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Telecardiology in the Management of Acute Cardiovascular Diseases: Case of the Ivorian Experience

Gnaba LA[1,2], Diby KF[1,2], Ouattara PAE[1,2], Coulibaly A[2], Diomandé M[1,2], Ayegnon KG[1,2], Sall-Meneas F[1,2], Koffi MN[1,2], Abro S[1,2], Erika E[1,2], Adoubi KA[1,2]

[1] University of Alassane Ouattara, Training and Research Unit, Bouake, Ivory Coast
[2] Bouake Teaching Hospital, Bouake, Ivory Coast

Abstract

Objective: Telemedicine is a tool to overcome the lack of access to health facilities in remote populations. The main aim was to assess a field of Telemedicine, Telecardiology in the management of acute electrocardiographic abnormalities in Ivory Coast. Methods: This was a cross-sectional descriptive and analytical study conducted from June 30, 2022 to September 30, 2022 which involved 19 health centers selected in the Teleelectrocardiogramm Project. Results: 529 ECGs were recorded. The prevalence of acute abnormalities was 52.93% (n=280). Atrial fibrillation, acute coronary syndrome, left ventricular hypertrophy and ventricular extrasystoles were the main causes of acute abnormalities. The presence of them was in older people (59.91 versus 54.95 years, p=0.00). Within 06 hours, abnormalities were diagnosed 70.86% of cases without any significant difference (p=0.056). Age class, gender, region of origin and blood pressure profile did not significantly influence the occurrence of ECG acuity. In 85% (n=238) of cases, the teleExpert recommended cardiological consultation via the interpretation platform (83.19%, n=198). In terms of follow-up over one month, more than half of the patients were reachable (n=174) compared to 38% who were unreachable. The main reasons were contactless files (67.92%, n=72), contact errors (13.21%, n=14) and the contact unavailability (11.32, n=12). Patients were informed about their remote diagnoses in 15% of cases (n=26). More than half of the patient evolved favorably (76.44%, n=133). Conclusion: Telecardiology contributes to the diagnosis of acute cardiovascular abnormalities for health centers without specialists. It can help primary care practitioners with immediate triage, which would result in early management.

Keywords: Telecardiology, Acute electrocardiographic abnormalities, Community settings, Ivory Coast.

INTRODUCTION

Countries in sub-Saharan Africa are experiencing an increase in the prevalence of cardiovascular diseases due to increasing urbanization and changing lifestyle factors [1]. These conditions often present in an acute or urgent form, involving the life-threatening and functional of the patient and requiring urgent treatment. However, their time to take charge remains insufficient [2]. It is therefore in order to face these challenges that WHO, through its resolutions in Geneva in 2005 and Malabo in 2010, encouraged the use of Telemedicine as a lever to face these constraints [3]. One area of application is Telecardiology which treats life-threatening medical conditions, many of which can be reversed with early diagnosis and prompt management of the patient's clinical condition [4]. Evidence of its cost-effectiveness has been tested in several places around the world, including Brazil. Before the introduction of this system, a period of approximately 24 hours was required in this country before an electrocardiogram (ECG) could be interpreted by a cardiologist, but the electronic system shortened this time to approximately 10 minutes [5]. In India, TeleECG has been shown to be a cost-effective practical tool for the diagnosis and monitoring of cardiovascular disease [6]. It has improved access and quality of care in a low- and middle-income rural population accordingly. In the Ivorian health system, primary care is the foundation of the system and acts as a guardian. In emergencies, however, it is the emergency units that deal with complex cases, which are generally available only in large cities. However, patients in emergency situations sometimes seek help from primary care for a variety of reasons. First, emergency services often suffer from very limited capacity. There is a shortage of ambulances and health professionals, especially in remote communities. Second, availability and accessibility at the community level make primary care the first point of contact, sometimes even for emergency care, and some patients deliberately avoid emergency services. In order to help the Ivorian community level take care of patients with cardiovascular diseases, a Telecardiology project through the TeleECG Project has been set up since 2014. It then expanded to reach a total of 22 sites since 2021. Although it has proved its worth [7-9]. Its contribution to the management of acute cardiovascular abnormalities has not yet been elucidated. The objective of this work is to evaluate the

***Corresponding author:**
Dr. Loa Ambroise Gnaba
University of Alassane Ouattara, Training and Research Unit, Bouake, Ivory Coast
Email: gnabaloa@yahoo.fr

impact of TeleECG in the management of acute cardiovascular anomalies with a view to its possible popularization in Ivory Coast.

MATERIAL AND METHODS

Choice of sites

Nineteen distributed health centers were selected in the Telecardiology Project. All these cities identified with their ECG reference centers are listed in Table 1. These centers were chosen partly because they do not have cardiologists and partly because they are geo-representative. All of them were equipped with medical kits that included a digital electrocardiograph, an internet connection, a platform for transmitting and receiving various ECGs, and a printer. The ECGs produced at these sites are transmitted to the Cardiology Department of Bouake Teaching Hospital where they are interpreted by the Expert Cardiologists, who each have an access code to the reading platform and a tablet. To this end, an annual stand-by program is defined.

Study population

We included in this study, TeleECGs from the TeleECG Project that were interpreted by Cardiologists. In this work, ECGs have been divided into two groups. These are acute electrocardiographic abnormalities with Level 1 ECGs (Urgent abnormalities) and Level 2 ECGs (Significant abnormalities). Non-acute anomalies included Level 3 (Non-serious) anomalies. These non-acute abnormalities take into account minor anomalies (all isolated automations, atrial hypertrophies, non-specific abnormal QRS, etc.) and normal plots [10]. The parameters analyzed were related to ECG performance (interpretation delay, regions of the transmitting centers), epidemiology (age, sex), electrocardiography (number of recorded Tele; acute and non-acute profiles), management (Attitude towards acute anomalies; methods used to report emergency; pharmacological management) and the outcome of acute abnormalities.

Practical organization of the study

This study involved 19 sites including a center of expertise that was the Cardiology Department of Bouake Reaching Hospital with experts. Patients were present at these 19 sites with an ECG indication. They are examined on site with the taking of sociodemographic parameters, clinical, and ECG measurements that were sent to the center of expertise for interpretation, unlike the traditional system in which the patient would have been referred to the nearest hospital with ECG capacity (Center of Reference). The data transmitted was available on the TeleECG reading platform of the Cardiology Department, accessible through a personalized code. From the survey sheet published for this study, we recorded daily the data of the interpreted plots that we ranked according to the profile of the ECG, acute or non-acute. This process was the first phase of our work. The second phase of our work consisted in calling subjects with acute plots to assess the care they received. The third step was to assess patients' fate and perception of the teleECG process after one month of diagnosis. The second and third phases were conducted by telephone.

Statistical analysis

This was a cross-sectional descriptive and analytical study. It ran from 30 June 2022 to 30 September 2022, a period of three months. The data collected on a survey sheet was entered on the EPI DATA software and analyzed on SPSS version 22 on PC. Qualitative variables are expressed by their number and percentages. Quantitative variables are expressed as means ± standard deviations if they are distributed normally. Where appropriate, they will be expressed by their medians.

Ethical considerations

The study was conducted with the consent of the project manager prior to data collection. The results have been analyzed in accordance with the laws on the protection of individuals' data and in accordance with ethical principles according to the Helsinki Declaration.

RESULTS

Prevalence of acute electrocardiographic abnormalities

Acute anomalies accounted for more than half (52.93%, n=280) of the abnormal ECGs. Acute abnormalities are defined as urgent (Table 1).

Description of acute anomalies

Urgent TeleECG (Level 1)

Urgent ECG abnormalities were dominated by atrial fibrillation followed by ST+ ACS in the proportions of 43.33% (n=13) and 23.33% (n=07), respectively (Table 2).

Significant abnormalities (Level 2)

Significant electrocardiographic abnormalities were dominated by left ventricular hypertrophy and ventricular premature beats in the proportions of 62.4% (n=156) and 12.4% (n=31), respectively (Table 3).

Average age of carriers of acute anomalies

People with acute abnormalities were significantly older. (59.91 ± 16.15 years versus 54.95 ± 16.19 years, p=0.00).

Interpretative time depending on severity

In our study, 70.86% (n=197) of the acute ECG abnormalities were within a reasonable time (<06 hours) with no significant difference (p=0.056) (Table 4).

Evaluation of parameters likely to modify the teleelectrocardiographic profile

Non-acute abnormalities were significantly found in the age range 50 to 59 years (p=0.02).

Gender had no significant influence on the ECG severity profile (p=0.19). The applicants' regions of origin did not significantly influence the ECG profile (p=0.69). The blood pressure profile had no significant influence on ECG severity (Table 5).

Support

Attitudes to acute ECG abnormalities

In our series, the teleExpert recommended a cardiac consultation in 85% of cases (n=238).

In our series, 83.19% (n=198) of the recommendations for a cardiac consultation were made via the TeleECG interpretive platform (Table 6).

Pharmacologic management

Pharmacological prescription was insufficient and no thrombolysis was performed (Table 7).

Follow-up of patients over one month

Contact with patients

More than half of our patients were reachable (n=174) compared to 38% not reachable (n=106).

Reasons for unreachability

In our series, 67.92% (n=72) of the cases were dominated by non-contact records followed by contact errors (13.21%, n=14) and unavailability of contact (11.32%, n=12).

Information of the requesters of their recorded injuries

In 15% (n=26) of the cases, the applicants were informed of their remote diagnoses on all the patients reached.

Patients outcomes

In our series, more than half of the subjects progressed favorably (76.44%, n=133) and unfavorably in 14.37% of cases (n=25). Overall mortality was 12.64% in our study (n=25).

Table 1: Classification of teleECG according to severity profile (N=529)

TeleECG Profiles	Numbers	Percentages
Level 3 ECG	249	47.07
Level 2 ECG	250	47.26
Level 1 ECG	30	5.67
Non-acute ECG abnormalities (Level 3 ECG)	249	47.07
Acute ECG abnormalities (Level 2 + Level 1)	280	52.93

ECG (Electrocardiogram)

Table 2: Description of urgent teleECGs (N=30)

Descriptions	Designations	Staff	Percentages
- Urgent rhythm - Urgent ventricular rhythm - Atrioventricular conduction emergency - Urgent repolarization - Hyperkalaemia, Hypokalaemia, ACS, myocarditis/ - Pericarditis.	Junctional tachycardia	01	03.33
	Prefibrillatory state	01	03.33
	Atrial fibrillation	13	43.33
	Atrial flutter	02	06.67
	Complete AVB	02	06.67
	Alternating sinus and junctional tachycardia	01	03.33
	Supraventricular tachycardia	01	03.33
	Atrial tachycardia	02	06.67
	STEMI	07	23.33

STEMI (acute coronary syndrome with persistent ST segment elevation), AVB (auriculoventricular block)

Table 3: Description of Important TeleECGS (N=250)

Descriptions	Designations	Numbers	Percentages
- High sinus rhythm - Significant ventricular rhythm - Significant atrioventricular (AV) conduction problem - Important automation: Large branch blocks - Ventricular hypertrophy - Ischemia - Rare disorder	AVB 2 Mobitz 1	01	0.4
	VES	30	12
	ESA	31	12.4
	RBBB	02	0.8
	LBBB	01	0.4
	Sinus rhythm>125bpm	23	9.2
	Sinus rhythm<45bpm	02	0.8
	LVH	156	62.4
	RVH	05	02

AVB (Atrioventricular block), VES (Ventricular extrasystoles), AES (Atrial extrasystoles), RBBB (Right bundle branch block), LBBB (Left bundle branch block), LVH (Left ventricular hypertrophy), RVH (Right ventricular hypertrophy)

Table 4: Distribution of electrocardiographic profile by time of interpretation

Time limit for interpretation	Acute abnormalities % (n)	Non-acute abnormalities % (n)	p-value
< 06 hours	70.86 (197)	77.02 (191)	0.056
≥ 06 hours	(81)	7.26 (57)	

Table 5: Parameters likely to modify the Teleelectrocardiographic profile

Age groups	Acute abnormalities % (n)	Non-acute Abnormalities % (n)	p-value
Age groups and electrocardiographic profile			
[10-19]	01.80 (05)	03.32 (08)	0.29
[20-29]	03.96 (11)	04.98 (12)	0.58
[30-39]	08.63 (24)	08.71 (21)	0.97
[40-49]	16.55 (46)	14.11 (34)	0.45
[50-59]	19.42 (54)	28.21 (68)	0.02
[60-69]	26.98 (75)	23.65 (57)	0.39
[70-79]	14.75 (41)	10.79 (26)	0.18
≥80	07.91 (22)	06.22 (15)	0.46
Distribution of ECG profile by sex			
Feminine	51.43 (144)	45.78 (114)	0.19
Male	48.57 (136)	54.22 (135)	
Distribution of the ECG Profile by Localities			
North	26.79 (75)	30.52 (76)	0.69
South	03.21 (09)	04.02 (10)	
Center	48.57 (136)	46.99 (117)	
East	0.36 (01)	0.40 (01)	
West	21.07 (59)	18.07 (45)	
Distribution of ECG profile according to the blood pressure profile			
Normotension	27.60 (77)	33.47 (83)	0.086
Hypertension	72.40 (202)	66.53 (165)	

Table 6: Methods used to report the value of a cardiological consultation (N=238)

Alert Methods	Numbers	Percentages
Platform	198	83.19
SMS	04	01.68
Call	29	12.19
WhatsApp	07	02.94

Table 7: Pharmacological management (N=280)

	Numbers	Percentages
Thrombolysis	**00**	**00**
Statins	04	1.43
Beta-blockers	08	2.86
Antiplatelet agents	**12**	**4.29**
RAASI	08	2.86
CCB	05	1.78
Diuretics	04	1.43
Heparin therapy	04	1.43
Other recommended emergency measures	97	34.64

RAASI (Renin Angiotensin Aldosterone System Inhibitors), CCB (Calcium channel blocker). Other emergency measures: optimization of anti-hypertension treatment, adjunctive therapy.

DISCUSSION

Through this process, acute electrocardiographic abnormalities were discovered in 52.93% of cases. 85% of these emergencies were addressed to the prescriber via the interpretation platform (75%). Thrombolysis, an emergency therapy par excellence, had not been carried out. More than half of the subjects have developed favorably. Three themes emerged from this work. These are the prevalence, management and outcome of acute ECG abnormalities. The prevalence of acute TeleECG anomalies in our work was 52.93%. Our prevalence is higher than that of Marcolino MS et al. in Brazil in 2017 which was 0.1% [11] and that of Sowizdraniuk J et al. in Poland in 2019 which found a proportion of 5.4% [12]. These observed differences between our study and that of the literature could be explained by the fact that our work combined Level 1 and Level 2 TeleECGs. On the other hand, our proportion is almost identical to that found in the study by Mappangara I et al. in Indonesia with a proportion of 44% [13]. Nevertheless, its data show the profitability of this digital process in the diagnosis of acute cardiovascular pathologies. In our work, level 1 abnormalities were dominated by atrial fibrillation followed by ACS in the respective proportions of 43.33% and 23.33%. Our prevalence is higher than that of Barbara JD. in California in 2006, which found a prevalence of 33.3% for atrial fibrillation and 30.3% for acute coronary syndrome [14]. The prevalence of atrial fibrillation in our work was also higher than that of Nogueira MF et al. in Brazil in 2022 which was 0.9% [15]. Similarly, the proportion of SCAs in our work was higher than that of Mappangara I et al. in Indonesia with a proportion of 1% of SCA ST+ in a study published in 2022 [13]. These data further demonstrate the contribution of digital technology in the diagnosis of these cardiovascular emergencies to serious complications including sudden death. The prevalence of large ECGs was dominated by left ventricular hypertrophy and ventricular premature beat in the proportions of 62.4% and 12.4%, respectively, in our study. The prevalence of HVG in our work was higher than that found in the Singh M et al. study in India in 2014 where it was 9.3% [16]. In the study of Nogueira MF et al. in Brazil, the prevalence of HVG was 0.25% [15] and in Russia, it was 1.17% with the study of Riabykina GV et al. [17]. All these ventricular hypertrophy prevalences found in Caucasian subjects were below ours, which was mostly black African. In Senegal, sub-Saharan Africa, Sarr SA in 2016 found a prevalence of left ventricular hypertrophy of 28.85% in a black hypertensive population [18]. No data on the prevalence of ventricular premature beats and telemedicine were found. Indeed, left ventricular hypertrophy is the consequence of several cardiovascular disorders, the most common of which is hypertension and seems more frequent in black people and remains frequent even in community settings. As it is associated with hypertension, it increases the risk of major cardiovascular events by 5-10 fold [19]. It is easy to diagnose if tools such as TeleECG are available. The average interpretation time in our study was longer compared to other work, including that of Sparenberg ALF et al. in Brazil in 2004, where it was about ten minutes [20], and 5.13 minutes in Amini Ket al. in Iran [21]. The relatively long delay in our context could be explained, on the one hand, by the fact that the same stand-by cardiologist for electrocardiogram interpretations carries out his daily hospital activities at the same time and, on the other hand, by the absence of an alert tool for acute anomalies. The second theme is support. In our series, the teleexpert's recommendation for a cardiological consultation was found in 85% of cases. Our prevalence is lower than that found by Vivek et al., who found a prevalence of 100% in India [22]. In any event, the applicant for teleECG is generally provided with guidance on appropriate care. However, the difference observed should perhaps encourage our TeleECG model to better structure. In our series, 83.19% of acute TeleECGs were reported via the TeleECG interpretive platform. Contrary to the study by Vivek C et al. in which Acute TEECGs were reported by telephone calls in 100% of 24-hour cases to rural doctors in Kangra, India [22]. The difference observed could be related to the fact that our telecardiology activities are purely expertise activities that will have to be improved through teleconsultation. In all cases, the prescriber of the teleECG is generally informed of the urgency of the abnormalities for appropriate management. Pharmacological prescribing had been insufficiently prescribed in our work. In contrast, in the study of Vivek C, which was reasified to India in 2015, peripheral centers that did not have the ability to test cardiac enzyme levels were advised to give aspirin 30 mg, clopidogrel and 80 mg artovastatin to suspected ACS patients and refer them to a hospital [22]. The third topic is the fate of subjects with acute anomalies. Our series was dominated by 49.42% of patients discharged on medical advice. Observation accounted for 39.08% of cases. In the study of Mappangara I et al. in Indonesia, 19% of patients had been hospitalized [13]. In Mohanan K et al.'s 2019 study in the United States, 11.18% of patients were discharged on medical advice after telephone consultation with a cardiologist and 88.82% were admitted to a cardiology department [23]. All these observations show the value of using electrocardiogram tele-expertise in the management of environments remote from large cities. In our work, more than half of our patients were reachable. In 12.14% of cases, they were unreachable. In the study of Mappangara I et al. in Indonesia, no patients were lost to vision and follow-up was done either by telephone call or by home visits [13]. The reason for this difference is believed to be that our subjects leave most of them, from remote areas, and travel to town for consultations and laboratory tests. In order to follow up patients with anomalies in our country, it would be desirable to organize teleconsultations very quickly so that telemedicine makes sense in our country. Where appropriate, structured community-based consultations could be established. In our study, 67.92% of patients' reasons for unreachability were dominated by non-contact records. Similarly, in the study by Mohanan K et al. in 2019 in the United States, 1.18% of patients had no data in their file following their initial visit and could not be reached for follow-up [23]. These observations underscore the need for rigor in collecting patient data during telemedicine activities for patient management. In our series, 15% of subjects were informed of their remote diagnoses on all patients reached. This low proportion of physician-patient communication is very common in Africa. Ungen JP et al. in 2022 gave some reasons for this in a published study [24]. It shows that in developing countries poor communication is the rule in public services [23,25]. In our study, 76.44% of subjects had a favorable outcome. In the study of Monahan K et al. in the United States, 10% of patients who left on medical advice had a favorable outcome during the 30-day follow-up [22]. This difference is due to the fact that hospitalized patients in the series of Monahan K et al. [22] were not included in the follow-up unlike ours. In short, the TeleECG process contributes effectively to the cardiovascular management of patients. In our study, the overall mortality rate was 12.64%. By contrast, the study by Mappangara I et al. found a 1.4% death rate recorded in Indonesia in 2020 [13]. This mortality rate is still high, perhaps because of the unreachability of some patients, the delay in diagnosis and the non-existence of teleconsultation. This trend could be reversed if some of the parameters listed above are controlled.

CONCLUSION

The objective of this work was to show the contribution of TeleECG in the detection and management of acute cardiovascular diseases from nineteen health centers integrated in a Telecardiogram Project. There is a strong demand for electrocardiogram. On all the evaluated teleECG, acute abnormalities were the most found (52.93%), dominated by atrial fibrillation, acute coronary syndrome with persistent ST segment, left ventricular hypertrophy and extrasystolies. These acute abnormalities were more found in the central regions of Ivoiry Coast and their diagnosis was made within a reasonable time (<06 hours). The urgent nature of these anomalies was reported to the Health Centre. This tele-expertise process made it possible to follow more than half of the patients concerned with a favorable evolution of them. However, a mortality rate of 12.64% was recorded. The satisfaction survey of the profitability of the TéléECG process allowed to note a satisfaction rate of 74%. In summary, Tele-ECG is

feasible and affordable that can help in the diagnosis of potentially fatal cardiovascular diseases, based on an expert opinion.

Conflict of Interest

The authors declare no conflicts of interest.

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ORCID ID

Loa Ambroise Gnaba: https://orcid.org/0000-0003-2143-760X

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