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First-aid Training through Medical Simulation Technology: The Case of Small-Scale Fishers

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Introduction: Safety and human health conditions are precarious in small-scale fisheries notwithstanding are an important source of income and food for millions of people. First-aid training is vital for small-scale fishers because the high frequency of fatal and non-fatal injuries during fishing seasons, however, training it is extremely uncommon. *Objective:* The aim of this study was to implement and to evaluate a first-aid training course tailored for fishers' using High Fidelity Medical Simulation Technology (HDMST). *Methods:* First-aid capacities strategy for CPR, choking and recovering position using HDMST were built for 32 small-scale fishers from the Yucatan coast. Fishers' knowledge was evaluated before and after the training with rubrics and checklists along the maneuvers. *Results:* Participants' age was 38 (±10) years old and the maximum educational level was equivalent to a college education. All fishers learned to recognize and react adequately in emergency situations and also to provide effective initial first-aid (individual maneuver efficacy ranged 89-99%). However, elderly and lower educational level influenced the achievements of training goals. *Conclusion:* The implementation and evaluation of first-aid training course based on HFMST was a well-accepted and effective strategy that increased knowledge and competences for proving first-aid life support among fisher divers from Yucatan, Mexico.

Key Words: CPR, training, heimlich maneuver, resuscitation, fisheries

Introduction

The occupational mortality in some countries has decreased, but in the fisheries industry, the relative risk of fatal injuries is still high with over 24000 fatalities per year occurring worldwide (ILO, 1999). Among small-scale fishers' the fatal and non-fatal accidents remains high. (FAO, 2017) Although small-scale fisheries are an important source of income and food for millions of people, safety and health conditions are precarious (Moffitt & Cajas-Cano, 2014; Jensen, et al., 2015).

Human health profiles and quality of life are vastly related to occupation and work. Fishing is an occupational activity that has been perceived in various cultures and settings as highly-risky (Murray, 2007a; Marianne et al., 1999). In certain developing countries, such as Mexico, the formal registry of fishing related injuries and accidents may not always reflect the true morbidity, due to underreporting (Murray, 2007b; Huchim-Lara et al., 2016).

Even when accidents and injuries are common in fisheries, the lack of research on the predisposing factors and generation of competences to prevent, limit or reduce the odds for disability or fatalities is scarce for small scale fishers in developing countries. Training and prevention strategies could provide a safer work environment for fishers, while reducing compensation expenses (Murray, 2007a) (5).

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In the coast of Yucatan, Caribbean spiny lobster and sea cucumber are harvested through diving with surface-supply air. Diving causes disabilities and fatal injuries among small-scale fishers in the region (Méndez et al., 2017; Huchim-Lara et al. 2017). With identification of predisposing factors and prognostic markers for disability and severity of injuries, fishers' training in recognition of those factors is a promising, cost-effective way for improving health and safety conditions of fisher divers (Huchim-Lara et al. 2015; Chin et al. 2015).

In any dangerous occupation, the first-aid training is highly recommended (Lingard, 2002). Existing evidence showed that first-aid provided by a bystander seems to increase the odds of survival for patients (Buick et al., 2018), while previous first-aid training seems to improve the quality of first-aid provided. Additionally, it is noted that people with proper first-aid training increase their willingness to act and timely time reaction in case of an emergency (Oliver et al., 2013).

Medical simulation technology facilitates learning and evaluation and though, it is widely used to teach health professionals and occasionally used to train non-medical personnel to develop medical maneuvers (Linde & Kunkler, 2016). High-fidelity simulators consist of manikins' programmed to represent real diseases (in the way they occur in live patients), and to monitor and register the efficiency and efficacy of the trainees´ attention. The aim of this study was to implement and evaluate first-aid courses to train fishers, using High Fidelity Medical Simulation Technology to recreate emergency situations of fisher divers.

Research Methods

Study design

This quasi-experimental study took place at the *Montagne Medical Simulation Center* of the Marist University of Merida, in Yucatan, Mexico. In the Yucatan, surface air-supply diving as fishing method is used in two adjacent coastal communities: San Felipe and Rio Lagartos. Our sample therefore, consisted of local small-scale fishers from both coastal communities, who practiced fishing thru diving.

Participants

We estimated a minimum sample of 32 fishers to test our hypothesis (using paired t test for numerical variables and chi-square proportion tests with 95% confidence intervals and $p<0.05$) that fishers could develop capacities to provide first-aid training and learn to adequately respond to an emergency when trained with high-fidelity medical simulators.

Procedures for implementation of the first-aid courses for fishers.

After analyzing retrospective quantitative and qualitative data about the emergencies that small-scale fisher-divers of Yucatan faced during fishing seasons (8-12), our team developed the theoretical and practical content of the training course, including simulated situations in which the fishers needed to help and provide first-aid to the manikin that simulated their co-workers.

For first-aid training in specific maneuvers (choking, recovering position and cardio-pulmonary resuscitation) our team used the standardized training procedures of the American Heart Association that had been previously implemented in the University simulation center for training the health staff and medical students.

Training procedures.

The training courses included: a) Anatomic, physiologic and pathologic theoretical concepts, for the comprehension of basic mechanisms underlying the main emergencies that fishers may face, as well as, alarm signs and symptoms; b) Case-specific analysis and recommended standard procedures; c) Practical training in basic life-support first-aid procedures: i) choking, ii) recovering position and iii) cardio-pulmonary resuscitation (CPR).

Outcome Measurements

Pre and post intervention evaluations were designed to evaluate the intervention before and after the training journey, a) Theoretical knowledge was evaluated using a previously validated questionnaire in a 1-10 continuous scale, b) Case-based evaluation was used to measure the capacity to correctly identify alarm signs and respond to emergency situations, c) Practical skills for providing basic life support first-aid in choking, recovering position were measured using a 15-item checklist. To evaluate cardio-pulmonary resuscitation (CPR), a 12-item checklist was used along with the score provided by the devices located within the high-fidelity simulators (manikins), HDSMT provide dichotomous and quantitative scoring of the performance of every fisher, individually.

Data collection and analysis

An excel database was designed to include evaluation's, where each participant´s name was

coded and corresponded to a single row, and each evaluation item corresponded to one column. CPR evaluation from the simulators were downloaded from the manikin's software and included in the database as variables of compression timing, depth, hand position and ventilation flow rates. Descriptive statistics and hypothesis tests were developed using Stata 14.0©.

Ethics approval. The study was approved with the IRB number 000352.

Results

Between December 2016 and January 2017, a total of 32 fishers from two different coastal communities that use hookah diving as fishing method were trained. All participants were male, because females do not participate in this type of fishery in the region. The age of participants ranged from 20 to 60 years with a mean of 38 years old (±10.5). The time since they started to fish had a mean of 21 years (±10.8) and ranged between 3 and 45 years. The most common educational level was junior high (43.7%) followed by primary school (28.1%), high school (18.7%), while one fisher completed community college and two other had university degrees (a Public Accountant and a Biologist). Only one of the participants mentioned having previous theoretical training in CPR, while the other reported a lack of training in first-aid.

Pre and Post-course evaluation.

In the pre-course test the average score was 2.6(±1.9)/10 and range between 0 and 6, only 12% had at least 60% of right answers, while 21% had zero answers right. The participant with previous training had a score of 4/10. The question with higher proportion of right answers was about how to react if a person is unconscious, but still breathing. The question with the fewer right answers about the signs of choking (Table 1).

Table 1. Questions included in the pre and post-course test and its corresponding percentage of right answers.

Question	Pre-test (%)	Post-test (%)	t-test *p*
What maneuver do you perform in an unconsciousness but breathing person?	37.5	84.3	0.0001
Which are the steps to perform CPR?	21.8	93.7	0.0000
To which people should we apply the CPR?	25.0	71.8	0.0001
How fast do we have to act in a no heart pulse and breathless person to avoid brain damage?	28.1	62.5	0.0052
What maneuver should you do with a person with airway obstruction?	21.8	71.8	0.0007
Overall			

In the post-course test, the average score was 7.6(±2.2) and the range between 2 and 10. The 90.6% of participants correctly responded to more than 60% of the questions and 34% responded correctly to all questions. The question with the 93.7% of right answers was the one regarding the steps to correctly provide CPR; and the questions with the less right answers was about the time to react to avoid brain damage.

The statistical analysis showed an increase in the first-aid knowledge among fishers' when the pre-course and post-course test score were compared [t (31) = -9.5, $p<0.05$].

By age group, the average score in both pre-course and post-course test decreased as the age increased. The age group between 20-29 years old had an average score of 3.2(±1.8) in the pre-course and 8 (±2.61) in the post-course test, among fishers >50 years old the average was 1.3 and 6, respectively (Table 2).

Table 2. Pre and Post test score by age group and educational level. (N=32)

	Age group				Educational level				
	20-29	30-39	40-49	>50	Primary	Elementary	High School	Community College	University
n %	25	31	34	10	28	44	19	3	6
Pre-test	3.2±1.8	2.8±1.9	2.5±2.2	1.3±1.1	1.5±1.6	3.2±2	2.3±1.9	4±0	4±0
Pos-test	8±2.6	8±2.9	7.6±1.2	6±0.0	7.1±1.4	7.2±2.7	8.3±1.5	10±0	10±0
t-test	0.001	0.000	0.000	0.019	0.0002	0.0001	0.0004	-	-

Regarding the educational level, in the pre-course test, the average score went from 1.5 among participants with primary education to 4 among those with university degree. In the case of the post-course test went from 7.1 for those with basic education to 10 in those the highest educational level. There was a significant difference between the scores of those with basic education and those with higher levels of education ($t=2.005$, $p<0.05$).

Manikin skill meter and checklist evaluation

All the participants had a successful performance setting up the manikin in the recovering position and applying the Heimlich maneuver to the different types of manikins (Table 3).

Table 3. Heimlich maneuver and recovering position checklist with percentage of accomplishment.

item	Heimlich maneuver	%	Recovering position	%
1	Stand behind the patient	100	Call patient and shake softly	100
2	Wrap arms around patient's waist	100	Call emergency number	94
3	Make a fist with one hand	100	Check patients breathing	94
4	Place fist above the navel but below the xiphoid	84	Kneel next to the person. Extend the nearest arm	100
5	Grasp fist with other hand	100	Position the arm with the back of the hand against the near cheek	100
6	Press fist into abdomen	100	Grab and bend the far knee	97
7	Repeat until the patient expels foreign body	100	Roll the person toward you, pulling the far knee over and to the ground.	100
8	Obese patient will be lying on the ground	100		

Regarding the CPR checklist, participant's range of accomplishment of each of the items was from 84% to 100% (Table 4). In average, 10.9 items (±1.7) out of 12 were completed. The 63% of the participants performed the 12 items during the simulation training, 15% achieve 10 items, 9% 8 items, 6% 11 items, and 3% with 9 and 5 items achieved. Lower scores were observed in older fishers.

Table 4. Percentage of accomplishment of the 12 items included in the CPR checklist.

Item	Indicator	Satisfactory (%)
1	Check responsiveness	97
2	Call for help	84
3	Check if the patient´s is breathing	94
4	Check pulse	94
5	Correct hands placement during compressions	87
6	Compressions rate of 100 to 120/min	94
7	Deliver 30 compressions counting out loud	84
8	Provides 2 breaths by using a mask	97
9	Properly seal the mask (opening airway adequately)	81
10	Check chest lift with breaths	97
11	Provide 5 cycles (30 compressions /2 breaths)	100
12	Check if patient recover breath	84

In the case of the CPR manikin, the skill meter registered an average of 84% (±21.33%) of efficacy in the compression depth and timing and ranged between 21 and 100%; once again the subject with the lowest score in compressions had the lower achievement points and the lowest score in ventilation (Figure 1). The efficacy in ventilation had in average 60% of achievement (±16.9%) and ranged between 31 to 96%. The main issues regarding the compressions were the depth of compressions and the localization of the hands fishers over the manikin chest. In the case of ventilation, the most common mistake was not sealing of the mask over the manikin face to ensure ventilation.

Figure 1. Fisher providing CPR to a manikin.

Discussion

In the 1980's, Goldberg et al., (1984) state the need of CPR training among family members of patients with coronary heart disease. Twenty years later, Herlitz et al., (2005) recommended the strategy to extend the CPR training for lay people as much as possible since having a skilled bystander in cardiac arrest event increase by two-fold the chances of survival (Todd et al., 1998). Also, having trained people in workplaces with a high risk of accidents could increase the awareness and prevention health promotion. (Lingard, 2002) With first-aid training, fishers gained self-efficacy to react in an emergency, prevent accidents from becoming fatal and increase the chances of survival of co-workers during the fishing journeys. As Herlitz et al. describe, the skills learned by flay-people can be useful in their working environment, but also in a social and family context, especially when the nearest hospital is located 50 miles away from the participants' communities (Goldberg et al., 1984; Herlitz et al., 2005).

The course design is relevant for building competences; the addition of video instructions in the CPR training has resulted in a higher performance of trainees when compared to traditional training. (Lingard, 2002; Todd et al., 1998) The feedback prompt devices during the training allow improving the skills acquisition of trainees. Brennan et al. (1996) first mentioned the importance of the evaluation of the chest compressions and ventilation quality with an instrumented manikin. In our present study we were able to document the good performance of fisher after training in each maneuver, including the chest compressions.

Barriers to properly perform CPR, as the participants' age, has been described in a study about factors predicting performance in life support maneuvers (Brennan et al., 1996), ideally, for that reason, we consider that first-aid training should be provided as early as possible and repeated periodically to keep the competences and knowledge in the fishers´ minds.

Swor et al. (2006) found that in a cardiac arrest the CPR-trained bystanders with an education higher than high-school were more willing to perform CPR. Clark (2008) described that people older than 40 usually do not engage in CPR training, but the educational level

is a facilitator to participate in CPR training (Brenna et al., 1996; Vaillancourt et al., 2008; Swor et al., 2006). As it was described in the results section, fishers with higher educational level had higher knowledge scores than those with only primary education, but when it came to practical competences, the difference did not prevail.

Medical simulators have been extensively used in health education because the benefits provided in terms of patients' safety, health care outcomes, cost-effectiveness, and complex learning (Scalese et al., 2008; Linde & Kunkler, 2016), what we found in the present study is that those benefits are not exclusive for university students or health professionals, but they are also useful for training fishers to potentially save lives and reduce disabilities.

Training personnel in first-aid should be also followed by safety procedures and equipment inspection in the workplace, given the precarious conditions at work is associated to injuries among employees (Varanen et al., 1979).

Conclusions

The implementation and evaluation of first-aid training course based on HFMST was a well-accepted and effective strategy that increased knowledge and competences for proving first-aid life support among fisher divers from Yucatan, Mexico.

Limitations and implications

The main limitations of our study rely on the reduced sample size and the lack of a long term follow up to elucidate the competences developed by fishermen would persist thru time. We also acknowledge that cannot know if under an emergency, the trained fishers would really provide first-aid. Nevertheless, the training courses will now be provided at our simulation center periodically, so we will be able to continuously evaluate our interventions and improve our training strategies and reevaluate longitudinally the fishers who were trained.

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