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Evaluation of the Efficiency of Telemedicine in the Management of Cardiovascular Diseases in Primary Healthcare in Sub-Saharan Africa: A Medico-Economic Study in Cameroon

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Abstract. Objective: To assess the efficiency of tele-expertise (tele-ECG) for patients and for health facilities in managing patients with cardiovascular diseases (CVDs) in primary health care in Cameroon. Method: This study was a medico-economic study combining two approaches: cost minimization and cost-effectiveness analysis. It was conducted alongside the previous published controlled multicenter study carried out in Cameroon's two health facilities where tele-ECG has been implemented (intervention centres) and two other where telemedicine has been not implemented (control centres). Results: The average total cost for patients was 9 286 F CFA (US$: 16) in the intervention centres compared to 28 357 F CFA (US$: 49) in the control centres ($p < 0.01$). The calculated ICER favouring tele-ECG was 25 459.6 F CFA (US$: 44). Discussion: Telemedicine is efficient for managing patients with CVDs in primary health care in Cameroon. It enables health facilities in remote areas to offer new healthcare services at a lower cost and improve patients' financial access to healthcare.

Keywords. Telemedicine, Efficiency, Cardiovascular Diseases, Cameroon, Sub-saharan Africa, Developing Countries, Low-middle Income Countries.

1. Introduction

Cardiovascular diseases (CVDs) are one of the major causes of death in the world [1] and represent a significant economic burden on health care systems [2]. In Cameroon, their mortality rate is about 12% [3]. This high mortality rate can be explained by the difficult access (geographical and financial) to care and the lack of healthcare professionals, infrastructures and governance [4]. With the rapid development of digital health, telemedicine can strengthen the health system by offering new possibilities for

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the management of patients with CVDs and the development of equitable access to healthcare, particularly in remote areas of developing countries. In addition, several studies have demonstrated its efficiency (ability to reduce patient care costs, good cost-effectiveness ratio) in other setings [5-8]. Following the first study we carried out and related to the effectiveness of tele-ECG [9], this study aimed to evaluate the efficiency of tele-expertise (tele-ECG) for patients and health facilities in the management of patients with CVDs in primary health care in Cameroon, sub-Saharan Africa.

2. Methodology

2.1. Study design

This is a medico-economic study combining cost minimization analysis (for evaluation of efficiency in patients) and cost-effectiveness analysis (for evaluation of efficiency in health facilities). This study was conducted alongside the previous published controlled multicenter study carried out in 2016 and 2017 in Cameroon's four health facilities: two intervention centres (Mbouda and Akonolinga District Hospitals) where tele-ECG was implemented and two control centres (Foumbot and Sa'a District Hospitals) where it was not implemented. Details of the methodology used in this study can be found in the previous publication [9].

2.2. Intervention and control centres

Intervention centres
Patients enrolled received usual primary healthcare: a conventional clinical exam carried out by a local healthcare provider, requests for diagnostic tests, management plan of healthcare and scheduling of appointments. Additionally, patients proposed to perform a resting ECG on-site with the Universal ECG^{TM} (a portable 12-channel ECG device associated with dedicated software enabling them to perform ECG tests, archive them, and print the report in PDF format). The ECG test was systematically associated with a local healthcare provider's request to a cardiologist (expert) for remote expertise via an internet tele-expertise platform Bogou [10]. The local healthcare provider had to send patients' data (demographic and clinical data, diagnostic hypothesis, ECG tests and current management plan) via this platform. Based on this data analysis, the cardiologist provided adapted expertise to better manage patients within 72 hours maximum.
Control centres
In the control centres, patients received the usual primary care only without tele-ECG. For all patients, we recommended a consultation at a cardiology centre or to meet a cardiologist in the nearest town: Bafoussam for Foumbot and Yaoundé for Sa'a.

2.3.Assessment of the effectiveness

The primary outcome (effectiveness) was to evaluate the rate of patients' access to an ECG test and to a cardiologist' expertise (number of patients who performed an ECG test and received a cardiologist's expertise divided by the number of recruited patients) at three months of follow-up.

2.4.Medico-economic assessment

Cost minimization analysis
Patients from different centres were subjected to spending diaries. They were asked to gradually record their spending and further data during the care process to identify various direct (directly linked to the intervention) and indirect (financial consequences of the intervention) costs. In intervention centres, the direct costs were: costs of the local consultation, ECG test and transport (from home to the local hospital). The indirect costs were: the waiting time in hours (time between arrival at the hospital, consultation and completion of the ECG test; 1h was estimated as equivalent to a loss of 1 000 F CFA - US$: 1.7), the cost of communication credit consumption and other expenses related to incidents. In the control centres, the direct costs were: local consultation, ECG test, specialist's consultation, transport (from home to the local hospital and from home to referral hospital), accommodation and feeding. The indirect costs were: the waiting time (at the local healthcare provider and at the specialist), the cost of communication credit consumption and other expenses related to incidents.

Cost-effectiveness analysis
Each hospital was subjected to an economic questionnaire to assess the expenses related to the tele-ECG intervention. It aimed to identify fixed (which do not vary with volume of activities) and variable (which vary according to the volume of activities) costs. In intervention centres, the fixed costs were related to tele-ECG. They included: fees, accommodation, nutrition and transport of staff trainers on the use of the ECG and the Bogou platform and the cost of material (ECG, computer, printer, internet modem). Variable costs included: the cost of electrical energy consumption (related to the production and sending of the ECG and to the interpretation and printing of the ECG), the cost of consumables (ink, ballpoint pen, paper, gel, toilet paper), the cost of coordination of tele-ECG activities, the cost of equipment maintenance, the cost of communication credit consumption (calls and SMSs between local healthcare providers, experts and tele-ECG activities coordinator) as well as the cost of their internet connection. As control centres did not use tele-ECG, their costs were therefore, considered zero. The efficiency of health facilities was calculated based on the Incremental Cost-Effectiveness Ratio (ICER) according to the formula [ICER = (C_{Int} - C_{Con}) / (E_{Int} - E_{Con})]. C_{Int} and C_{Con}: the average of total costs of intervention and control centres; E_{Int} and E_{Con}: effectiveness in intervention and control centres.

2.5. Data analysis and ethics

Appropriate statistical tests and relative risk (RR) were performed for the comparison between the two groups. The study received an ethical clearance CE00398/N°CRERSHC/2016 issued by the Centre Regional Ethics Committee for Human Health Research.

3. Results

About the Sociodemographic and clinical characteristics of participants, one hundred seventy-one participants were recruited, 93 (54.4%) in the intervention centres and 78 (45.6%) in the control centres. In the intervention centres, 57% of participants were

women, and the mean age was 59.3±12.3 years. The main cardiovascular risk factors found were: age (84.9%) and High Blood Pressure -HBP- (48.4%), whereas evaluation of HBP (24.7%) and exertional dyspnea (18.3%) were the main complaints. In the control centres, 55.1% of participants were women, and the mean age was 62.4 ± 12.2 years. The main cardiovascular risk factors found were: age (73.1%) and HBP (56.4%), while evaluation of exertional dyspnea (37.2%) and HBP (14.1%) were the main complaints. There was no statistically significant difference between the two groups except for the primary complaint related to exertional dyspnea. Regarding the Effectiveness (primary outcome), ninety-two (98.9%) of participants had access to an ECG test associated with expertise in the intervention centres. In comparison, 26 (33.3%) only had it in the control centres with a p <0.01 (table 1) and a relative risk equal to 2.97 [CI 95%: 2.17 - 4.06].

Table 1. Effectiveness (primary outcome)

Primary outcome	Intervention centres (N=93)		Control centres (N=78)		p
	n	%	N	%	
ECG + Expertise	92	98.9	26	33.3	<0.01

Regarding patient efficiency, the average total cost for patients was 9 286 F CFA (US$: 16) in the intervention centres compared to 28 357 F CFA (US$: 49) in the control centres (p <0.01), see table 2. The actual costs for the implementation of tele-ECG in intervention centres are shown in table 3. The average total cost in these intervention centres was 1 680 336 F CFA (US$: 2900). As control centers do not use tele-ECG, their costs were considered zero. Considering the parameter of effectiveness, the calculated ICER was 25 459.6 F CFA (US$: 44).

Table 2. Comparison of costs by participants in different centres

Costs	Intervention centres (N=92)		Control centres (N=26)		p
	Mean±SD	Min-Max	Mean±SD	Min-Max	
Direct costs (F CFA)	6575±566	5600-6900	18350±3272	8600-23100	<0.01
Indirect costs (F CFA)	2711±1122	1000-6000	10187±3979	4000-20000	<0.01
Total costs (F CFA)	9286±1504	6600-11600	28357± 5918	16600-43100	<0.01

4. Discussion

For telemedicine to become truly anchored as a credible alternative to usual care [11], evidence of its added value in terms of effectiveness and efficiency is essential. After carrying out the study that demonstrated telemedicine's effectiveness in managing patients with CVDs in Cameroon [5], this study shows its efficiency in promoting financial access to healthcare for patients and improving its efficiency for the provision of care in health facilities. This study shows that participants spent an average of 9 286 F CFA to obtain an ECG and expertise in intervention centres, compared to 28 357 F CFA in control centres, for a savings of 19 071 F CFA (US$: 33 or 67.3%). These results are similar to those of Bagayoko et al. in Mali, who assessed the medico-economic contribution of telemedicine (tele-ultrasound in obstetrics and tele-ECG in cardiology) in remote areas and found that patients who used telemedicine spent less than those who

used the standard practice (19 000 F CFA (US$: 33) against 54 000 F CFA (US$: 93)) [5]. The standard practice was the displacement of these populations towards the capital to benefit from specialized care. Van Os-Medendorp et al. in the Netherlands had also found that in the intervention centres, patients spent less in direct and indirect costs (US$: 3 378) than those in the control centres (US$: 3 972) to benefit from tele-expertise for the treatment of atopic dermatitis [6]. About health facilities, we observed that with an investment of only 25 459.6 F CFA per patient in telecardiology, the State or a health facility would guarantee its population the possibility of performing an ECG and having the expertise of a remote cardiologist in a primary care setting. Like other studies [7, 8], this result shows that telemedicine is cost-effective, especially in remote areas, if we compare it to the cost of moving people to the city or sending specialists to these areas when we know that they will not work efficiently and will leave. Therefore, there is a need to promote, vulgarise and implement this modality of health care in our context.

Table 3. Comparison of costs for the implementation of tele-ECG by centres

Intervention centres	Type of costs	Costs (F CFA)	Control centres	Type of costs	Costs (F CFA)
Mbouda District Hospital	Variable costs	347 867	**Fombot District Hospital**	Variable costs	0
	Fixed costs	1 434 520		Fixed costs	0
	Total costs	**1 782 387**		**Total costs**	**0**
Akonolinga District Hospital	Variable costs	202 765	**Sa'a District Hospital**	Variable costs	0
	Fixed costs	1 375 520		Fixed costs	0
	Total costs	**1 578 285**		**Total costs**	**0**

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