Evaluation of the Effectiveness of Telemedicine in the Management of Cardiovascular Diseases in Primary Health Care in Cameroon: An Interventional Study

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Abstract. Objective: This study aimed to evaluate the effectiveness of tele-expertise (tele-ECG) in primary health care in Cameroon for the management of patients with cardiovascular diseases or risk factors. Method: It is a controlled multicenter study carried out in Cameroon's two health facilities where tele-ECG has been implemented (intervention centers) and two other where telemedicine has been not implemented (control centers). Patients having cardiovascular risk factors or diseases received usual primary health care in the control centers. In contrast, they received usual primary health care and could perform an ECG associated with cardiologists' remote expertise (tele-ECG) in the intervention centers. The primary outcome was to evaluate the rate of patients' access to an ECG test and to cardiologist' expertise. Results and Discussion: Telemedicine is effective for the management of patients with cardiovascular diseases in primary health care. It could improve healthcare providers' clinical processes, clinical outcomes of patients and their satisfaction.

Keywords. Telemedicine, Effectiveness, Cardiovascular Diseases, Cameroon, Africa, Developing Countries, Low-middle Income Countries

1. Introduction

The objective was to evaluate the effectiveness of tele-expertise (tele-ECG) for the management (healthcare providers' clinical processes, clinical outcomes and satisfaction) of patients with cardiovascular risk factors or diseases in primary health care in Cameroon located in remotes areas.

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2. Methodology

2.1. Study design

This is a controlled multicenter study carried out in 2016 and 2017 in Cameroon's four health facilities: 2 intervention centers (Mbouda and Akonolinga District Hospitals) where tele-ECG was implemented and two control centers (Foumbot and Sa'a District Hospitals) where it was not implemented. The control centers had similar characteristics (matching clusters) to the intervention centers regarding the level of care, location and distance to the nearest big town having a higher healthcare facility level.

2.2. Participants, inclusion and exclusion criteria

Eligible patients had to meet the following inclusion criteria: (i) to have at least one of the following cardiovascular risk factors - age ($\geq$ 45 years) or high blood pressure ($\geq$ 140/90 mmHg) - or (ii) to have one or more cardiovascular complaints. Patients hospitalized or having a serious altered general condition were excluded.

2.3. Intervention and control centers

Intervention centers: 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, it was proposed to patients to perform a resting ECG on-site with the Universal ECG™ (a portable 12-channel ECG device associated with dedicated software enabling to perform ECG tests and to print reports 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 [1]. Through this platform, he had to send patients' data (clinical data, diagnostic hypothesis, ECG tests and current management plan). Based on these data, the cardiologist had to provide adapted expertise to better manage patients within 72 hours maximum.
Control centers: In the control centers, patients received the usual primary care only without tele-ECG. For all patients, we recommended a consultation at a cardiology center or to meet a cardiologist in the nearest town (Bafoussam and Yaoundé).

2.4. Sampling

Based on the primary outcome, we predicted a 25% difference in favor of intervention centers for performing ECG tests and obtaining remote expertise. For an allocation ratio of 1:1 in both groups, a study power of 80%, an alpha error of 5% and a "two-sided" test, we should include a minimum sample size of 140 patients (calculated with OpenEpi [2]), 70 patients in intervention centers and 70 in control centers.

2.5. Recruitment, monitoring and data collection

The recruitment of patients, clinical assessment, establishing a diagnostic hypothesis, implementing a management plan and patient orientation by the local healthcare provider were done during the first visit. The second visit took place three months after, during which secondary outcomes and satisfaction of patients were evaluated. Data were collected through a questionnaire designed for this study.

2.6. Outcomes, data analysis and ethics

The primary outcome 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). The analysis of this outcome was done by intention to treat: all patients that we cannot determine if they performed an ECG test and received an expertise of a cardiologist at 3-month, were considered as not having had access to it. Secondary outcomes and participants' satisfaction (measured using a 5-point Likert scale) were also evaluated. 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.

3. Results

3.1.Sociodemographic and clinical characteristics of participants

One hundred seventy-one participants were recruited, 93 (54.4%) in the intervention centers and 78 (45.6%) in the control centers. Table 1 illustrates the sociodemographic and clinical characteristics of participants in the two groups.

3.2.Primary and secondary outcomes and satisfaction

In the intervention centers, 92 (98.9%) of participants had access to an ECG test associated with expertise. In comparison, 26 (33.3%) only had it in the control centers with a $p < 0.01$ (table 2) and a relative risk equal to 2.97 [CI 95%: 2.17 - 4.06].

Compared to control centers, a significant improvement of some secondary outcomes was observed in intervention centers: the diagnosis of local healthcare providers, the time required to perform an ECG test, the quality of medical references from local healthcare providers, the attendance of participants at 3-month, the favorable evolution of their BP at 3-month and their satisfaction (table 3).

4. Discussion

For telemedicine to become truly anchored as a credible alternative to usual care [3], evidence of its added-value in terms of effectiveness and efficiency is essential. Today, more and more research is done on the evaluation of its effectiveness and efficiency. A systematic review found that 73% of the 141 selected studies found a positive effect of telemedicine in chronic clinical conditions such as asthma, heart failure, high blood

pressure and diabetes [4]. These positive effects were also observed explicitly in cardiovascular diseases [5,6]. Although this evaluation culture is gradually being implemented, there is little robust scientific work on evaluating the effectiveness of telemedicine projects implemented in Africa.

Table 1. Sociodemographic and clinical characteristics of participants

Characteristics	Intervention centers (N=93)		Control centers (N=78)		p
	n	%	n	%	
Gender (female)	53	57	43	55.1	0.88
Cardiovascular risk factors					
Age	79	84.9	57	73.1	0.05
High Blood Pressure (HBP)	45	48.4	44	56.4	0.36
Cardiovascular main complaints					
Need to assess HBP	23	24.7	11	14.1	0.08
Exertional dyspnea	17	18.3	29	37.2	0.01
HBP Grade (mmHg) European Society of Hypertension					
Optimal	18	19.4	15	19.2	
Normal	13	14.0	7	9.0	
High Normal	8	8.6	4	5.1	0.77
Grade 1	16	17.2	13	16.7	
Grade 2	19	20.4	21	26.9	
Grade 3	19	20.4	18	23.1	
	n	Mean±SD	Min-Max	n	Mean±SD	Min-Max	
Age (years)	79	59.3±12.3	45 - 93	57	62.4±12.2	45 - 86	0.16

Table 2. Primary outcome

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

Our study demonstrates telemedicine's ability to improve patients' access to healthcare in cardiology (ECG test + expertise) and clinical processes of healthcare providers practising primary health care in remote areas. These results are similar to some research carried out in Mali. They showed that it could be a tool for equitable access to health care by favoring a delegation of specialist tasks to peripheral healthcare providers [7] and it could improve patients' diagnostic and treatment processes [8]. Although this requires more robust studies, this study highlighted telemedicine's potential to improve clinical outcomes, such as improving blood pressure control, as demonstrated in this study [9]. It may be due to the high patients' confidence in the local healthcare provider whom they know to be supported by the expert and better compliance to the treatment, even if its effect measured by a subjective approach is not statistically significant in this study.

Finally, we observed that patients who benefited from telemedicine had better satisfaction during their healthcare process, as demonstrated in other studies [10].

The results found in this study suggest that telemedicine is an effective healthcare activity for the management of cardiovascular diseases in primary health care in limited-resources countries like Cameroon.

Table 3. Secondary outcomes and satisfaction

Secondary outcomes	Intervention centers (N=93)		Control centers (N=78)		p
	n	%	n	%	
Attendance at the 3-month appointment	92	98.9	26	33.3	<0.01
Diagnosis modification of the local healthcare provider by expert	43	46.2	14	17.9	<0.01
Inappropriate drug prescriptions from local healthcare providers	32	34.4	24	30.8	0.75
References from local healthcare providers deemed unnecessary by expert	22	23,7	9	11,5	0.01
Favorable evolution of BP at 3-month	38	40,9	14	17,9	<0.01
	n	Mean±SD	Min-Max	n	Mean±SD	Min-Max	
Time required to perform an ECG test (days)	89	1,3± 4,1	0-20	26	7,0± 14,5	0-69	<0.01
Time required to receive the expertise (days)	89	10,3±11,6	0-50	23	11,2±27,9	1-121	0.82
	n	Med(IQR)	Min-Max	n	Med(IQR)	Min-Max	
Compliance to treatment at 3-month during the last 30 days	91	4 (3-5)	1-5	23	4 (3-5)	1-5	0.08
Satisfaction of participants at 3-month	92	5 (5-5)	1-5	26	4 (3-5)	1-5	<0.01

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