surgery does not preclude the performing of implantology or fixed prostheses in case of failure.

Furthermore, in addition to the biological benefits, the costs incurred by the patient are much lower than for an implant rehabilitation. In

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a recent article the costs of transplantation and other rehabilitations were compared, revealing that the costs of the transplantation were 23.5% of the average costs of implant rehabilitations, according to the American 2016 Dental Fees, identifying the tooth autotransplantation as a valid economic alternative to the aforementioned solution. [Boschini et al. 2020]

For all these reasons tooth autotransplantation was one of the best options for the management of the impacted canine of the presented case. Time, costs and possibility to resort to implant rehabilitation in case of failure were the reasons why the patient accepted this kind of treatment.

IV. CONCLUSION

Autotransplantation of impacted teeth is a well-documented and successful technique, which can be considered as a valid solution for both functional and aesthetic aspects for the management of impacted and/or ectopic maxillary canines.

Although surgical exposure and following orthodontic treatment remain the main and most documented techniques, this approach is not always practicable, especially in adults; on the other hand, the patient may simply refuse the orthodontic due to economic reason or timing.

In such cases, if the case meets the right requirement, autotransplantation should represent the best solution.

V. CLINICAL RELEVANCE

Autotransplantation represents a successful choice in the management of canine's impaction in adult patients, when orthodontic or surgical-orthodontic treatments are impracticable. The success key of this therapeutic option is determined by different factors, mainly referred to the surgical procedure, as well as to the presence of healthy periodontal ligament cells on the root surface, to the root formation stage and to its splinting once replanted.

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Exploratory Assessment of Challenges Related to Timely Detection, Notification and Confirmation of Selected Disease Outbreaks in Kano and Kebbi States – Nigeria

Fashoto, B. Metiboba, L. Anarado, C. Akpan, D. Odogwu, J. Danjuma, J. Agogo, E, Lee. C. Kauranmata A. & Abubakar M.

ABSTRACT

Nigeria established Public Health Emergency Operations Centers (PHEOCs) across its 36 sub-national units to prepare, respond and recover from public health emergencies. PHEOCs require timely access to data to support disease detection, notification and confirmation. But delayed data has led to delayed actions by PHEOC before and during an outbreak. This study identified the challenges to data production and use to support decision-making during surveillance and disease outbreaks. We deployed a participatory approach to understand the challenges of data for action among PHEOC actors during disease outbreaks.

Keywords: disease preparedness, outbreak detection, timeliness milestones, technology- based surveillance system.

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Exploratory Assessment of Challenges Related to Timely Detection, Notification and Confirmation of Selected Disease Outbreaks in Kano and Kebbi States – Nigeria

Fashoto, B[α], Metiboba, L[σ], Anarado, C[ρ], Akpan, D[Ѡ], Odogwu, J[¥], Danjuma, J[§], Agogo, E[χ], Lee, C[ν], Kauranmata, A[ϴ] & Abubakar, M[ζ]

ABSTRACT

Nigeria established Public Health Emergency Operations Centers (PHEOCs) across its 36 sub-national units to prepare, respond and recover from public health emergencies. PHEOCs require timely access to data to support disease detection, notification and confirmation. But delayed data has led to delayed actions by PHEOC before and during an outbreak. This study identified the challenges to data production and use to support decision-making during surveillance and disease outbreaks. We deployed a participatory approach to understand the challenges of data for action among PHEOC actors during disease outbreaks. A participatory workshop session was held with PHEOC actors in Kano and Kebbi states. We conducted a content analysis by coding deductively and presented the findings in themes. The range for detecting a disease outbreak was 1 – 28 days. The time to notification ranged from 1 to 2 days. Lassa fever had the longest time to detection of 28 days, while cholera had the shortest (1 day). The use of paper and technology-based reporting tools contributed to delays in outbreak detection, notification and confirmation of a suspected case. So was the use of numerous reporting tools, low capacity for case identification, insecurity and ill-equipped laboratories. We recommended capacity building for PHEOC actors, the automation and integration of data gathering and analysis structure into PHEOCs. These proposed interventions will improve case identification, data management, automation and integration of disease reporting systems, to permit improved data visibility, analysis and evaluation to promote timely data gathering and usage in PHEOCs.

Keywords: disease preparedness, outbreak detection, timeliness milestones, technology-based surveillance system.

Author α σ ρ Ѡ ¥: eHealth Africa (eHA)
§ χ ν: Resolve to Save Lives.
ϴ: State Ministry of Health.
ζ: Kebbi State Ministry of Health.

I. INTRODUCTION

Public Health Emergency Operations Centers (PHEOCs) serve as hubs for effective coordination of disease outbreak and response activities [1]. They coordinate multi-sectoral response to emergencies by gathering, analysing and articulating surveillance data used to develop response strategies before, during and after disease outbreaks. PHEOCs are expected to collect, analyse and disseminate data while supporting operational and logistical activities during outbreak response at the sub-national level [1].

In Nigeria, PHEOCs coordinate the surveillance and notification of epidemic-prone diseases and those targeted for elimination and eradication to the right authorities. This process leverages data from multiple sources and stakeholders and follows a reporting hierarchy. The Nigeria Center for Disease Control (NCDC) leads the pre-paredness, detection and response to infectious disease outbreaks and public health emergencies [2]. The NCDC is centrally based, positioning it to receive public health monitoring reports from the 36 sub-national units in Nigeria and the Federal

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Capital Territory (FCT). Subsequently, the effectiveness of the national disease surveillance and notification system largely depends on the district and Local Government Area (LGA) disease monitoring and control mechanisms, with health personnel actively involved [3, 4, 5].

Nigeria implements the Integrated Disease Surveillance and Response (IDSR) strategy as its means of implementing the International Health Regulations (IHR [2005]) through the FMoH [6] through NCDC. The NCDC also serves as the National Focal Point (NFP) for IHR implementation in Nigeria. Nigeria's IDSR strategy requires health facilities to participate in a surveillance process that includes the routine reporting of 43 priority diseases. These data are monitored daily, weekly, and monthly using the IDSR001, IDSR002, and IDSR003 forms, respectively [6].

II. PROBLEM STATEMENT

In reportable disease surveillance systems, public health data come from various sources [5]. This data flows from the LGA to the state to the national level and informs which disease signals or cases should be placed at the watch, alert, or response phases of the disease outbreak response protocol [6].

Previous studies on disease surveillance and notification attributed the failure in mandatory reporting of notifiable diseases among public health surveillance stakeholders to a lack of awareness of the surveillance systems, technical know-how on tools and requirements for reporting notifiable diseases, including how, when, and to whom reporting should be done [5, 7, 8, 9]. Evaluating the surveillance system in Nigeria requires an understanding of the factors that contributed to gaps in the timeliness of outbreak response over time, having an insight into factors (data sources and tools) that enable or inhibit effective outbreak response, and providing guidance for identifying or refining adapted interventions to improve performance. Several metrics have been proposed for objective, quantitative [10] and qualitative evaluation [11] of outbreak response by systematically capturing and analysing data on timeliness for reaching key milestones in outbreak detection and response.

III. STUDY OBJECTIVES

The general purpose of this study is to identify and review challenges related to achieving timely detection, notification and confirmation of selected disease outbreaks in Kano and Kebbi states. Specifically, the study:

- Identified data sources for public health surveillance process in Kano and Kebbi states,
- Identified bottlenecks/gaps within these data sources,
- Reviewed timeliness metrics for five (5) disease outbreaks, and
- Identified various challenges to timely disease surveillance and response

IV. STUDY SETTINGS

Nigeria established a National Polio Emergency Operation Center (EOC) in Abuja in October 2012 under the National Primary Healthcare Development Agency (NPHCDA), an agency of the Ministry of Health. EOCs were subsequently established in seven polio high-risk states, starting with Kano and expanding to Bauchi, Borno, Kaduna, Katsina, Sokoto, and Yobe states, as part of the polio endgame plan for Nigeria [17, 18]. These EOCs were integrated into the Presidential Task Force on Polio Eradication framework, a government-led structure co-ordinating the work of polio eradication initiative partners. Leveraging on the success of the polio EOC structure, the NCDC, Nigeria's public health institute, supported sub-national authorities in Nigeria to set up Public Health Emergency Operations Centers (PHEOCs) [1].

All 36 states in Nigeria and the Federal Capital Territory (FCT) have a PHEOC. However, in Kano and Sokoto states, the PHEOCs sit alongside polio EOCs under the State Primary Healthcare Development Agency (SPHCDA). Several arguments have been advanced for these two EOCs to be merged. But the existing governance structures in Nigeria make this a challenge.

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Polio EOCs report to the SPHCDA. They were initially established to coordinate state polio eradication programmes and support non-polio supplementary immunisation activities (SIAs) such as measles campaigns. PHEOCs, on the other hand, are domiciled within the authorities of state Ministries of Health with reporting lines to the NCDC. As of the period of this study, both states have no evidence of an event-based surveillance system. Meanwhile, both Kano and Kebbi state PHEOCs have no legal recognition.

V. METHODS AND SAMPLING TECHNIQUES

5.1 Methodology

The study adopted a qualitative research approach which provided in-depth insights on the challenges of timely detection, notification and confirmation of selected disease outbreaks in Kano and Kebbi states. We used a participatory approach to conduct a bottleneck assessment of previous outbreaks to identify major challenges in using data to detect and respond to outbreaks across two sub-national entities in Nigeria; Kebbi and Kano states. We reviewed three timeliness milestones in outbreak detection and confirmation. These are detection, notification and laboratory confirmation. The bottleneck assessment approach was adapted from production and project management. A bottleneck analysis facilitates the identification of the exact point along the workflow that is causing blockages and works to mitigate them. We employed this tool to give us a systematic view of the challenges to effective use of data as an evidence base for disease outbreak detection and response within the public health system [13, 14, 15].

On the premise of diseases peculiar to the study locations and the trend of disease outbreaks, we selected five (5) disease outbreaks that occurred during 2006–2020 from the NCDC dashboard for disease outbreaks [15]. The name and aggregate of the confirmed diseases are measles (1663), cholera (255), Lassa fever (25), cerebrospinal meningitis (24) and yellow fever (8). This use case review approach availed us the platform to assess PHS experience in line with timeliness milestones in Kano and Kebbi states, Nigeria [15, 16].

5.2 Study sample and sampling techniques

In this study, PHEOC actors are the sample frame. We employed the convenience sampling technique to identify relevant actors for the participatory workshop. Before the workshop, we asked authorities in the Ministry of Health in each of the focal states to identify stakeholders that are influencers and decision-makers in the outbreak detection and response system in their states. A list of participants was shared from the office of the Commissioner of Health in both states. Some of the study participants included: The Commissioner for Health, Permanent Secretary at the State Ministry of Health, Emergency Operations Center (EOC) Incident Manager/State Epidemiologist, EOC Manager, Executive Secretary of State Primary Health Care Management Board (SPHCMB), State Immunization Officer, Director of Public Health and Disease Control, State Disease Surveillance and Notification Officers (DSNO), State Assistant DNSOs, and international development partners working in the public health space in those states, including the Africa Centre for Disease Control, the World Health Organization (WHO), the United Nations Children Fund (UNICEF) and many more. Twenty-six (26) and thirty-two (32) participants attended the workshops in Kano and Kebbi states, respectively.

During the participatory workshop, we adopted the best practices of qualitative data collection and ensured to implement COVID-19 physical distancing guidelines. The ethical approval for the study was obtained from the National Health Research Ethics Committee in Nigeria (NHREC /01/09/2020-18/09/2020), and appro- val was also sought from the Commissioners of health in both states before the implementation of the workshops.

5.3 Data Collection Tool

We used a peer-reviewed group discussion interview guide to elicit relevant information from participants. The guide consisted of sections

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designed to explore the bottlenecks existing in the surveillance and outbreak response systems in Kano and Kebbi states. Section A of the interview guide consists of demographic information of stakeholders (age, gender, designation and years of experience), and section B consists of questions relating to sources of PHS data within the state. This was followed by a section that explored the milestones of past and recent outbreaks in the state. Another section assessed the major bottlenecks or challenges at each milestone of disease outbreaks. The last section captured the recommended solutions to data use challenges for prompt actions during disease outbreaks.

The peer-reviewed interview guide was administered on select public health actors with the same characteristics as the respondents to validate the tool. Their responses and feedback were used to update and finalise the interview guide before administering it to the study respondents.

5.4 Pre-Data Activities, Rationale and Process

We partnered with the NCDC and Resolve to Save Lives (funding partner) to implement the participatory workshop to identify the public health (PH) data sources, challenges, and response time to outbreaks in Kano and Kebbi states, Nigeria. Assessment findings was to inform capacity building activities that will strengthen surveillance. Through the Ministry of Health, we mapped the relevant PHEOC actors and invited them to a two-day participatory workshop in each state. During the workshops, we explored the milestones reached during the last outbreak of five priority diseases as deduced from the NCDC dashboard report. These diseases are cholera, measles, meningitis, Lassa fever, and yellow fever [15]. We identified barriers in the detection and response process and assessed the effectiveness of the PHEOCs in gathering, analysing and presenting data useful for decision making. This bottleneck approach offered an opportunity to evaluate the capacity of existing skill sets that implement these activities. The language of engagement was English. Workshop facilitators used approximately 50 minutes to explore each section of the guide. The data collection continued till the saturation level was reached. Session responses were audio-recorded with the consent of participants, and notes were also taken. Strict privacy and confidentiality were maintained for all recordings and data.

5.5 Data Analysis

The audio recordings from the assessment were first transcribed and verified with the recording by data analysts to enhance the accuracy of the data. Expert data analysts developed a coding guide. The data analyst read the transcripts several times to gain familiarity and understanding of the content. After that, a qualitative manual content analysis was used to interpret the manifest content (what the text says) and the latent content (the interpreted meaning of the text). Relevant words and phrases within the content were selected, and the data was divided into meaningful units. The units were then condensed and labelled with meaningful codes that identified timeliness metrics. The data analyst performed the coding. The codes were further grouped as sub-categories and then into themes. Finally, the project team collectively discussed the themes, and the final version of the analysis was produced and agreed upon. We analysed the timeliness metrics for the selected diseases by calculating the mean of all responses given by the participants at the workshop.

VI. RESULTS

Our findings range from data sources for disease surveillance, gaps within the data sources, timeliness metrics for disease outbreaks using the selected diseases as use cases and the challenges contributing to delayed timely outbreak response among PHEOC actors in Kano and Kebbi states.

- Identified data sources for public health surveillance process in Kano and Kebbi states,
- Identified bottlenecks/gaps within these data sources,
- Reviewed timeliness metrics for five (5) disease outbreaks, and
- Identified various challenges to timely disease surveillance and response

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6.1 Objective 1: Data Sources for Disease Surveillance

In both states, PHEOC data was categorised as Human Resource (HR) data, routine immunisation, logistics and health surveillance data. In this study, it was found that each category of data had its peculiar sources of data for action. For public health surveillance data, the PHEOC actors mostly utilise the Surveillance Outbreak Response Management and Analysis Systems (SORMAS), Health Management and Information System (HMIS) and Integrated Disease Surveillance Response (IDSR) tools. The IDSR tool was found to be the major reporting tool for PHS. The tool is presented in five (5) unique Forms and uses; Form 001A (for immediate case-based reporting of notifiable diseases), IDSR Form 001B (laboratory request form for immediate reporting), IDSR Form 001C (line-list form), IDSR Form 002 (weekly summary reporting form) and IDSR Form 003 (monthly summary reporting form). Other sources of data for action include health facility registry, survey data by the Ministry of Health (MoH), Nigeria Demographic Health Survey (NDHS), Navision, Drug Management Agency, Integrated supportive Supervision Data (ISSD), DHIS2, and SORMAS. Some non-conventional sources of data, such as "rumours" and "Community Informants and leaders", were reported across both states. In Kebbi state, DHIS2 and health facility registries stood out as the major conventional data sources. Table 2 documents more details on data sources by their categories.

6.2 Objective 2: Gaps Existing within the Data Sources for Disease Surveillance

In each state, findings from our study show that PHEOC decision-makers have had some challenges in either accessing the data sources or utilising the data. The challenges experienced are quite similar across both states. For example, participants in both states identified overburdened health staff, poor skill-transfer plans, inadequate training of personnel, data falsification, network instability, and security constraints as some of the most significant challenges of data sources used for outbreak detection and timely intervention.

The existing challenges around the RI data sources in both states are delays in case reporting and poor data. The facility register often has missing or incomplete data. In addition, the mismanagement and short supply of paper-based data reporting tools (IDSR and HMIS tools) were also discussed as one of the main challenges of accessing routine immunisation data. This study further found that community resistance and security constraints contribute to PHS data collection and reporting delays.

The logistics of moving the appropriate quantity of consumables, drugs, and equipment across locations in both states was aided through Navision and Logistics Management Information Systems (LoMIS), especially in Kano state.

6.3 Objective 3: Timeliness metrics for disease outbreaks

The responses to timeliness metrics of disease outbreaks in both study states were similar, and we present aggregate means in Table 4. In this study, it was found that Lassa Fever had the highest estimated mean days (28) to detect a case as compared to all diseases assessed. This is followed by polio (5 days) and measles (4 days). Cholera had the shortest days of being detected, at an average of 2.5 days. Food/waterborne diseases such as cholera had the shortest days for detection. The notification period is slightly even across all the disease categories. The number of days to confirm a suspected case of measles is 30 days as shown in table 4.

From the findings on notification of disease outbreaks, respondents asserted that it took fewer days to notify the relevant authorities when an outbreak has been detected compared to the time it took to detect the outbreaks. Laboratory confirmation for viral hemorrhagic fevers such as measles was 30 days. Table 4 details the timeliness of each disease.

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6.4 Objective 4: The challenges of timely detection and notification of disease outbreaks in Kano and Kebbi States, Nigeria

For all priority diseases assessed in this study, we identified the bottlenecks or challenges experienced at each outbreak milestone attained. This study shows that most of the recurring challenges for the workshop participants at the milestone of detection is the delayed identification of suspected cases. This was largely due to the case-identification gap of some PHEOC actors, such as the CIs, the DSNOs and the community health workers. It was reported that the symptoms of some outbreak diseases such as meningitis and flu seem similar. As such, there is some level of difficulty in case identification. For quick and fast case detection, the capacity of the informant to quickly identify the disease is a major factor that delays the detection of a disease outbreak notification.

"Late reporting from rural communities to health facilities (Some patients die before identification and reporting)" Workshop participant from Kano state.

During case notification, we found out that delayed detection had stretched its timing into the notification period. Thus, PHEOC actors (the DSNOs, focal officers and M&E officers for the surveillance team) notified of suspected cases receive data that fails the quality test of timeliness and completeness. There were instances where a case was notified seven days after it was detected. Respondents across all states further reported that suspected cases had been missed during the detection period. Thus, there were experiences of low case reporting.

This study identified other challenges contributing to delayed detection and notification of diseases: internet/network constraints in some areas within the states and poor use or absence of electronic medical records systems at the facility level. Insecurity concerns also constrained access to some communities and settlements from where a case is reported.

"Insecurity also deprives the team of having access to the settlement of concern when a report of an outbreak has been received". Workshop participant from Kebbi state.

Below are four major factors contributing to delayed confirmation of a disease outbreak in Kano and Kebbi.

1. Inadequate functional and well-equipped laboratories

Participants that attended the participatory workshop informed the research team of the limited functional laboratories within the states. Most of the laboratories in the states are not fully equipped to undertake case confirmations. As such, case samples are sent to neighbouring states for confirmation. As of the period of this study in Kebbi state, samples of meningitis have to be sent to nearby Sokoto state, and the result takes between 48 to 72 hours. In addition, participants from Kano state shared an experience that occurred in 2017, when a sample of yellow fever was sent to another state; the feedback of a confirmed case was received after three months. Such a delay could result in an outbreak of yellow fever in the community. This could have been prevented if the confirmatory result had been received within an acceptable time frame. Some other attributable reasons for delayed results of a sample sent to another state are the missing samples, prioritised samples to test, and stock-outs of laboratory testing supplies.

"Measles, Yellow fever lab confirmation is only done at specific laboratories. Samples are sent to the reference laboratory [in Abuja]". Workshop participant from Kano state

"Getting feedback from the laboratory results is a big issue because the results don't come on time". Workshop participant from Kebbi state

2. Limited skills in sample collection

This study identified a bottleneck in sample collection for some diseases like meningitis. Due to the peculiarity of the disease, participants reported that a specialist is needed for sample collection. However, the responses in both states reveal that the DSNOs or health workers have limited sample collection skills. Some reported actions and events fell short of best practices whilst responding to the recent outbreaks. For

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instance, in Kano state, the sample collection criteria were not strictly adhered to by the laboratory personnel, especially in cases of meningitis. This led to the rejection of samples at the reference laboratories. Hence, some samples are rejected because they have failed the quality criteria.

"For cerebrospinal meningitis, sample collection is a major challenge as it requires skilled personnel. There is little or no response that can be provided without confirmation. Cases are sometimes not documented in facility registers". Workshop participant from Kano state.

"Essentially, we have a lot of suspected cases for meningitis, but very few confirmed cases because the samples were not collected due to lack of skill".

Workshop participant from Kebbi state.

3. Personnel shortage

Another major finding from this study is the shortage of skilled personnel for sample collection, contact tracing, data management and documentation. In the event of several confirmed cases in an area, the opportunity to embark on effective contact tracing becomes a challenge as the ratio of the number of skilled personnel, and the workload is unbalanced. Furthermore, we found that staff focused on data management activities such as records, data capturing, and interpretation are not enough across the focal states. With these shortfalls, opportunities to confirm a case are missed or delayed.

"When there are several confirmed cases in an area, tracing all their contacts becomes difficult due to shortage of personnel" Workshop participant from Kano state.

"With many cases tracing becomes difficult due to lack of manpower but no issues when the cases are few". Workshop participant from Kano state.

Inadequate or lack of qualified medical record personnel to serve at the health facility in collecting data" Workshop participant from Kebbi state.

4. Numerous reporting tools

In addition, confirmation of a suspected case is delayed due to numerous reporting tools in both states. The PHEOC actors present at the workshop reported that the process of updating the surveillance tools is cumbersome and seems like duplicating efforts. Updating the same information on both digital and analogue was identified as a bottleneck. In Kano state, participants reported that the data transmitted to different platforms often do not synchronise. In Kebbi state, SORMAS, DHIS2 and paper-based forms are used for reporting. Some examples:

"data is transmitted to different platforms when you need to triangulate how they speak differently". workshop participant from Kano state.
"SORMAS, DHIS2 and Paper based forms are used for reporting". Workshop participant from Kebbi state. "Paper based forms: IDSR 016 - immediate case desk form, IDSR 01a - Lab form of immediate case, IDSR 01c – line list for outbreak. IDSR 002 is weekly reporting, IDSR 003 is monthly, while IDSR 1a,1b,1c are filled, when necessary, as soon a case is reported. IGSM O12 is the general form filled by the DSNO" Workshop participant from Kebbi state.

The time it takes to update these tools was reported to have delayed case reporting and confirmation. In Table 2, we have highlighted the challenges encountered from recent disease outbreaks in Kano and Kebbi states, as described by the workshop participants.

VII. DISCUSSION

Timely detection, notification, and confirmation of a suspected case can reduce the impact of an outbreak as it promotes access to quality data that can be used for prompt and informed decision-making by PHEOC actors. This study has identified the bottlenecks that have prevented timely detection, notification and confirmation of disease outbreaks by PHEOC actors in Kano and Kebbi states and informed capacity building programs.

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This study has revealed empirical data on the identified bottlenecks for outbreak timeliness metrics and can be used as a basis for disease timeliness interventions. It was found in this study that the most used tool for health surveillance in Kebbi and Kano states is the IDSR forms. This finding conforms with numerous studies establishing IDSR as a major health surveillance tool (5, 19, 20). As this study aimed to understand the bottlenecks at each outbreak milestone, we found that the use of the IDSR strategy was consistent among the DSNOs and surveillance officers. However, there were complaints of duplication of efforts as they still utilise a technology-based surveillance tool (DHIS2 and SORMAS). In addition, it was found that the same surveillance information is reported on both platforms. Our study demonstrated that the utilisation of the blended tools (paper-based tools and technology-based tools) had been a factor that has contributed to delayed and incomplete reporting [21,22].

Although data was available in all spheres of data entry, the challenges almost make these data unreliable and difficult to use. Different forms of data were stored at different levels ranging from human resources, immunisation tools, logistics tools, and surveillance tools. The functionality of the surveillance system requires a chain of staff who have been adequately trained and supported [23]. Our study shows that health workers were overburdened, invariably leading to incomplete data and misinformation. This challenge also affects routine immunisation, as records on DHIS2 and health facilities registry were often not fully completed or properly filled. Further gaps were identified in routine immunisation processes with delays in case reporting, shortage of tools, and report system gaps. Moreover, several improvements on IDSR have been implemented on SORMAS by converting paper forms into an electronic format, using SMS reporting, using the mobile version of DHIS2 to manage all public health facilities, and implementing an Integrated Surveillance System (ISS) to improve health care service. These measures have improved disease surveillance in African countries such as Tanzania [24], Zambia [25], Malawi [26] and Ghana [27]. Meanwhile, due to the complexity of public health surveillance, and the need for integration services at the community level, Unstructured Supplementary Service Data (USSD) technology linked with SORMAS for the immediate reporting for IDSR would be a good strategy for disease surveillance as implemented in Tanzania [24].

In our study, the disease category was associated with differences in time to detection, laboratory confirmation, and outbreak end. The average time of detection for cholera is shorter than other diseases. This is to the fact that laboratory capacities for confirming *Vibrio cholerae,* particularly in cholera-prone settings, have improved, [29] and also incubation period which contribute to early detection compared to other disease outbreak [30]. For cholera, the IDSR outbreak threshold is one confirmed case, but most measles and meningitis outbreaks require five (5) cases over to achieve the epidemic threshold. Furthermore, monitoring of diseases reaching an outbreak threshold continues to be performed mainly through indicator-based surveillance that relies on structured weekly IDSR002 reports from health facilities. This structure could likely result in delays in early detection of vaccine-preventable diseases such as polio, measles and meningitis outbreaks because this system captures only those cases from health facilities. However, introducing community events based through the IDSR 001 has addressed this limitation by capturing reports from a wide variety of sources from community/ traditional rulers, community informants and religious leaders. This has increased reporting of suspected cases of other diseases leading to early detection of outbreaks as implemented in Liberia [31].

Our findings further validate that efficient and reliable disease surveillance systems are vital for monitoring public health trends and early detection of disease outbreaks [28]. Any good decision in health care hinges on the quality of the data available, which is reflected in decision making [27]. One of the critical findings from this study was the shortfall in the timely confirmation of suspected cases. The shortage of functional laboratories within these states has contributed

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immensely to the delayed confirmation of cases during outbreaks. The experiences reported by the workshop participants showed that most times, laboratories within the states are out of stock of reagents. When reagents become available, the samples become unfit for use. When results are released after a long period, they become useless as the suspect has recovered or died. Confirming suspected cases of meningitis, measles, and yellow fever was most challenging as samples are always sent to the reference laboratory in both states. This is a typical experience of the challenges experienced in laboratories domiciled in Africa (16). This study further revealed an existing knowledge gap in case identification among surveillance actors. There is a need for retraining of community informants and health workers on case definition and identification, and also a refresher training on IDSR strategies across the states. This conforms with the findings of a study conducted in northern Ghana, where the challenges to the core functions of the IDSR were assessed (22).

VIII. STUDY LIMITATIONS

This study was limited to a qualitative assessment of stakeholders in the public health sector using a bottleneck approach. This was because the approach employed required robust information on the experiences of actors involved in the subject under review. This will elicit deeper issues that a quantitative process could mask. It was also the best means to elicit prompt responses to the collection instrument. The findings on the timeliness metrics were elicited from participant responses. As such, there could be a recall bias among participants. This was addressed by developing a robust interview guide and ensuring responses for each question item were confirmed during the validation meeting.

IX. CONCLUSION AND RECOMMENDATIONS

This study provided insight into the value of timely response to disease outbreaks, especially during detection, notification, and confirmation. The timeliness of an outbreak milestone can be affected by different factors, including the capacity of human resources, available data tools, and laboratory-related challenges. We thus recommend the periodic training of health personnel on disease identification, data quality measures, harmonised reporting tools, and well-equipped laboratories.

On the premise of this study's findings, we proposed a set of benchmark actions to improve the timely detection and notification of a suspected case. These include automating data and improving data integration from various data sources and eliminating all paper-based collection tools; strengthening the disease reporting structures by introducing a technology-driven disease reporting and notification process using Unstructured Supplementary Service Data (USSD). This automation will reduce the paper workload on health workers and simplify the surveillance system. These are alongside the interventions suggested by the state, some of which include capacity building on data gathering, data quality checking and analysis. With these in place, capacity building efforts will help ensure that outbreak reporting is optimal, while information and data analysis are implemented every week at the very least.

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Table 1: Definition of outbreak timeliness

S/N	Outbreak Timeliness	Definition of terms
1	Time to detection	The number of days between the date of onset (first reported case) and detection
2	Time to notification	The number of days between the date of detection and the date the event was first reported to a government representative or DSNO for the local government area (LGA)
3	Time to laboratory confirmation	The number of days between a suspected case sample collection and the day th result is available
4	Time to outbreak end	The number of days between the day an outbreak was declared and the day it was declared over

Source: [20, 21]

Table 2: Challenges of accessing data sources and utilising data in Kano and Kebbi states

Category of Data	Kano	Kebbi
Human Resources	• Insufficient HR to address multiple outbreaks. • Inadequately trained data entry clerks. • Knowledge gap due to the transfer of skilled personnel. • Lack of effective supervision. • Personnel overburdened with several reporting tools. • Administrative bureaucracy in submitting reports by technical officers. • Poor involvement of traditional leaders/healers.	• The access code to DHIS2 is restricted only to a few key personnel. • Inadequate or lack of qualified medical record personnel to collect data at the health facility. • Lack of documentation from the traditional leaders in the community leading to loss of key information. • Inadequately trained personnel for capturing data. • Lack of effective supervision. • Inadequate skills transition amongst health workers when transferred from one location to another. • Underreporting and entry of wrong data during data entry.
Routine Immunisation	• Network challenges accessing DHIS2. • Incomplete reporting. • Server not capturing data. • Delays in reporting. • Incomplete data between health facility, LGA, and state. • Data storage and archival. • Missing data. • High patient inflow. • Commodities stock-out • Shortage of data tools leading to reporting gaps. • Mismanagement of reporting tools.	• Vaccine Stockouts. • Inadequate facility tools for data collection. • Miscommunication with the community led to difficulty in getting access to the community during COVID 19 outbreak intervention.

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Logistics	• Security challenges. • Difficulties in accessing hard-to-reach areas. • The Immunology unit relies on a drug management agency when there is an outbreak.	• Security challenges in accessing some settlements. • Difficulty accessing hard-to-reach settlements due to physical barriers. • Lack of electronic medical records systems at the health facility level. • Network challenges also affect the reporting to DHIS2. In several instances, LGA M&E Officers have to travel to another LGA to send reports in order to meet deadlines.

Source: Workshop assessment data in Kano and Kebbi states, 2020

Table 3: Distribution of Public Health Data Sources in Kano and Kebbi states

State	Human Resources in the PHEOC system	RI in the PHEOC system	Data for logistics in the PHEOC system	Surveillance in the PHEOC system
Kano	• Integrated Supportive Supervision Data • Community Leaders • Community Informants	• RI coverage data • NDHS/Ministry of Health	• Drug Management Agency • Navision	• IDSR • SORMAS • DHIS2
Kebbi	• Rumors • Community Informants • Traditional Leaders	• DHIS2 • Health Facility Registry		

Source: Workshop assessment data in Kano and Kebbi states, 2020

Table 4: Mean of timeliness metrics of five priority diseases that occurred in Kano and Kebbi states between 2006 and 2020

Disease outbreaks	Detection days	Notification (days)	Lab confirmation (days)	Outbreak end (days)
Cholera	2.5	1.5	2.5	14*
Measles	4	1.5	30*	30*
Meningitis	3*	2	2.5	14*
Lassa Fever	28	1.5	5	42*
Polio	5	1.5	30*	90*

Source: Workshop assessment data in Kano and Kebbi states, 2020. (is the exact day)*

Table 5: Challenges of timely detection and notification of disease outbreaks

S/N	Challenges	Timeliness Milestone
1	Low capacity in disease identification	Detection phase Confirmation phase
2	Low index case reporting/late reporting	Detection Notification
3	Inadequate functional and quick-to-access network of laboratories	Laboratory confirmation
4.	Limited skills in sample collection	
5	Too many tools to Report and update	Notification phase
6	Shortage of Drugs	Outbreak end
7	Shortage of PHEOC actors	Detection and, Lab. confirmation

Source: Work shop assessment data in Kano an dKe bbistates, 2020

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Table 6: State-specific challenges encountered in recent disease outbreaks

State	Cholera	Measles	Meningitis	Lassa Fever
Kano	Absence of outbreak data Low reporting of cases Lack of drugs	Inadequate samples from community or health facilities Delays in getting lab results leading to the withdrawal of access to health workers to collect samples. Late reporting Non-compliance due to traditional beliefs The technical definition of outbreaks differs from the community definition Difficulty in obtaining blood samples, especially from small children	Only physicians have the authority to collect samples for meningitis and call for an investigation	Harvest seasons attract more rodents. Rodent droplets and urine are the vectors for Lassa fever. More rodents increase the possibility of an outbreak. Cases are missed because of the low index of suspicion among healthcare workers
Kebbi	Absence of outbreak data Low reporting of cases Lack of drugs	Late lab confirmation	Complicated sample collection methods Shortage of drugs availability Lack of lab confirmation	No information

Source: Workshop assessment data in Kano and Kebbi states, 2020

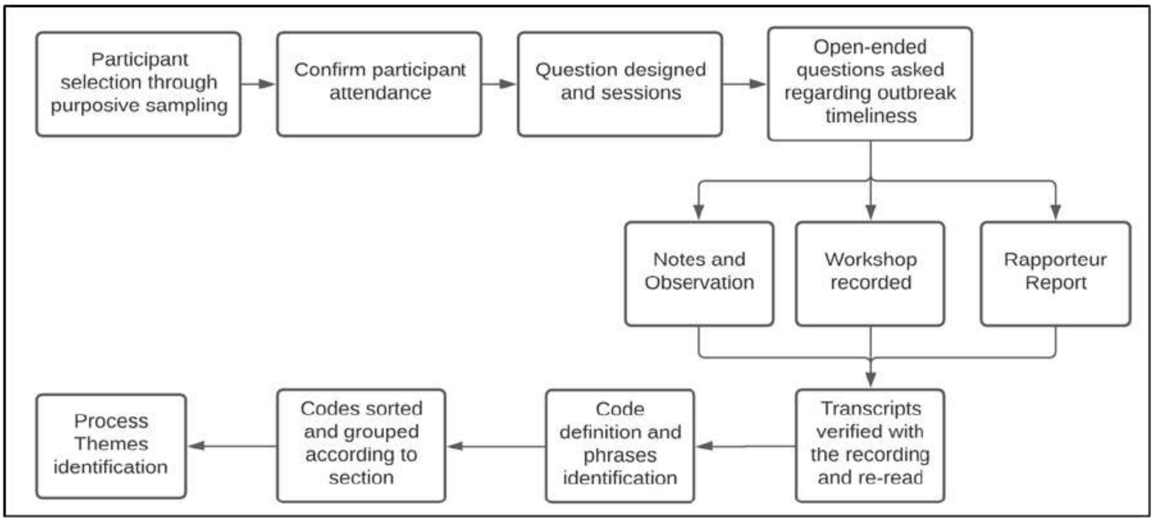

Figure 1: Flow diagram of the participatory workshop and qualitative analysis

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List of Abbreviations

AFRO - Africa Regional Office of the World Health Organization
Africa CDC - Africa Centre for Disease Control
ADSNO - Assistant Disease Surveillance and Notification Officer
COVID-19 - Novel Coronavirus Disease
CSM - Cerebrospinal Meningitis
DHIS2 - District Health Information Software
DSNO - Disease Surveillance and Notification Officers
GPW13 - 13th General Program of Work
H1N1 - Hemagglutinin Type 1 and Neuraminidase Type 1
HCoH - Honourable Commissioner for Health
IDSR - Integrated Disease Surveillance and Response
IHR - International Health Regulation
IM - Incident Manager
JEE - Joint External Evaluation LGA - Local Government Area MoH - Ministry of Health
NCDC - Nigeria Center for Disease Control
NDHS - National Demographic Health Survey
NHREC - National Health Research Ethics Committee
NPHCDA - National Primary Healthcare Development Agency
PH - Public Health
PHEIC - Public Health Emergencies of International Concern
PHEOC - Public Health Emergency Operations Centre

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PHS - Public Health Systems RI - Routine Immunisation RTSL - Resolve to Save Lives
SERCB - Sub-national Emergency Response Capacity Building Program
SORMAS - Surveillance Outbreak Response Management and Analysis System
SPHCDA - State Primary Healthcare Development Agency SPHCMB - State Primary Healthcare Management Board UNICEF - United Nations Children Fund
USSD - Unstructured Supplementary Service Data
WHO - World Health Organization

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Bicornuate Uterus with Multiple Uterine Fibroids, Metroplasty and Myomectomy; Case Profile and Literature Review

Akani C.I, John C.O, Korubo I.K, Olaka E.W & Omoruyi S.A

University of Port Harcourt Teaching Hospital

ABSTRACT

Introduction: Bicornuate Uterus is a Mullerian duct anomaly which results from failure of fusion of the paramesonephric duct. The prevalence of uterine malformations like bicornuate, septate or arcuate uterus in the general population is about 6.7%, but in patients with recurrent miscarriage it is about 16.7%. Bicornuate uterine malformations are of clinical significance due to their adverse reproductive outcomes. Metroplasty has been shown to improve reproductive outcomes of bicornuate uterine malformation.

We document a case of bicornuate uterus with co-existing fibroids that was managed with conventional abdominal myomectomy and Strassman metroplasty.

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Bicornuate Uterus with Multiple Uterine Fibroids, Metroplasty and Myomectomy; Case Profile and Literature Review

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ABSTRACT

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We document a case of bicornuate uterus with co-existing fibroids that was managed with conventional abdominal myomectomy and Strassman metroplasty.

Case: A 35 year old nulliparous woman presented to the gynaecological clinic with complaints of recurrent lower abdominal pains, dysmenorrhea and abdominal mass of 3 years duration.

She was evaluated for uterine fibroids and an incidental diagnosis of Bicornuate uterus was made during this evaluation. She had an abdominal myomectomy and metroplasty.

Conclusion: Strassman metroplasty is an uncommon procedure amongst gynaecologists in West Africa. This case seeks to increase awareness and add to the body of knowledge on surgical management of mullerian duct anomalies specifically bicornuate uterus in this region.

Author: Department of Obstetrics and Gynaecology, University of Port Harcourt Teaching Hospital.

I. INTRODUCTION

The prevalence of uterine malformations like bicornuate, septate or arcuate uterus in the general population is about 6.7%, but in patients with recurrent miscarriage it is about 16.7%.1 Bicornuate uterus is one of the most commonly diagnosed mullerian duct anomaly, constituting about 25% of all uterine anomalies and it is a type IV mullerian duct anomaly according to the classification of the American Society of Reproductive Medicine. 2,.3 Other classes include I-Hypoplasia/Agenesis, II-Unicornuate, III-Didelphus, V-septate, VI-arcuate and VII-Di-ethylsibestterol drug related.2,3.

The class IV malformation (Bicornuate uterus) is caused by partial non-fusion of the upper part of the mullerian ducts. This results in a central myometrium that may extend to the level of the internal cervical os (bicornuate unicollis) or external os (bicornuat bicollis), with a fundal cleft.1cm deep. 3–6 The horns of the bicornuate uteri are not as fully developed and are smaller than those in the didelphys uteri.

Patients with bicornuate uterus are usually asymptomatic but can present with symptoms like menorrhagia and dysmenorrhea which are non-specific symptoms and also a history of recurrent miscarriage, preterm deliveries and persistent abnormal lies and presentation in pregnancy. 2–4 The diagnosis is usually made as an incidental finding during evaluation for infertility and patients with recurrent miscarriage. 2–4, 7

It is important to differentiate a bicornuate from a septate uterus. Hysterosalpingogram (HSG) alone cannot differentiate these entities, because this imaging approach cannot evaluate the external contour of the uterus.8 While laparoscopy was used primarily for this purpose in the past, modern imaging techniques including 3D ultrasonography and MRI can adequately differentiate these two entities. Imaging criteria to differentiate septate and bicornuate uteri have been developed. A septate uterus has a flat or convex fundus or a fundal indentation 60°. 3,8 On MRI, a septate uterus will fail to show an intervening myometrium between the T2-hypointense septum that separates the endometrial cavities. 3 In contrast, a bicornuate uterus will show two T2-hyperintense endometrial cavities, each with a junctional zone, myometrial band of intermediate signal intensity and a uterine fundal cleft of about 1cm or more. 3, 7.

Endoscopic procedures like laparoscopy and hysteroscopy are diagnostic and therapeutic. 3, 8.

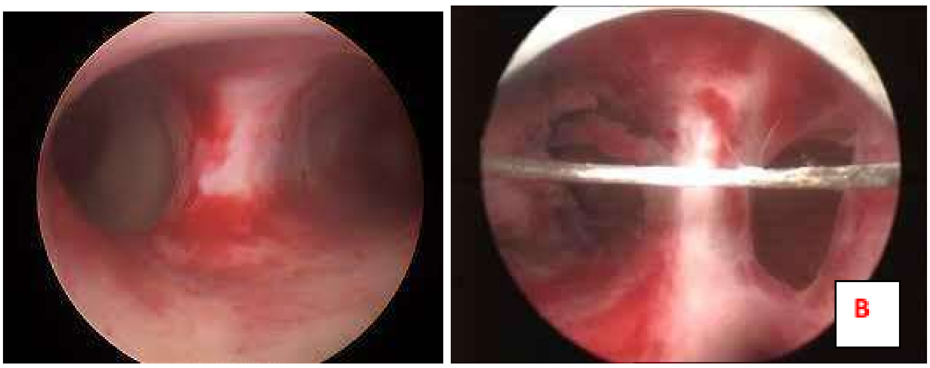
Most cases of Bicornuate uterus may not need any treatment unless they are associated with infertility, recurrent pregnancy loss or Uterine pathologies like fibroids.6, 8.

Conventional transabdominal metroplasty has been shown to significantly improve the pregnancy outcome in patients with bicornuate uterus. 2, 8 Laparoscopic approach is also technically challenging but offers the general positive benefits of endoscopic surgeries. 2, 4, 5, 8–11 Thus, the most common surgical treatment options for bicornuate uterus may include the Strassman metroplasty. The surgery entails removing the abnormal tissue that separates the cornua of the uterus, then using several layers of stitches to create a normal shape and single uterine cavity. 2, 4, 5, 8–11 The pregnancy rate following metroplasty has been seen in up to 90% of cases. 4

II. CASE REPORT

A 35 year old nulliparous woman who presented to the gynaecological clinic with complaints of recurrent lower abdominal pains, dysmenorrhea and abdominal mass of 3 years duration. There was no menorrhagia, urinary or pressure symptoms from the mass.

Abdominal examination revealed a 22 week sized abdomeninopelvic mass. She was evaluated for symptomatic uterine fibroids. Incidentally the hysterosalpingography revealed a congenitally malformed uterus, suggested to be bicornuate uterus. She was further assessed using a diagnostic hysteroscopy which showed the obvious septation with the two cavities. An intravenous urography ruled out a pathology of the urinary system. These are shown in figure 2.



A-HSG showing bicornuate uterus B findings of septal protrusion on hysteroscopy

A diagnosis of symptomatic uterine fibroids co-existing with a bicornuate uterus was made. She was counseled and taken up for Abdominal Myomectomy and Metroplasty for uterine fibroids in a Bicornuate uterus.

Intra-operatively, the abdomen was opened by a midline incision. The uterus was exteriorized and inspected to confirm the two horns with obvious big fibroid nodules. The tubes and ovaries were normal. A conventional myomectomy was done using only anterior uterine wall incision. An

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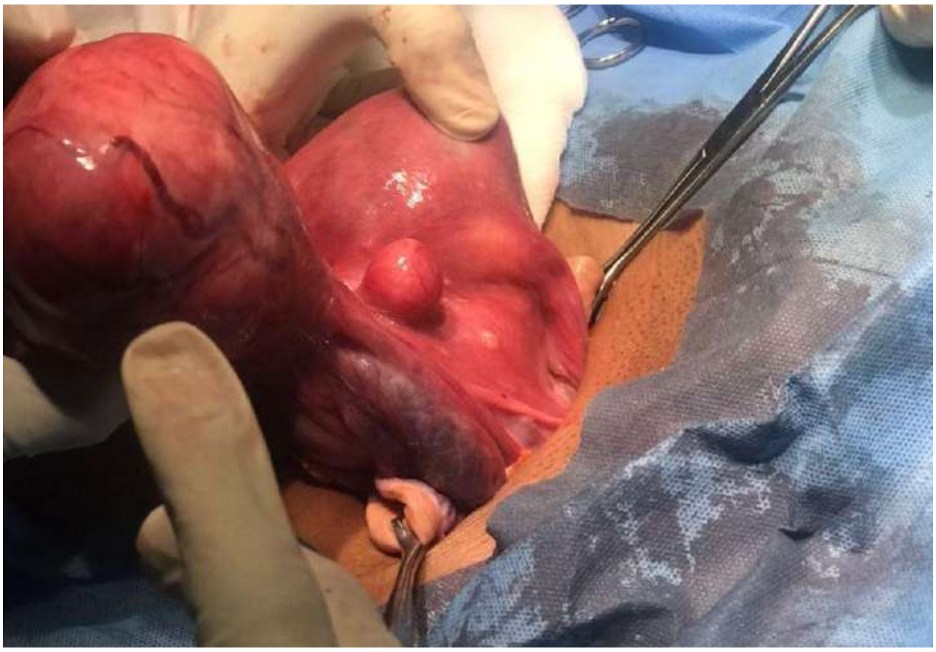
incision extended from the superior aspect of each horn near the interstitial region of the fallopian tubes to the inferior aspect of the uterus was made to access the two cavities. The endometrium of both cavities were exposed, septum was identified and excised. Apposition of the myometrium excluding endometrium was done using interrupted sutures with 2-0 PDS to form a single uterine cavity. The rest of the uterus was reconstituted using conventional surgical techniques. The uterus was reperitonized and the abdomen was closed. Figure 3 shows intra-operative steps.

A - Uterus with fibroids on the two horns



B - The uterine horns and appendages shown (grasped with the two babcock forceps)

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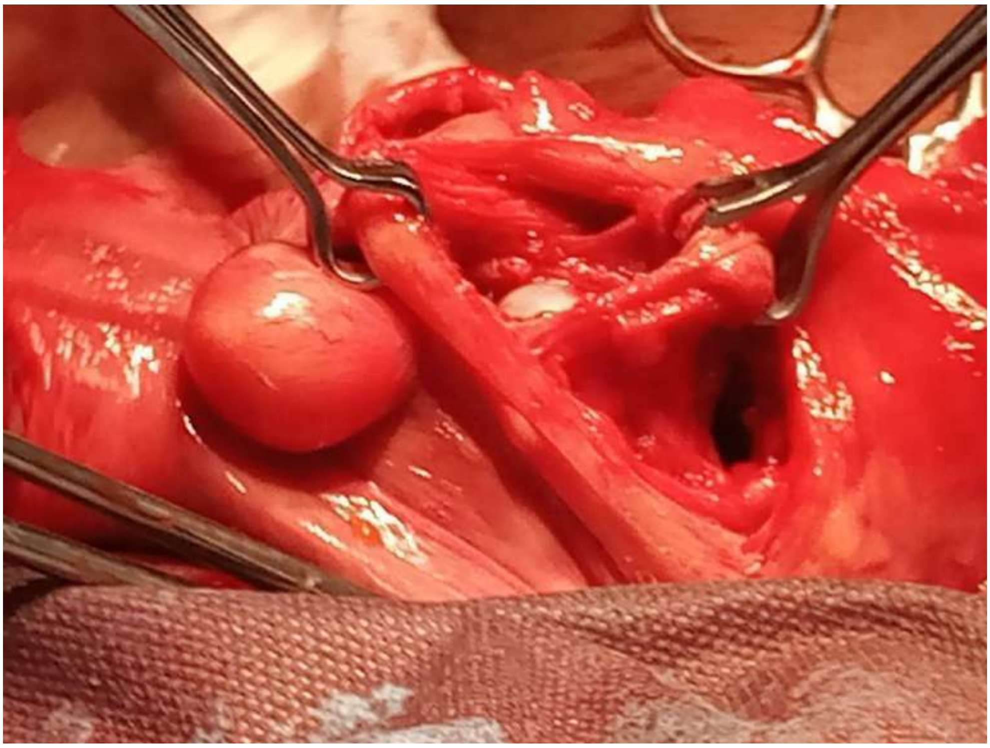
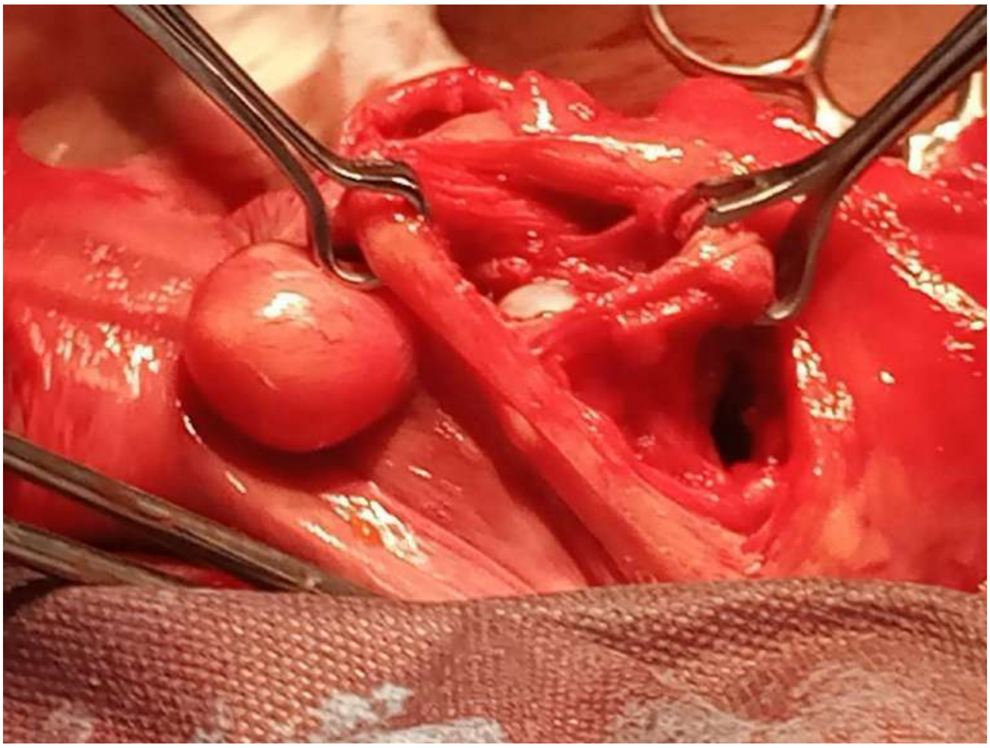


C - Yellow and Green tags showing the two different cavities, blue line showing the septum



Uterine septum coloured yellow above

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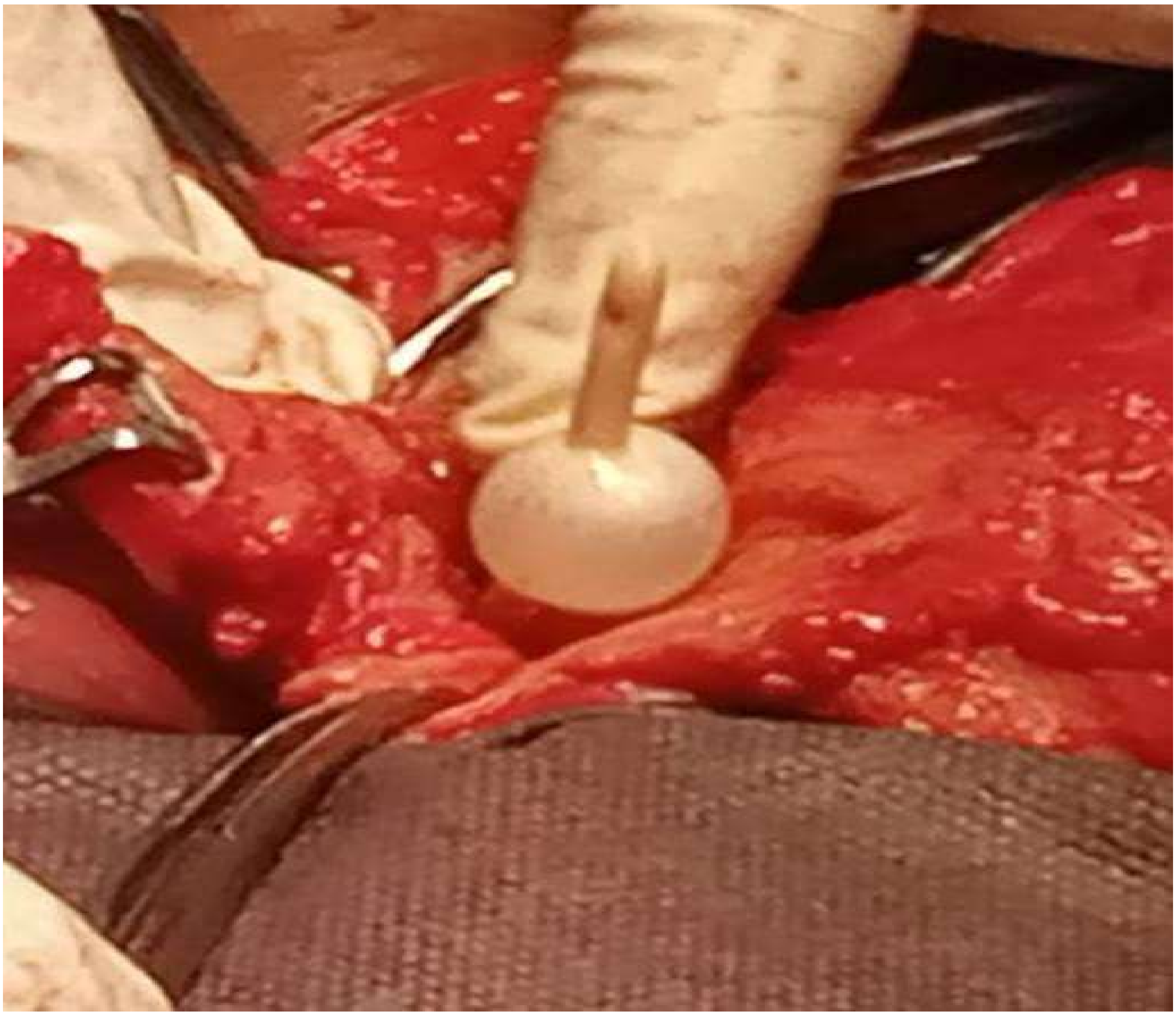
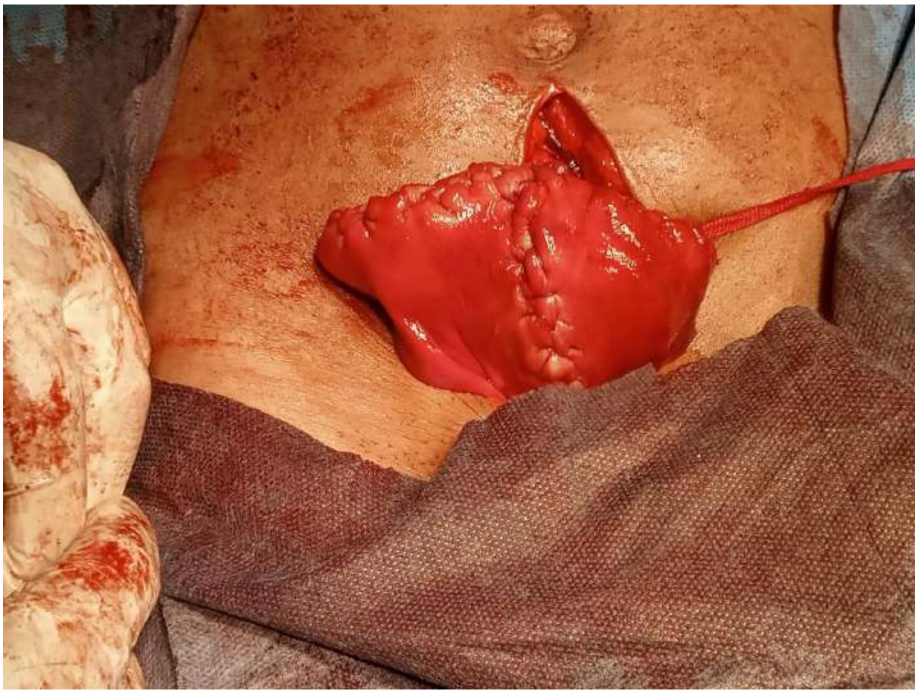


D- Septum excised and a single cavity with catheter bulb in situ



E- Reconstructed uterus

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The post-operative period was uneventful and an intra-uterine foleys catheter was inserted to keep the cavity patent. It was removed after 10 days. The patient was given conjugated estrogen for 21 days and medroxyprogesterone for last 10 days for 3 months.

III. DISCUSSION

Uterine bicornis was an asymptomatic incidental finding in the course of radiographic studies of the uterus of this patient. Complimentary hystero-scopy review confirmed the earlier noted findings. There was also no tubal patency on HSG, which maybe as a result of the huge fibroids on the horns of the uterus. This is the usual pattern of arriving at a diagnosis for most cases of Bicornaute uterus and other congenital anomalies of the uterus. 12–15

There are very few cases of fibroids co-existing with Mullerian anomalies reported in literature and thus the diagnosis is not often made because of the low incidence. 16

Metroplastic surgery was described by Strassman in 1952 for class III, IV and V anomalies, and it was subsequently modified and simplified by Jones in 1953 (wedge excision of the septum) and Tompkins in 1962 (incision of the septum). 4,10

Open conventional metroplasty and laparoscopy for the treatment of Bicornuate uterus are both safe and viable options. 8 The patient had an abdominal modified strassman's metroplasty that involved excision of the septum. This procedure has been widely practiced in the few symptomatic cases of Bicornuate ueterus.4,8 Intra-operatively, adequate care was taken to ensure that the myometrial edges are not sutured under tension, as it is prone to hematoma formation.

In this patient laparoscopy was indicated as an option, but considering the multiple uterine fibroids, its size and unavailability of the facilities and experience, an open abdominal procedure was considered.

Post-operative hysterosalpingography studies confirmed a single cavity and patent tubes. Pregnancy has been widely reported following metroplasty, although there is increased risk of placenta previa, morbidly adherent placenta and uterine rupture. 9,17–19.

Considering the age of the patient, even though nulliparous, pregnancy outcome as recorded in literature holds a good prognosis for the patient. 20

IV. CONCLUSION

The correction of uterine anomalies is recommended in patients who show symptoms. Surgical metroplasy has been shown to be an effective method of treatment of the symptomatic patients and also offers improvement in fertility and pregnancy outcome.

The use of laparoscopic approach to myomectomy and metroplasty is gaining grounds worldwide and Africa need to rise up to the occasion in order to offer patients the benefits of these advancements in clinical practice.

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Availability and Allocation of Rresources for Epidemiological Surveillance in the Edea Health District

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University of Doualal

ABSTRACT

Background Epidemiological surveillance is a key intervention to break the epidemiological silence of a disease. The complexity and workload of maintaining surveillance systems on an ongoing basis, as well as the ability to mobilize human resources in an alert situation, requires specialized professionals, material resources and financial resources. In many developing countries, particularly francophone ones, the development of surveillance systems is hampered by a number of difficulties, including the lack of financial means and specialized human resources. This study therefore assesses the availability and allocation of resources for epidemiological surveillance in the health facilities of the Edea health district.

Keywords: availability, resource allocation, epidemiological surveillance.

Classification: DDC Code: 289.5 LCC Code: BX6941

Language: English

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Availability and Allocation of Rresources for Epidemiological Surveillance in the Edea Health District

Alex S. Ndjip Ndjock[α], Steve R. Souga[σ], Electha E. Asagandou[ρ], Ingrid C. Djuikoue[Ѡ] Rodrigue Yemene[¥], Carlos Tiemeni[§], Frank W. Nounkeu[χ], Leila P. Mfongouot[ν], Marie Tekou[ϴ] & Ernest Tambo[ζ]

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Background Epidemiological surveillance is a key intervention to break the epidemiological silence of a disease. The complexity and workload of maintaining surveillance systems on an ongoing basis, as well as the ability to mobilize human resources in an alert situation, requires specialized professionals, material resources and financial resources. In many developing countries, particularly francophone ones, the development of surveillance systems is hampered by a number of difficulties, including the lack of financial means and specialized human resources. This study therefore assesses the availability and allocation of resources for epidemiological surveillance in the health facilities of the Edea health district.

Methodology This was a descriptive cross-sectional study conducted from 15 January to 30 March 2021 among 17 surveillance focal points in 17 health facilities in the Edea health district. Our sampling was a non-probability sampling by convenience. Data were obtained using several tools, namely: The questionnaire entitled "Cameroon Integrated Supportive Supervisory Checklist" with Open Data Kit (ODK) and the binder "Edea Monitoring Surveillance 2021".

Results The coverage of health facilities was 100%, i.e. 17 health facilities surveyed and 17 surveillance focal points. Concerning material resources, 59% (10/17) of health facilities had computer equipment, although this equipment was not always entirely dedicated to epidemiological surveillance. In 47% (8/17) of health facilities, data entry was done on personal tablets and/or smartphones. Concerning human resources, 6% (1/17) of the focal points were trained in epidemiological surveillance. Also, 24% (4/17) surveillance focal points were briefed at the Edea district health service on the use of the DHIS 2 (District Health Information System 2). None of the health facilities, or 0%, had operating funds for monitoring surveillance activities.

Conclusion Surveillance and monitoring programs must be able to adapt to new epidemiological scenarios. The lack of material resources, the lack of training of focal points on epidemiological surveillance and the DHIS 2 as well as the lack of financial resources dedicated to epidemiological surveillance contribute to the inefficiency of this surveillance in the Edea health district and the lack of anticipation of potential public health emergencies.

Keywords: availability, resource allocation, epidemiological surveillance.

α σ ρ ¥ § χ ν ϴ: Edea District Health, Cameroon; Department of Public Health, University of Douala, Douala, Cameroon.
Ѡ ζ: Faculty of Health Sciences, University des Montagnes, Bangangte, Cameroon; Prevention and Control Foundation, Yaounde, Cameroon.

I. INTRODUCTION

Availability and allocation of resources for epidemiological surveillance needs arise from the state's interference with the allocation function, which seeks to promote the adjustment of resources with the provision of certain public goods and services [1]. Surveillance is the

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continuous, systematic collection, analysis and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice [2]. Event-based and community-based surveillance are being implemented for priorities zoonotic diseases and illnesses of public health importance in Cameroon [3].

The surveillance strategy depends on the diseases under surveillance, the objectives of the surveillance system, the methods for conducting surveillance and how the surveillance data are used to inform public health policy and practice.

For example, an early warning surveillance system needs to be more comprehensive while a system that serves a program monitoring function could be conducted through sentinel sites [3]. The important surveillance levels are central, intermediate (province/region, district) peripheral (sub-district, health facility) and community level. Each of these levels may comprise formal and private health-care providers that may or may not be included in the surveillance system. Other stakeholders and implementers include the disease-specific programs, public health laboratories, and public health training institutions [3]. Thus, the establishment of an effective and integrated epidemiological surveillance system requires the existence of an efficient health information system and governance, which in turn requires a number of materials, human and financial resources and mechanisms [4].

However, enhanced surveillance and response activities can only be performed if the required and appropriate financial, human and logistic resources are in place. This means identification of the resources needed to implement the various surveillance activities at each level of surveillance during planning stage. These resources should be mobilized from potential sources, managed and used efficiently [3]. In many developing countries, particularly francophone countries, the development of surveillance systems is faced with multiple difficulties, including the lack of financial means and specialized human resources [4]. Very few studies have examined the availability and allocation of resources for zoonotic disease of public health interest surveillance and response activities in Cameroon. This study assesses the availability and allocation of resources for integrated epidemiological surveillance in the health facilities of the Edea health district, in Cameroon.

II. METHODS

2.1 Study Design and Study Duration

This was a descriptive cross-sectional study conducted from 15 January to 30 March 2021

2.2 Study Sites Selection

A total of 17 surveillance focal points in 17 health facilities in the Edea health district, namely: Plateau Integrated Health Centre, Mount Charity Health Centre, Domus Mariae Health Centre, Manna Health Centre, the military garrison Health Centre, Trinity Health Centre, Santa Maria Health Centre, Malimba park Integrated Health Centre, Balm in Gilead Health Centre, Esperance Health Centre, Ekite Integrated Health Centre, Malimba urban Integrated Health Centre, Ad lucem Hospital, Regional hospital annex Edea, Delangue Medical District Centre, Sainte Odile Catholic Hospital, Beon Integrated Health Centre.

2.3 Sample Size

Our sampling was a non-probability sampling by convenience and a total of 17 surveillance focal points in 17 health facilities.

2.4 Inclusion Criteria

- Health facility present in the Edea health district
- Health facility present in the planning of epidemiological surveillance site visits.

2.5 Exclusion criteria

- Health facility outside the Edea district
- Health facility present but not planned in the epidemiological surveillance site visits.

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2.6 Data collection tools and data processing

Data were obtained using several tools, namely: The questionnaire entitled "Cameroon Integrated Supportive Supervisory Checklist" and the binder "Edea Monitoring Surveillance 2021".

2.7 Quality assurance of data and information

520\ata collected was protected and stored at the Edea health district and in password protected software (ODK, DHIS 2).

2.8 Data analysis

We used MS Excel to calculate the proportion of staff trained on epidemiological surveillance; the proportion of staff trained/briefed on DHIS 2; the proportion of health facilities with computers and the proportion of health facilities with funds for epidemiological surveillance.

Ethical considerations

We proceeded through a series of steps to obtain the various authorizations necessary for data collection. In addition, all health personnel in the health facilities concerned were informed of the purpose of the study and had voluntarily agreed to participate.

III. RESULTS

In the Edea health district, there are 23% (4/17) high priority sites, 18% (3/17) medium priority sites and 59% (10/17) low priority sites.

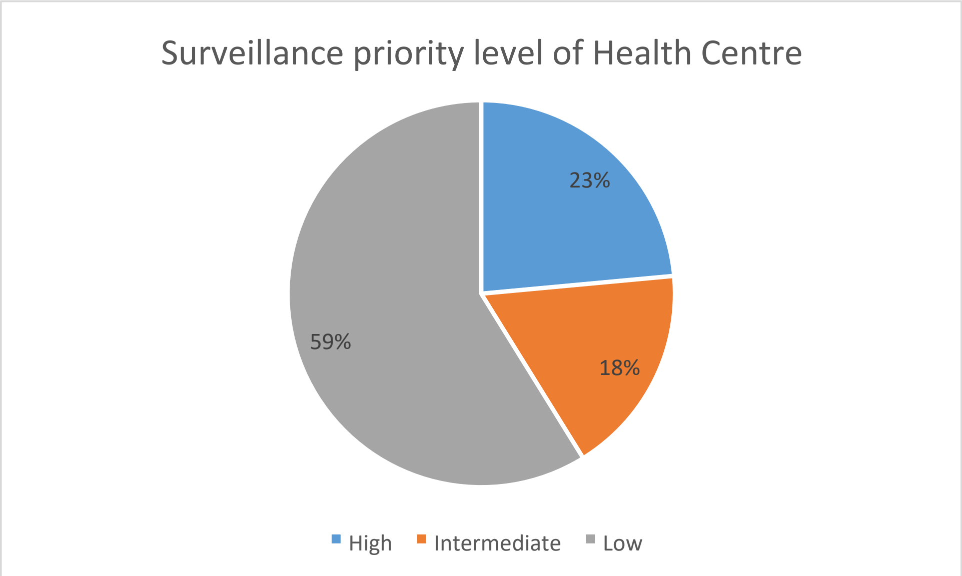

Figure 1: Surveillance priority level of Health Centre

3.1 Material resources

Fifty nine per cent (10/17) of health facilities had computer equipment, although this equipment was not always entirely dedicated to epidemiological surveillance.

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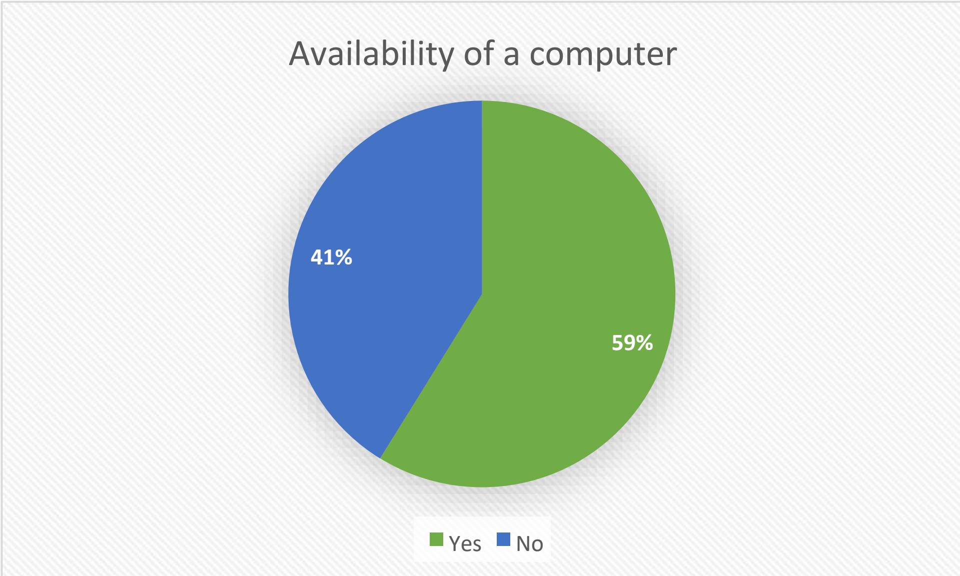

Figure 2: Availability of computers

Human resources

Six per cent (1/17) of the focal points were trained in epidemiological surveillance.

Figure 3: Training of surveillance focal points on epidemiological surveillance

Twenty four per cent (4/17) of the surveillance focal points were briefed at the Edea district health service on the use of the DHIS 2. However, at least one of the health personnel in these facilities had been trained/briefed on the use of the DHIS 2.

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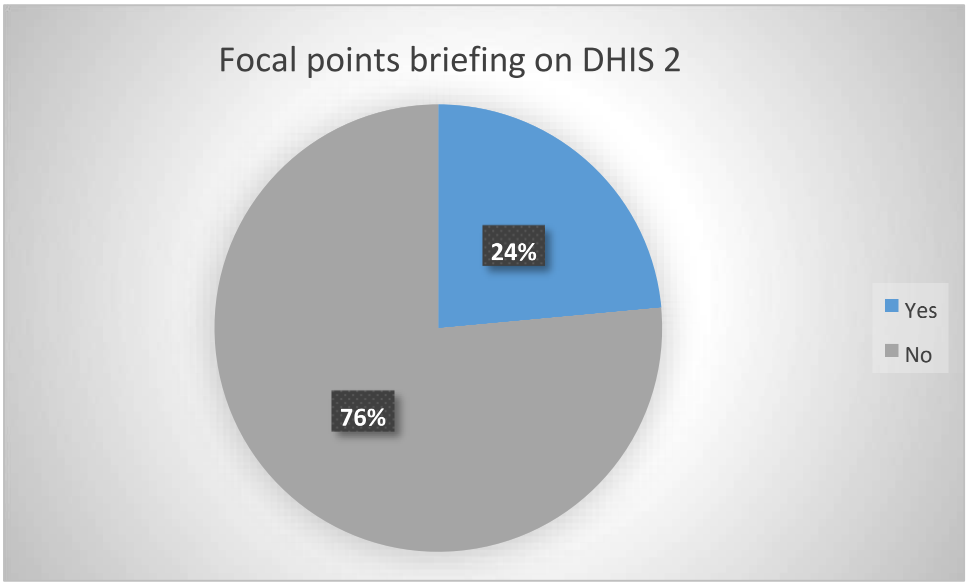

Figure 4: Focal points briefing on DHIS 2

Financial resources

None of the health facilities, or 0%, had operating funds for monitoring surveillance activities.

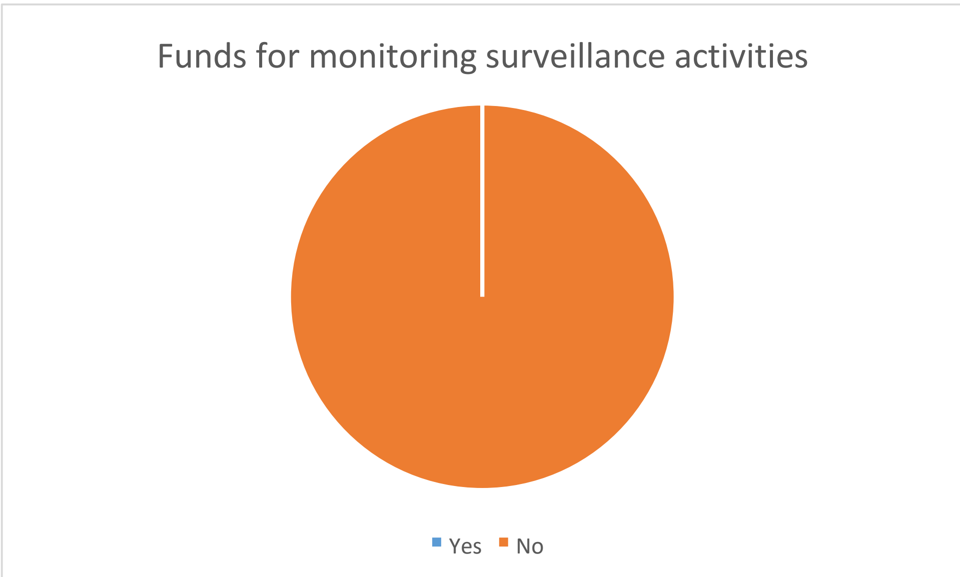

Figure 5: Funds for monitoring surveillance activities

IV. DISCUSSION

Our study focused on the availability and allocation of resources for epidemiological surveillance in the Edea health district. Our objective was to assess the availability and allocation of resources for epidemiological surveillance in the health facilities of the Edea health district; this is in line with a study in Cameroon in 2019 [4] which aimed to assess the availability and allocation of resources for epidemiological surveillance in Cameroon as well as a study carried out in Brazil in 2020 [1] which focused on the systematic review of resource allocation in public health. This shows the need expressed in terms of resources allocated to epidemiological surveillance although international literature indicates that the topic is

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still unexplored with a current lack of theoretical basis that needs to be highlighted [1].

The coverage of health facilities was 100%, that is 17 health facilities surveyed, which is contrary to the study by Ngo Mouaha et al. which was 68.4%. This is certainly due to the difference in sample size which was quite large (118/17) [4].

Fifty-nine percent (10/17) of the health facilities had computer equipment although this equipment was not always entirely dedicated to epidemiological surveillance. This result corroborates that of a study conducted in Cameroon in 2019 in which none of the public health facilities had computer equipment entirely dedicated to event and community-based epidemiological surveillance [4].

In 47% (8/17) of the health facilities, data entry was done on personal tablets and/or smart phones. However, on 3 December 2013, WHO handed over 1,200 telephones to the Ministry of Public Health for the extension of the telephone surveillance fleet to the health areas, that is, equipment to strengthen epidemiological surveillance worth 67,000,000 CFA francs, and the 2013 e-Health Award for the "Telephone Fleet" initiative was presented to the Minister of Health. These telephones were supposed to enable the finalization of telephone coverage in the health areas of the regions, with a view to increasing the telephone fleet to a national scale, with the hope of further improving the circulation of health data and information between the different levels of the health pyramid "at zero cost" [5].

There is no doubt that hardware resources such as computers, smartphones, and tablets will allow health workers to have access to all information in real time, to consult data via the internet and thus check consistency and quality, to analyze data and to ensure interoperability between different databases [6].

Regarding human resources, 6% (1/17) of the focal points had been trained in epidemiological surveillance. This is a major problem as untrained staff could miss cases of diseases under epidemiological surveillance. The Minister of Public Health, Manaouda Malachie, prescribed the reinforcement of epidemiological surveillance during his visit to the district medical centres of Ambam and Kye-Ossi in the South region of Cameroon, drawing the attention of staff to the recognition of cases of diseases of epidemiologic potential [7].

Training for epidemiology and laboratory personnel and/or community health agents is a support function of integrated surveillance systems. Capacity building and training refers to the needs for engagement and empowerment of staff involved with integrated surveillance and response systems through workshop training and knowledge transfer. Surveillance staff at different levels have varying training needs. An assessment can help to identify the training needs for different categories of staff, which in turn can be used to draw up a training plan. The implementation of the training plan and the proportion of surveillance staff (epidemiology, laboratory and community resource persons) trained on the different aspects of surveillance and response can then be improved and monitored. Evaluation could examine the quality, relevance, impact and cost-effectiveness of the training as these resources should be mobilized from potential sources, managed and used efficiently [3]. It was in this context that, following the establishment of 47 Epidemiological Surveillance Centres, the Mérieux Foundation and the Centre for International Cooperation in Health and Development (CICIHD) organized several training workshops in West Africa; at the end of this training, one staff member declared: "The 14 days of training had a real impact on my life and my career. During the training, I learned the importance of my role in the laboratory. I was trained on the main diseases with epidemic potential such as measles, cholera, shigellosis, meningitis, E. coli, etc. I learned the importance of biosafety and biosecurity in the lab and at home] We also covered equipment maintenance and data management. Before the training, I was only dealing with one of the diseases with epidemic potential: Ebola virus disease. " [8]. This statement highlights the impact of the epidemiological surveillance training for health

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staff in general and for the epidemiological surveillance focal points of the health facilities in the Edea health district.

Also, 24% (4/17) surveillance focal points were briefed at the Edea district health service level on the use of DHIS 2 which is a software tool to facilitate the collection of individual or primary data; the aggregation, storage, sharing and analysis of data [9]. It is also a database that can be consulted by all health workers to facilitate decision-making in the event of epidemics. Its use is important because it allows the collection of all the data needed to improve epidemiological surveillance [6]. However, at least one of the health personnel other than the focal points of these health facilities had been trained/briefed on the use of the DHIS 2. This result is in line with the previous study which found that at least one staff in the visited sites had been trained in the use of the DHIS 2, but was not systematically in charge of the data [4]. This can be explained by the fact that the National Health Information System in Cameroon (NHIS) is fragmented and not very efficient due to the absence of an organic framework for coordination and management of health information, the absence of mechanisms that promote the use of health information in decision making, the archaic nature of the data collection and processing infrastructure, and the absence of norms and standards for the use of health information [10].

Thus, this deficit influences the efficiency of the system, the quality of the data collected, and their use. The surveillance of a disease or health-related event requires careful monitoring, based on a network of actors and well-coordinated sources of information. It involves observing the emergence of pathologies, depending on people, time and place; alerting on acute problems requiring rapid action; evaluating epidemiological trends over time; and measuring the impact of health policies. Collect, analyze, interpret, disseminate to those who need this knowledge for public health decision-making. Basically, data are generated by health care providers who continuously record procedures, diagnoses and treatments. Depending on the information and the time needed for decision-making, the organizations that centralize the collection and analysis of data set up various collection and analysis systems; these concern the choice of actors, the data to be collected, the collection tools, the data transmission circuit and the periodicity of collection and transmission operations [11].

None of the health facilities had operating funds for monitoring surveillance activities, which is in line with the study by Ngo Mouaha et al. which showed that no operating funds were available for monitoring surveillance activities in the sites visited [4]. This lack of funds allocated to epidemiological surveillance leads to negligence and non-involvement in the monitoring of related activities by health personnel, yet epidemiological surveillance must be an integral part of the activities of professionals, especially on the front line. Data collection should not overburden them, because it is an essential duty to learn through data about the population we are caring for, its state of health and the factors that influence it in order to take measures to improve it [12].

According to Tonia Marek, health outcomes in Africa are often disappointing, as are most government-funded projects, and some health indicators are struggling and others are stagnating because only half the picture in terms of resource allocation for health has been considered. This would be due to the concentration of interventions on the public sector, without taking into account that half of health spending in Africa goes to the private sector. It is time to look at the health system as a whole, not just the public sector [13]. This idea is not consistent with the results of our study because no funds were allocated to either public or private hospitals.

Surveillance and response activities can only be performed if the required and appropriate financial, human and logistic resources are in place. This means identification of the resource needs to implement the various surveillance activities at each level of surveillance during planning stage. These resources should be mobilized from potential sources, managed and used efficiently [3].

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Enhanced and integrated epidemiological and laboratory surveillance and response activities can only be performed if the required and appropriate financial, human and logistic resources are in place. This means identification of the resource needs to implement the various surveillance activities at each level of surveillance during programming and implementation stage.

V. CONCLUSION

The event- and community-based surveillance and response system is an important component of programs for the prevention and control of persistent zoonotic diseases and emerging epidemics. Our study therefore assessed the availability and allocation of resources for epidemiological surveillance in the health facilities of the Edea health district. It was found that the availability and allocation of material, human and financial resources are very inadequate in the health facilities of the Edea health district. It is with this in mind that it is urgent to remedy the lack or limitation of material resources and the lack of financial resources, coupled with the lack of training of focal points on epidemiological surveillance and the DHIS 2 dedicated to epidemiological surveillance which contribute to the inefficiency of epidemiological surveillance in the Edea health district and the lack of anticipation of potential public health emergencies. This remediation will facilitate the identification of suspected cases of diseases under epidemiological surveillance and subsequently the notification and investigation of suspected cases, followed by the prompt transmission of data to the health district. Future research should therefore focus on the factors associated with the lack of availability and poor allocation of resources in the health facilities of the Edea Health District.

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Abbreviations

DHIS 2 District Health Information Software 2, ODK Open Data Kit, NHIS National Health Information System, CICIHD Centre for International Cooperation in Health and Development.

Availability of data and material

All data are available on request.

Ethics approval and consent to participate

This study was approved by the institutional ethics committee of the University of Douala. Also, research authorizations were obtained from the Regional Tuberculosis Technical Group of the Littoral and from the various officials of the Douala Tuberculosis Diagnostic and Treatment Centres. Informed consent was obtained from the participants.

Competing interest

The authors declare no conflict of interest.

Consent for publication

All authors have read and approved the final version of the manuscript.

Authors' contributions

ANN gathered the literature, drafted the manuscript and was responsible for the data collection, EEA and SS were responsible for the follow-up of this research. RY, CT, LPM, MT and FWK supervised this research. ICD and ET supervised and substantially revised the manuscript.

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