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Teleconsultation Services to Support the Management of Non-Communicable Diseases in Paediatric Populations in Niger, Africa

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Abstract

Introduction: While communicable diseases are more prevalent in Low-Resource Settings (LRSs), the increasing prevalence of Non-Communicable Diseases (NCDs) requires physicians to be skilled in diagnosing these diseases. Despite the benefits of using teleconsultation to support physician mentorship, a lack of evidence exists as to whether this is helpful to support the management of NCDs. This study aimed to describe the extent to which teleconsultations proved beneficial in the establishment of diagnoses and treatment plans of NCDs in the Madaoua hospital, Niger.

Methods: The Médecins Sans Frontières database, consisting of 206 teleconsultations, was analyzed using descriptive and inferential statistics.

Results: Results indicated a nearly statistically significant difference between the initial and final diagnosis when comparing the frequency of communicable and NCDs, indicating that there was more diagnostic elaboration for NCDs in the final diagnosis. Moreover, the overall diagnostic precision between one's initial and final diagnosis increased; yet, there was more diagnostic discrepancy in NCDs when compared to communicable diseases, indicating that clinicians were more effective in establishing a diagnosis for communicable diseases, likely because they had more professional exposure to communicable diseases than NCDs.

Discussion: Research is needed to explore the added value of telemedicine in LRSs for management of NCDs.

Keywords: Diagnostic discrepancy; Low-resource settings; Médecins Sans Frontières; Non-communicable diseases; Teleconsultation; Videoconferencing

Introduction

In recent decades, Low Resource Settings (LRSs) have been facing a double burden of disease [1]. Communicable diseases continue to be the leading causes of death or potential years of life lost, yet the prevalence of Non-Communicable Diseases (NCDs), also known as chronic diseases, is steadily increasing in Sub-Saharan Africa (SSA) [2,3]; causing a growing burden of death and disability [4]. Furthermore, if current trends are maintained in Africa, it is projected that NCDs will exceed the death rates from communicable, nutritional, maternal, and perinatal deaths combined [5,6,7]. Although all population groups are at risk of developing NCDs, SSA children under the age of five who are living in urban areas are particularly vulnerable given their increased exposure to NCDs induced environmental factors, such as air pollution, chemicals and nutrient poor food [8]. To improve access to quality healthcare services, the widespread implementation of technology-enabled interventions using information and communication technologies will be needed to strengthen the already resource-strapped health systems, to address the acute shortage of physicians, and to provide specialized professional support and Continuing Medical Education (CME) to local practitioners [9]. Evidence exists on the usefulness of teleconsultation to support local physicians in LRSs across several medical fields [10,11,12]. However, there is scarcity of data available on its use to support the management of paediatric populations, and on the clinical decision-making process during teleconsultations [13]. Hence, this

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hypothesis-generating study, which used an existing *Médecins Sans Frontières* (MSF) dataset, had a dual purpose:

1) to assess the usefulness of real-time teleconsultations for the establishment of diagnoses and treatment plans for clinically complex paediatric cases; and

2) to determine whether the advice given by specialists have changed the NCD diagnosis.

Background

Due to the shortage of physicians in rural regions [14], the new reality of increased NCDs in SSA requires that physicians are knowledgeable in new areas, such as the treatment of cancer, cardiovascular and lung diseases, and diabetes; beyond their typical practice of managing communicable diseases [15]. In the field, clinicians spend a disproportionate time attempting to diagnose, manage or take timely referral decisions for complex cases, such as NCDs, given the limited diagnostic capability and subsequent therapeutic options [16]. In response to this lack of expertise, several on-site training initiatives were established to build capacity, or increase foundational knowledge, in African countries. For example, since 2015 the UK Royal College of Physicians partners with the West African College of Physicians (WACP) to deliver a clinical NCD training program, where local physicians have access to specialists, providing support and mentorship [17]. Along the same lines, the World Health Organization (WHO) [18] provided workshops to rural physicians to improve primary care management of NCDs. Evidence exists that the provision of CME for physicians through in-service training programs enhances their level of confidence in terms of diagnosis, disease management and prescribing [19,20], and increases the retention of physicians locally [21].

In addition to providing NCD in-service training, evidence exists that teleconsultations between two or more physicians have been a promising avenue for decades to alleviate the shortfall in skilled medical specialists in developing countries [22]. A physician-to-physician teleconsultation is defined as the use of synchronous (e.g., live videoconferencing) or asynchronous (e.g., via email or other Internet-based platforms) technologies between two or more geographically separated practitioners for the provision of diagnostic and therapeutic advice and for educational purposes [13]. The latter is also called 'store-and-forward' and it has been the ideal platform for LRSs with limited connectivity. It allows local physicians to initiate and store teleconsultations on their devices without Internet or satellite connectivity [23]. The use of live videoconferencing between a specialist and a physician located in a rural and under-served region offers an opportunity for medical supervision, CME, exposure to medical development, and it facilitates access to expert opinions and discussions about clinical cases [24,25,26,27]. These real-time clinical case discussions are beneficial for establishing a diagnosis, for reinforcing the referring clinician's knowledge base, for providing reassurance, and for supporting patient management [28,29]. According to Deldar et al. [13] teleconsultations often result in change in treatment plan, referral or evacuation rate, change in diagnosis and rapid decision making. Overall, better patient outcomes and improved quality of patient care are obtained for discussed cases through teleconsultations [30,31,32].

Study Setting

The international medical humanitarian organization MSF began working in Niger in 1985 and is involved in responding to malnutrition and outbreaks of epidemic diseases. MSF is also providing humanitarian assistance to refugees and displaced populations, particularly in the Diffa region. At the Madaoua district hospital in the Tahoua region of Niger, MSF is supporting the inpatient therapeutic feeding centre for malnourished children and the maternity, paediatric and neonatal wards [33]. Since 2016, MSF's telemedicine pilot project has been used by local physicians to connect with specialists abroad. The hybrid model of telemedicine as piloted in Madaoua allows two types of telemedicine services utilization: clinical case discussions using real-time videoconferencing with experienced paediatricians abroad for certain 'complicated' cases and using store-and-forward to obtain second clinical opinions for cases that were deemed necessary. The weekly, one-hour clinical case discussions that take place via videoconferencing with the specialist abroad do not involve patients or offer immediate, emergency intervention, as treatment cannot be delayed while awaiting expert consultation. Rather, cases that are of sufficient complexity and pertinent from an educational or patient management standpoint are discussed in a group setting, like grand rounds in hospital departments. Local physicians and nurses are physically present during the case discussion and the paediatric specialist is attending via videoconferencing. Before the consultation, the patient's clinical data is uploaded to the secure MSF interactive platform and consent for these case discussions is obtained from the child or the legal guardian. Details of each type of telemedicine service use, whether clinical case discussion or store-and-forward case, are documented by local physicians in an excel spreadsheet, which has been used for this study.

Materials and Methods

The excel dataset contained all details of the telemedicine consultations conducted between November 2016, or the start of the MSF telemedicine pilot project, until January 8th, 2018. Patient-related information was de-identified and available in French. The dataset consisted of the following variables: 1) Telemedicine Case Number; 2) Mode of Telemedicine; 3) Department; 4) Temporary Diagnosis; 5) Telemedicine Added Value; 6) Patient Outcome; 7) Final Diagnosis; and 8) Comments. Before commencing data analysis, a data cleaning process was conducted, and the content of the dataset was translated from French to English. The data presentation contained errors such as misspellings and the override of pre-determined drop-down menus for four of the variables (Mode of Telemedicine, Department, Telemedicine Added Value, and Patient Outcome) in the excel dataset, resulting in the creation of a number of new categorical answer categories. For each patient record, the variable columns 'Temporary Diagnoses' and 'Final Diagnosis', contained a list of diagnoses and disease-related symptoms. To analyze these diagnoses, we considered each diagnosis separately and eliminated all disease-related symptoms; in other words, we regrouped the diagnoses into communicable,

NCDs and malnutrition groupings. We determined that the 'Final Diagnosis' was established after the videoconferencing telemedicine intervention with the paediatric specialist.

Descriptive and inferential statistics have been used to analyze all retrospective data, using the SPSS (Statistical Package for the Social Sciences) Statistics software package. To establish a significant difference between groups, chi-squared tests were used to determine relationships between categorical variables, with an established significance level at $p = 0.05$. This research fulfilled the exemption criteria set by MSF Ethics Review Board (ERB) for a posteriori analysis of routinely collected clinical data and thus did not require MSF ERB review. It was conducted with permission from Dr. Jean-Francois Saint-Sauveur, Medical Director, Operational Centre Barcelona Athens (OCBA), MSF.

Results

The database consisted of a description of 206 cases using both forms of telemedicine services, of which 93 (45%) were real-time clinical case discussions and 113 (55%) were store-and-forward cases. Most of the 93 clinical case discussions pertained to paediatrics (n = 48, 51.6%), followed by malnutrition (n = 29, 31.2%) and neonatology (n = 16, 17.2%). In terms of the 113 store-and-forward case consultations, half of the cases pertained to paediatrics (n = 57, 50.4%), followed by malnutrition (n = 32, 28.3%) and neonatology (n = 24, 21.2%). The 'Patient Outcome' variable had 4 answer categories: cured/discharged, death, medical referral, and hospitalization. About this variable, the majority of patients for both types of telemedicine services were cured/discharged (61% of clinical case discussions versus 51% of store-and-forward). The rate of medical referrals and hospitalizations were relatively similar between 'Modes of Telemedicine'; however, the number of deaths was slightly elevated but not significant for the clinical discussion group (n = 28, 30.1%) when compared to the store-and-forward cases (n = 26, 23%).

When considering the reality of multiple diagnoses per patient record over the total patient population, we observed a maximum number of 5 differential diagnoses within the variable 'Temporary Diagnosis', compared to a maximum of 4 within the variable 'Final Diagnosis'. However, of the 160 patient records that document a final diagnosis (46 of the 206 records were missing a final diagnosis), the distribution was right skewed with 111 cases (69%) having only 1 final diagnosis. The potential causes why only for 160 patient records a final diagnosis was recorded, are important: however, unknown in the dataset. In contrast, within the variable 'Temporary Diagnosis' which is established at initial contact, 87 cases (42.2%) had 2 diagnoses and interestingly 66 cases (32%) had 3 or more diagnoses. When grouping the diseases into communicable, NCDs and malnutrition, under the variable 'Temporary Diagnosis', we observed that the leading communicable diseases were pneumonia (40%), malaria (33%) and diarrheal disease (16%), while malnutrition accounted for 22%, and the most prevalent NCD, sickle-cell-disease, accounted for 13%.

When looking at the variable 'Final Diagnosis', the grouping of communicable diseases was led by tuberculosis (17%), followed by pneumonia (9%), malaria (8%), and meningitis (7%), while malnutrition accounted for 8%, and NCDs were led by congenital cardiopathy (5%) and sickle cell disease (3%). It is important to note that communicable disease remains much more prevalent across diagnostic variables, or 85% of 'Temporary Diagnosis' and 87% of 'Final Diagnosis'. Yet, when comparing communicable versus NCDs between the variables 'Temporary Diagnosis' and 'Final Diagnosis', we are close to statistical significance ($p = 0.059$), indicating a higher number and more diversity among NCDs in the final diagnosis. Along the same lines, a nearly statistical significance ($p = 0.095$) was observed when isolating and comparing the NCDs between the 'Temporary Diagnosis' to 'Final Diagnosis'; in contrast, there was no difference ($p = 0.32$) when isolating and comparing the communicable diseases between diagnostic variables.

The variable 'Telemedicine Added Value', which had 3 answer categories: establish diagnosis, facilitate diagnosis, and facilitate diagnosis & patient management plan, was cross-tabulated with the total number of communicable (n = 111) and NCDs (n = 99) under the final diagnosis. The findings indicated that for the total of 160 patient records where a final diagnosis was documented, clinicians recognized that utilizing real-time clinical case discussions supported them in establishing a diagnosis that not would have been possible otherwise in nearly a quarter of cases (n = 34, 21.2%). Moreover, real-time clinical case discussions contributed to establishing a diagnosis that would not have been otherwise possible, more frequently in NCDs (20%) when compared to communicable disease (13%).

For the purpose of this analysis, the third author, a medical graduate from Africa, and the fourth author, a last year medical student in Belgium, both francophones, have independently compared the variables 'Temporary Diagnosis' and 'Final Diagnosis' in their original format for the 160 records that had a documented final diagnosis, scoring each record from 1 to 3 in terms of consistency between the temporary and final diagnoses. The meaning of the scores are as follow: (1) Identical Diagnosis; meaning the 'Temporary Diagnosis' is the same as the 'Final Diagnosis', (2) Positive Refined Diagnosis; meaning the 'Temporary Diagnosis' is correct but the 'Final Diagnosis' was more refined and specific, and (3) Diagnostic Discrepancy; meaning the 'Temporary Diagnosis' is different from the 'Final Diagnosis'. When cross-tabulating the total number of communicable and NCDs against the newly-created variable, 'Comparison', we observed that, for both disease groupings, the total number of cases that were labeled as 'Positive Refined Diagnosis' was high; and slightly higher for the grouping of communicable diseases, possibly highlighting the contribution of expert input on honing one's diagnosis. Interestingly, within the grouping of NCDs, the findings indicated a higher number of 'Diagnostic Discrepancy' (n = 30, 30%) when compared to the communicable diseases (n = 23, 20%), possibly reflecting less familiarity with NCDs on the part of local physicians.

In summary, the main findings indicate that there is a slightly higher mortality rate in cases where real-time clinical case discussions were used and that these cases tended to have a higher number of multiple diagnoses: both of these facts reflecting the complexity of cases as the prime inclusion criteria for this mode of telemedi-

cine service. In addition, there was a nearly statistically significant difference between the temporary and final diagnosis variables when comparing the frequency of communicable and NCDs, indicating that there was more diagnostic elaboration for NCDs in the final diagnosis. Moreover, the diagnostic precision between one's temporary and final diagnosis increased, either due to the passage of time or to the telemedicine intervention (real-time clinical case discussion); yet, there was more diagnostic discrepancy in NCDs when compared to communicable diseases. This indicates that, either due to the passage of time or the real-time clinical case discussion intervention, clinicians were better able to properly diagnose communicable diseases, for which they were more familiar and better able to 'think more broadly', than NCDs, for which they had less professional exposure.

Discussion

Results of this study are consistent with the existing evidence that communicable diseases are still more prevalent in SSA, and that teleconsultations among physicians are effective and play a constructive role in capacity building of local practitioners. To add, this study has shown that the diagnostic discrepancy after a real-time clinical case discussion with a paediatric specialist is slightly higher in NCDs when compared to infectious diseases, which is the focus of the discussion.

The prevalence of some NCDs in SSA is beginning to match those in high-income countries; yet the implementation of the WHO recommendations remains slow [34,35]. One key issue described in the numerous knowledge, policy and implementation gaps is the deficiency in medical training around NCDs [36]. Despite regional differences in terms of NCD capacity development in SSA, evidence exists that besides their inability to provide the necessary patient education and counselling [37,38], physicians may lack the ability to diagnose and treat patients with diabetes, hypertension, asthma, and epilepsy [39]. Shwartz et al. [40] mentioned that healthcare providers are limited in their capacity for NCD surveillance and data collection. Interestingly, little is known about the factors contributing to the deficits in knowledge and confidence of physicians related to NCDs and how they affect the quality of care provision [36].

Overall, limited data is available on the use of physician-to-physician teleconsultations in SSA for NCDs; however, some studies have evaluated the store-and-forward approach using mobile devices to support local healthcare workers diagnosing NCDs. For example, due to the lack of trained dermatologists, Frühauf et al. [41] tested the use of mobile tele dermatology consultations in Uganda. A discordance between the onsite diagnostic decision and the final working diagnosis after the teleconsultation was found in 26% of the cases, mainly for the categories of inflammatory skin diseases. In the fields of tele dermatology, teleradiology and telepathology, Shiferaw et al. [42] reported a change in diagnosis in 50% of the patient cases in Ethiopia after email consultations with experts. Using real-time videoconferencing to support physicians in rural Arkansan (USA), expert consultants stated a change in 28% of the patient's diagnosis [43]. Specifically, for paediatric orthopedic cases in the Republic of Djibouti, Bertani et al. [44] indicated that email teleconsultations with experts resolved 90% of the diagnostic uncertainties, and expert advice modified the management in 77% of cases. While the inferences we can make in this study are limited by the quality of collected data, our findings seem to indicate that teleconsultation services, more specifically, real-time clinical case discussions, are useful to the refinement of diagnosis and the correction of diagnostic discrepancy. Especially in the case of chronic and complicated NCDs, which affect the paediatric populations.

In conclusion, based on our findings and those from the literature, teleconsultation services are beneficial to both patients and local providers as they contribute to providing expert opinions on particular cases and to the professional development of local clinicians, and as such, improve the quality of patient care. Research is required to further explore the added value of hybrid models of teleconsultation services, especially in resource constrained humanitarian landscapes for the management of NCDs.

Study Limitations

Oftentimes, evaluations are rarely included as part of the implementation of telemedicine services, which are usually offered in response to clinical needs. An evaluation is necessary, not only to examine to what extent a service was effective, but also to expose its shortcomings, as the data collected can guide necessary modifications and suggest improvements [45]. Sometimes, even when there is collected data as part of an evaluative mechanism, the quality of data is inadequate. The current MSF dataset, while a step in the right direction, limited our ability to make inferences. For example, there was a lack of clarity of the variables, overlapping answer categories within each variable, incomplete data, and a lack of documentation of contextual factors such as the date of the teleconsultation services.

Declaration of Conflicting Interests:

No conflict of interest.

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