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RESEARCH ARTICLE

THE IMPACT OF TARGETED TRAINING OF MEDICAL INTERNS ON THE SURVIVAL OF CARDIAC ARREST IN THE EMERGENCY ROOM

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Abstract

Introduction: The prognosis of patients with cardiac arrest is closely related to the quality of cardiopulmonary resuscitation (CPR). The aim of this work was to assess the impact of targeted training on CPR, in accordance with the latest international recommendations, on the management of cardiac arrests in SAUV.

Methods: This is a prospective study carried out between January 1 and December 31, 2011 at the SAUV of Ibn Sina University Hospital in Rabat, including all adult patients who experienced cardiac arrest after admission. The main primary objective is to evaluate the impact of targeted training of medical interns on the survival of cardiac arrest in the ER expressed by the Hospital Discharge Survival (HDS) rate. Secondary objectives include the rate of recovery of circulatory activity (RCA), 48-hour survival, and quality of CPR performance.

Results:342 patients were included, 159 before and 183 after training. There was no significant difference in terms of recovery from spontaneous circulation, 48h survival or discharge rate at home without sequelae. On the other hand, there was a statistically significant improvement in all the quality criteria for performing CPR.

Conclusion: This work shows that the introduction of short training courses such improves the quality of CPR. The lack of impact on the improvement of patient survival seems to be related to numerous shortcomings, in particular basic medical training in emergency medicine, organization and protocolization of care, equipment of emergency rooms, supervision of emergency clerkship and the existence of a CA national registry. These are all areas to be developed in order to improve the prognosis of CA in our hospital structure.

Introduction:-

The prognosis of patients with cardiac arrest (CA) is closely related to the quality of cardiopulmonary resuscitation (CPR). The management of cardiac arrest is based on the concept of chain of survival with its 4 elements or components: early recognition of cardiac arrest and alert, basic CPR, early defibrillation and finally specialized CPR [1].

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In Morocco, there are major dysfunctions in the management of cardiac arrest. One of the lines of improvement is the development at the national level of Emergency Care Teaching Centers (ECTC), the objective of these centers is to improve the skills of emergency practitioners through short targeted training courses inspired by experiences widely developed in France such as the "Attestation de Formation en Gestes d'Urgence, AFGSU" [2] and in the United States such as Basic Life Support, BLS, and Advanced Cardiac Life Support, ACLS [3], whose effectiveness is widely recognized [4]. In Morocco, this is a first experience with the specificities of the local emergency services.

Using the Ibn Sina University Hospital in Rabat as a model, this study aims to evaluate the impact on patient survival of the training in the management of cardiac arrest in the Emergency Room.

Materials and Methods:-

This is a prospective study carried out in the Emergency Room of the Ibn Sina University Hospital over one year.

Its primary objective is to evaluate the impact of targeted training of medical interns on the survival of cardiac arrest in the ER expressed by the Hospital Discharge Survival (HDS) rate. Secondary objectives include the rate of recovery of circulatory activity (RCA), 48-hour survival, and quality of CPR performance.

Inclusion criteria are the following:
- Age > 18 years,
- Admission to the ER between January 1st and December 31st, 2011,
- Occurrence of cardiopulmonary arrest after admission, as evidenced by the absence of neurological reactivity and cessation of spontaneous breathing and/or the existence of gasps,
- The performance of CPR.

Exclusion criteria are:
- Age < 18 years,
- Admission to the ER in a state of apparent death,
- No CPR performed.

Data collected:
- Patient demographics: age, gender, origin (University hospital, another hospital, public road or home), nature of the pathology motivating the emergency room visit (medical, traumatic or surgical pathology),
- Time of occurrence of cardiac arrest after admission,
- Quality of CPR, evaluated by a questionnaire filled in by the practitioner at the end of the procedure:
o Time of start of CPR,
o Frequency of chest compressions
o Frequency of insufflations,
o Order of intubation ~~between~~ in relation with chest compressions
o Intensity of defibrillations.
- Patient outcome is assessed by 3 criteria:
o Recovery of circulatory activity,
o Survival at 48 hours,
o Survival at hospital discharge.

The study is conducted over two periods:
- January 1st to June 1st 2011: Collection of the above data. This period defines the "Before Training" group
- From June 1st to June 3rd 2011: Training of all interns on duty in the emergency room ~~in~~ for the management of vital distress by the ECTC team. This program is approved by the Moroccan Ministry of Health in accordance with international guidelines of 2010 [18].
- From June 4th to December 31st 2011: Collection of the same data after the training was completed. This period defines the "After Training" group.

Statistical analysis of the data used SPSS 13.0 software for Microsoft Windows (SPSS inc, Chicago, IL, USA). The normality of the data distribution was assessed by the Kolmogorov-Smirnov test. Descriptive data are presented as means and standard deviations for quantitative variables and as numbers and percentages for qualitative variables. In univariate analysis, comparison of normally distributed quantitative data used the Student t test. The $\chi 2$ test was used

for comparison of the numbers of qualitative variables. Multivariate analysis used logistic regression. A p value of less than 0.05 was considered statistically significant.

Results:-

Between January 1st and December 31st 2011, 1725 patients were admitted to the ER. 476 patients presented with CA, 104 of who were in astate ofapparentdeath on arrival. As they did not receive CPR, they were not included in the study. Of the remaining 372 patients, 168 arrived during the first period, including 9 excluded for insufficient or incomplete data. 198 patients arrived during the second period, 15 of whom were excluded for missing data. In total, 159 patients were included in the "Before Training" group and 183 in the "After Training" group. (Figure 1)

The mean age of patients was 48 ± 13.5 years. The total number of patients was 225 men (65.8%) and 117 women (34.2%), i.e., a sex ratio (M/F) of approximately 2:1.

The nature of the pathologies was medical in 234 patients (68.5%), surgical in 60 patients (17.5%) and traumatic in 48 patients (14%). 186 patients (54.5%) came from their home or the public road, 72 (21%) were transferred from another department of the university hospital, and 84 (24.6%) were referred from another hospital. Cardiac arrest occurred within 1 hour of admission in 234 patients (68.4%).

There was no significant difference in age, gender or time to cardiac arrest between the 2 groups. However, it should be noted that traumatic pathology was significantly more frequent in the second group and that patients referred from other hospitals were also more numerous. (Table 1)

Regarding the main objective of the study, 36 out of 159 patients (22.6%) recovered circulatory activity after CPR during the first period, compared with 48 out of 183 (26.2%) during the second. Of these patients, 18 survived more than 48 hours (11.3%) and 6 were discharged home (3.8%) during the first period compared with 30 (16.4%) and 9 (4.9%) during the second period. In univariate analysis, the difference between the two groups regarding these criteria was not significant (Table 2).

In multivariate analysis and after adjustment for age, gender, pathology, origin and time of arrest, this difference was also not significant.

Finally, concerning the quality of CPR performance, and except for the delay in starting CPR declared null by all the interveners, there was a significant difference between the 2 groups on all the criteria retained (Table 3). Indeed, the frequency of chest compressions was 101±9 after training compared with 81±16 before training. 171 physicians (93.4%) gave priority to chest compressions after training compared to 107 (67.7%) before training. The frequency of insufflations was 19±4/min after training versus 28±7/min before training. Finally, 129 physicians (70.5%) used a defibrillation intensity of 200 J during the second period versus 51 (32.1%) during the first period.

Discussion:-

A- Benefits of properly performed CPR:

It is currently accepted that CPR performed according to international guidelines improves survival in cardiac arrest.

For example, the study by Feneley et al. [20] compared 2 groups of 13 dogs in which ventricular fibrillation was induced and who received chest compressions at a rate of 60 or 120/min. The success rate of defibrillation (2 versus 13%, $p<0.002$) and 24-hour survival (2 versus 8%, $p<0.03$) were significantly higher in the 2nd group.

The study by Van Hoeyweghen et al [21] evaluated the impact of the quality of CPR performed by the 1st bystander on the survival of 3306 out-of-hospital cardiac arrests. Patients who had CPR judged ~~as~~ "correct" had a significantly higher long-term survival than those whose CPR was judged ~~as~~ "incorrect" (12% versus 4%).

In the work of Ko et al. [22] which studied 52 pre-hospital cardiac arrests managed by trained professionals, 15 patients (29%) had received CPR judged "adequate" and 37 (71%) "inadequate". The survival rate was significantly higher in the first group, 53% versus 8%.

Finally, a study based on the Swedish cardiac arrest registry of 29711 patients found a survival rate of 10.8% when the initial CPR was performed by a professional, 6.2% when it was performed by a bystander and 3.1% when it was not [23].

In our study, we did not find a significant improvement in survival after physician training (4.9% versus 3.8%, p=0.404), despite an objective improvement in the quality of CPR performance. In addition to the inherent limitations of the methodology adopted, this lack of significant difference may be explained by the multitude of factors involved in cardiac arrest mortality. Improving the skills of practitioners is a necessary but not sufficient condition for improving patient survival.

B- In-hospital CA survival rate:
Successful CPR, from the rescuer's viewpoint, corresponds to the recovery of a circulatory activity. However, it must be remembered that the ultimate goal is patient survival. CPR is therefore only onebundlein the chain of survival.

In the literature, the indicators of success are stable and much higher than in our study. Indeed, the rate of recovery of circulatory activity after CPR is around 40% and survival at hospital discharge varies between 15 and 25%. A summary of the studies dealing with this subject is shown in Table 4.

With a RCA rate of 22.6% and a HDS rate of 3.8%, the results of our study are much lower than those reported in the literature. This can be explained by many factors.

1- Human factor:
First of all, the responders in the ER are interns who have received basic medical training including a single 20-hour resuscitation module. In France, for example, only hospital practitioners with a diploma in emergency medicine or resuscitation are authorized to provide on-call services in the emergency room [31]. The implementation of ECTC at the national level started a few years ago [19], but the lack of human resources means that to date, no official training has been given to doctors in the emergency departments of teaching hospitals.

The concept of ~~the~~ in-hospital chain of survival (IHCS) in France [31,32] and of the "Medical Emergency Team" (MET) [33] in Anglo-Saxon hospitals, has become an essential strategy. It is based on the idea of adding to the on-call teams on site a rapid intervention team specialized in the management of vital emergencies.Thiscouldrepresenta support to Moroccan emergency services. The effectiveness of this type of organization has been reported in numerous studies [34-35] such as that of Konrad et al. over a period of 7 years [33]. The implementation of a MET significantly reduced the rate of in-hospital cardiac arrest (1.12 to 0.83/1000, OR 0.74, 95%IC 0.55-0.98, p=0.035) and in-hospital mortality by 10% OR 0.90 (95% IC: 0.84-0.97, p=0.003).

2- Organizational Aspects:
Other organizational aspects that may explain the lack of reduction in CA mortality in our study are:

- Equipment, protocols, and referrals:
The equipment of the ER, including the contents of the emergency cart, its location and conditions of access, must be clearly defined by pre-established protocols [32,36]. Protocols for the standardized management of CA should be validated and updated at the institutional level in accordance with international guidelines and made available to physicians. The whole process should be managed by a specific committee. In the university hospital where our study was conducted, such a committee does not exist and there is no standardization of protocols or equipment.

- Management of CA downstream of the ER:
An essential link in the survival of recovered CA is subsequent management in the intensive care unit. The lack of beds at resuscitation and intensive care units and the lack of supervision by seniors are problems that concern all vital emergencies in our hospital. These problems place a heavy burden on CA mortality.

- Patient flow:
In our study, the ER of the university hospital is the only one that remains open 24 hours a day in the Rabat Salé region and suffers from a chronic lack of available beds. This leads to stagnation of patients with a number of

hospitalized patients permanently exceeding the hospital's bed capacity and a duration of hospitalization often exceeding several days in the ER.

In the study by Smith et al. [28] the prognosis of patients with CA was much better in the cardiology department where all patients were adequately hospitalized and monitored (RCA = 52.2%, HDS = 41.3%) than in the medicine department where patients were not monitored (RCA = 24.9%, HDS = 8.8%).

C- Benefits and limitations of short training courses:
In the prospective study by Abella et al. [37] carried out at the University Hospital of Chicago, which assessed the quality of in-hospital CPR, the frequency of chest compressions was insufficient in 28.1% of cases and the frequency of pulmonary insufflations was excessive in 60.9% of cases. As a result of these findings, the authors recommended regular follow-up and skill maintenance for the physicians involved. Other studies have shown that following guidelines was far from being the norm [38]. In the work of Buist et al., human error was identified as an independent factor of mortality in CA [39].

1- Value of short training courses:
One possible solution is the implementation and development of ECTCs. In the work of Dane et al. [4], "Advanced Cardiac Life Support (ACLS)" training had a positive impact on survival in CA. Other studies have shown that staff training in defibrillator use significantly decreased CA mortality [40].

In our study, the quality criteria for CPR were significantly improved by the training of responders. The rate of prioritizing chest compressions over tracheal intubation was improved from 67.7% to 93.4% ($p<0.05$). Explaining the importance of chest compressions and the priority of ventilation over intubation improved clinical practice. Insufficient frequency of chest compressions is one of the most common errors found in the literature [38]. In our study, explanation of the importance of proper frequency and the use of a metronome for practical training increased the frequency of compressions from 81 ± 16 bpm to 101 ± 9 bpm ($p<0.05$).

Hyperventilation is also a classic error described in the literature [41]. In our study, training decreased the frequency of insufflations from 28±7 to 19±4/min ($p<0.05$).

2- Limitations of short training courses:
The main interest of short training courses such as AFGSU or BLS/ACLS is to rapidly train a large number of people. Their main limitation is the deterioration of the acquired knowledge over time. Indeed, many studies describe the decline in competence of practitioners after varying periods of time and pleads for the repetition of the training at regular intervals [42,43]. In the work of Eisenberg et al. [44], 50% of learners were unable to perform CPR correctly 4 months after training. After 6 months, only 7% could perform it effectively.

Another problem that may limit the impact of these courses is their performance on mannequins. Indeed, daily practice before a patient with a real risk of death cannot be entirely reproduced on computerized mannequins [45].

Thus, short training courses are certainly part of the solution to the excess mortality in CA, but they cannot compensate for the absence of quality medical training in emergency medicine and a global strategy for the management of life-threatening emergencies.

D- Limitations of this study:
The conclusions drawn from this work must be nuanced by a certain number of biases.

First of all, the choice of a questionnaire as a data collection method necessarily introduces a risk of error linked to the absence of an objective evaluation. In the emergency context, it was sometimes impossible to complete the questionnaire immediately. Collecting data retrospectively could lead to difficulties in finding the intervener and to the risk of losing information. Some studies have been able to avoid this problem by using recordings made by dedicated devices, measuring for example the frequency of compressions and insufflations [37].

It should also be noted that there were significant differences between the 2 groups and in particular more traumatic pathologies and patients referred from other hospitals in the 2nd group. These differences were related to the time

period when the study was conducted: the "After training" period occurred during summer time when traumatic pathologies are more frequent.

In Conclusion:-

The mortality of in-hospital CA is multifactorial. The lack of training of university hospital interns in the management of CA is one of the factors contributing to the excess mortality found in this study compared to the literature.

This work shows that the introduction of short training courses such as AFGSU or BLS/ACLS improves the quality of CPR. The lack of impact on the improvement of patient survival seems to be related to numerous shortcomings, in particular basic medical training in emergency medicine, organization and protocolization of care, equipment of emergency rooms, supervision of emergency clerkship and the existence of a CA national registry. These are all areas to be developed in order to improve the prognosis of CA in our hospital structure.

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Figures Legends:

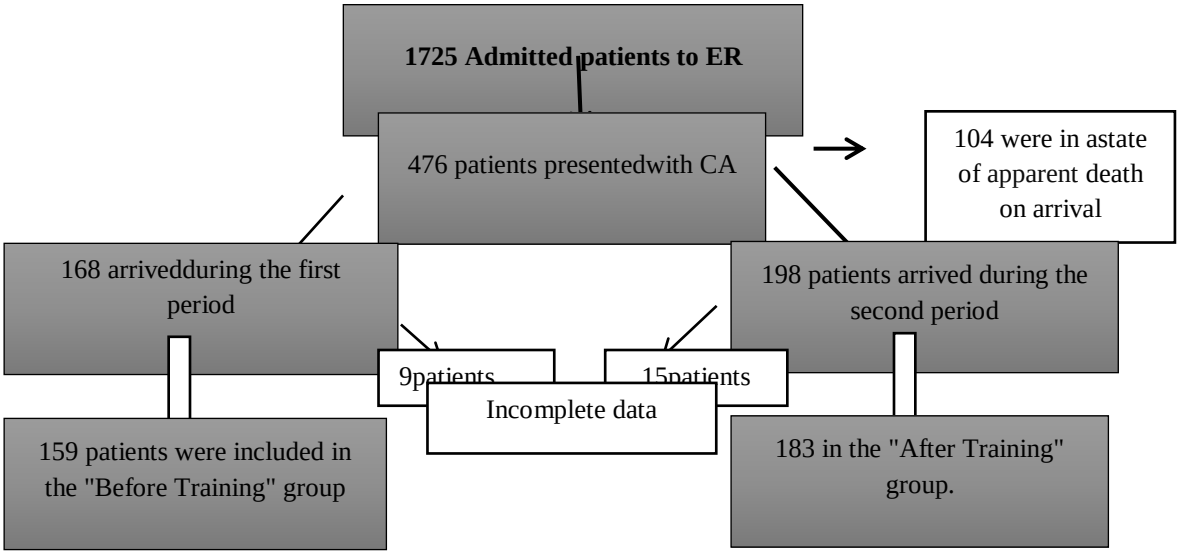

Table 1:- Characteristics of the 2 groups.

	1st period (n=159)	2nd period (n=183)	P
Age	49,5 ± 13,3	46,8 ± 13,6	0,069
Gender			
Male	105(46,7%)	120(53,3%)	0,928
Female	54(46,2%)	63(53,8%)	
Pathology			
Medical	123(77,4%)	111(60,7%)	
Surgical	21(13,2%)	39(21,3%)	**0,004**
Traumatic	15(9,4%)	33(18%)	
Origin			
Home/ public highway	90(56,6%)	96(52,5%)	
Universityhospital	39(24,5%)	33(18%)	**0,052**
Anotherhospital	30(18,9%)	54(29,5%)	
Time to CA			

< 1h	114(71,7%)	120(65,6%)	
> 1h	45(28,3%)	63(34,4%)	0,245

Table 3:- Comparison of quality indicators of CPR performance between the 2 groups.

	1st period (n=159)	**2nd period (n=183)**	**p**
RCA	36(22,6%)	48(26,2%)	0,453
> 48hSurvival	18(11,3%)	30(16,4%)	0,212
HDS	6(3,8%)	9(4,9%)	0,404

Table 2:- Comparison of the survival indicators of the 2 groups.

	1st period (n=159)	**2nd period (n=183)**	**p**
Time to CPR	0	0	Na
Frequency of chest compressions	81±16	101±9	**<0,05**
Priority of compressions	107(67,7%)	171(93,4%)	**<0,05**
Frequency of insufflations	28±7	19±4	**<0,05**
Defibrillationintensity			
200 joules	51(32,1%)	129(70,5%)	
360 joules	69(43,4%)	30(16,4%)	**<0,05**
Unkonwn	39(24,5%)	24(13,1%)	

**Values are expressed as mean ± standard deviation or number (%)

Table 4:- Survival indicators for cardiac arrest in the literature.

Ref	**Year**	**n**	**RCA**	**HDS**
[24]	2000	390	-	21%
[25]	2000	1368	47,7%	17,6%
[26]	2003	14720	44%	17%
[27]	2006	36902	-	18%
[28]	2007	243	38,7%	21%
[29]	2011	517	-	26,9%
[30]	2012	64339	48,5%	15,4%

Conflict of interest:
The Authors declare that there is no conflict of interest.

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