

Cardiopulmonary resuscitation program for secondary schools (PROCES): conclusions after 5 years

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Objective: To describe 5 years of experience providing training in basic cardiopulmonary resuscitation (CPR) for students in Spanish obligatory secondary school education, including the percentage of satisfactory learning immediately after training and 1 year later; and to analyze factors associated with satisfactory learning.

Methods: The trainers applied the CPR program developed for secondary schools (PROCES). All students who took the course from 2002 through 2007 were included. Learning was assessed with a test containing 10 items on theory and 10 on practice; the test was administered immediately before and after the course and again a year later. We also studied the influence of independent variables related to school (public vs private, neighborhood per capita income), course (the grade when the CPR course was taken by a student, instructors giving the practical classes), and student (age, gender, intention to study a health science, courses failed in previous years, and whether a life-saving course had ever been taken).

Results: A total of 1501 students took the PROCES course over 5 academic years. The test was taken immediately before and after the course by 1128 students; it was taken again a year later by 428 students. Fifty-eight percent had satisfactory test scores immediately after the course; 42% had satisfactory scores a year later. Multivariate analysis showed that private schools, those in neighborhoods with a low per capita income, those in which the PROCES course was given entirely by instructors belonging to the school, and not carrying failed subjects from previous years were the independent variables associated with better performance just after the course. However, only the last 2 factors were significantly related to maintenance of learning.

Conclusion: The PROCES course in the hands of specialists in urgency and emergency medicine is an excellent tool for creating a broader base of CPR knowledge among secondary school students. Maintaining and extending the program over the coming years, as well as integrating it into the school curriculum, are matters that require clear commitment from the relevant public administrations. [Emergencias 2008;20:229-236]

Key words: Cardiopulmonary resuscitation. Students. Teaching. Schools.

Introduction

Sudden death is the situation of maximum medical emergency which all emergency medicine physicians encounter relatively frequently regardless of whether this is developed during their activity in the extrahospital setting or within the hospital¹⁻⁶. It has therefore been calculated that more than 25,000 deaths are produced annually in Spain only by myocardial infarction before the

patient can receive medical care⁷. Many of these deaths take place in public in the presence of other persons. This indicates that, theoretically, many of these patients could recover if basic cardiopulmonary resuscitation manoeuvres (CPR), which are relatively easy to provide with minimum training, are performed. Despite this, in less than 25% of the cardiac arrests observed in public are CPR manoeuvres implemented⁸. We should, therefore, assume that the population is poorly prepared to

apply these manoeuvres and that efforts aimed at increasing the knowledge of such manoeuvres are urgently required among the general public.

Numerous institutions and international medical societies have recommended that teaching of basic CPR be introduced during obligatory education since schools constitute an ideal setting to initiate the population in the knowledge and learning of the basic techniques which make up CPR. Norway was one of the first countries to promote the teaching of basic CPR to schoolchildren during the 1960s⁹. Later, prestigious medical societies such as the American Heart Association (AHA) or the European Resuscitation Council (ERC) have decidedly recommended that CPR skills should be taught in schools. The current framework of Catalonian education, which has the possibility of incorporating programmes adapted to the needs and preoccupations of students in Secondary Obligatory School (ESO), provides a unique opportunity to implement the previously mentioned recommendations. In this setting, the Cardiopulmonary Resuscitation Program for Secondary School Centres (PROCES) was initiated in 2002 with the aim of diffusing knowledge of basic CPR to the population through its teaching in schools, demonstrating its feasibility and sensitising the administrations as to the need to generalise this programme. PROCES was especially designed to be incorporated into the curricular material for children from 14 to 16 years of age in their educational centres making the identification of pedagogical aspects key to the success of the programme. The present study analyses the experience acquired during the first 5 years of the implementation of the programme.

Methods

The formal structure of PROCES has been described in depth in a preliminary study¹⁰. PROCES was developed in six 45-minute sessions, 3 of which are devoted to the theoretical bases of CPR and 3 to the explanation and practice of the manoeuvres themselves in addition to a seventh knowledge recap and consolidation session. The practical classes have a student:instructor relationship of 1:12 and manikin/student of 1:6. The minimum time of CPR per student is 15 minutes and the session is considered to be over when more than 90% of the students achieve an adequate CPR sequence and their manoeuvres are correct according to the system of automatic detection of the manikin and by the observation of the health-

care personnel. The theoretical classes are always given by teachers of the centre. In some groups the practical classes are provided by emergency healthcare personnel while in other groups these are given by the teachers themselves. In the latter case, these teachers have received a 6-six hour instructor's course on basic CPR following the methodology of the AHA.

From 2002 to 2007 PROCES was carried out in 20 ESO centres in the city of Barcelona free of charge. The capacity of annual training was limited to a maximum of 400 students and the participating schools entered in the project by order of application.

The principal dependent variable was considered to be the percentage of students with satisfactory learning at the end of the programme. This was evaluated with a 20-question multiple choice (one correct answer out of a possible four) test (10 questions on notions of physiopathology taught in the theoretical sessions and 10 referring to the practice of basic CPR shown in the theoretical-practical sessions) prior to and after having received PROCES assessing the progression in theoretical and practical knowledge¹⁰. Learning was considered satisfactory if at least 8 out of the 10 questions referring to the practice of CPR were answered correctly after having undergone PROCES. A secondary dependent variable was considered the persistence of satisfactory learning one year after having done PROCES. To evaluate the persistence of satisfactory learning the students were given a third 20-questions multiple choice test (without warning) using the same definition (at least 8 out of 10 questions correctly answered in the practical section) as the main dependent variable.

Dichotomous variables related to the centre, the course and the student were considered independent variables. The variables related to the centre were the type of school (public/private) and the income per capita of the neighbourhood in which the school was located (above the mean of the city/below the mean of the city). The variables related to the course were the type of teachers which gave the practical classes (school teachers/emergency healthcare personnel) and the course in which it was carried out (3rd ESO/4th ESO). Finally, the variables related to the students were age (less than or equal to 15 years/greater than 15 years), the sex (male/female), the interest in studying a career in healthcare sciences (yes/no), the presence of subjects failed in previous years (yes/no), and having taken previous first aid courses (yes/no). The income per capita in the different districts of the city of

Barcelona corresponded to 2005 and was obtained from the data of the Department of Statistics of the City Council of Barcelona¹¹.

The results are presented in percentages and means \pm standard deviation. The chi square test was used for comparisons of qualitative variables or the Fisher exact test was used for effectives less than 5. The odds ratio (OR) was calculated with its confidence interval of 95% (CI 95%). A logistic regression multivariate analysis was performed introducing the variables which were significant in the univariate analysis in the model. Statistical significance was considered with p values less than 0.05 or when the CI 95% of the OR excluded the value of 1.

Results

A total of 1,501 students were included in PROCES during the 5 years of study, with the annual distribution being shown in Figure 1. The students were from 15 different educational centres, 6 public and 9 private. Seven of the centres were located in neighbourhoods with a per capita income above the mean of the city and 8 were below this mean. The characteristics of these students are presented in Table 1.

The results of the first (prior to undertaking PROCES) and the second test (immediately after taking PROCES) in 1,128 students (62.2% of the participants) were available. No significant differences were observed in any of the characteristics of the centre, the course or the students in this subgroup which answered compared to the characteristics of the total of 1,501 students (data not presented). Of these 1,128 students, the third test answered one year after undertaking the PROCES was available from 428 (37.8%) students. The evolution of these scores is shown in Figure 2. Of the scores obtained, it was concluded that 58.1% of the students achieved satisfactory learning immediately after having taken PROCES and 41.6% maintained this knowledge one year after having concluded the programme.

On analysing the factors related to having achieved better learning, it was observed that immediate satisfactory learning was associated with private centres, their location in low income per capita, PROCES being completely given by teachers from the centre, student age less than 15 years, female sex, and with having failed subjects in the previous year (Table 2). The multivariate study demonstrated that all these previously mentioned variables except for age and sex were sta-

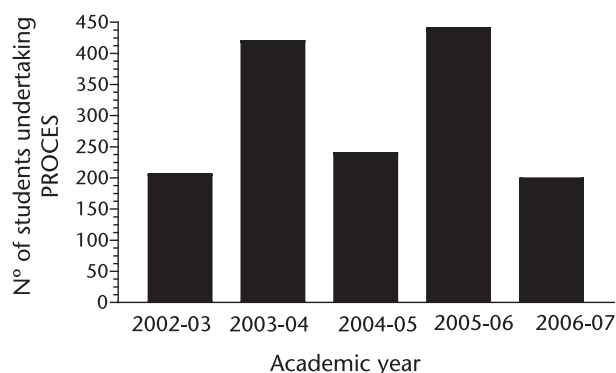


Figure 1. Number of students included in each academic course.

tistically significant independent predictors of satisfactory learning.

On analysing the factors related to the persistence of knowledge one year after having taken PROCES, univariate analysis showed that this was associated with practically the same variables as immediate satisfactory learning (Table 3). Multivariate analysis, however, showed an independ-

Table 1. Characteristics of the 1,501 students who took PROCES during the 5-year study period

| Characteristics of the centre | N (%) |
|---|--------------|
| Type of school | |
| Public | 984 (66) |
| Private | 517 (34) |
| Income per capita of the neighbourhood of the centre | |
| Below the mean of the city of Barcelona | 877 (58) |
| Above the mean of the city of Barcelona | 624 (42) |
| Characteristics of the course | N (%) |
| Course in which PROCES was performed | |
| 3 rd ESO | 1337 (89) |
| 4 th ESO | 164 (11) |
| Type of instructor for the practical part of PROCES | |
| Secondary school teacher | 433 (29) |
| Emergency service and emergency medicine personnel | 1068 (71) |
| Characteristics of the student | N (%) |
| Age | |
| Less than 15 years | 714 (47) |
| Greater than or equal to 15 years | 717 (48) |
| Do not know | 70 (5) |
| Sex | |
| Male | 770 (51) |
| Female | 698 (47) |
| Do not know | 33 (2) |
| Had taken previous first aid courses | |
| Yes | 89 (6) |
| No | 848 (56) |
| Do not know | 564 (38) |
| Subjects pending from previous courses | |
| Yes | 515 (34) |
| No | 470 (30) |
| Do not know | 516 (34) |
| Intention to study healthcare sciences | |
| Yes | 163 (11) |
| No | 821 (55) |
| Do not know | 517 (34) |

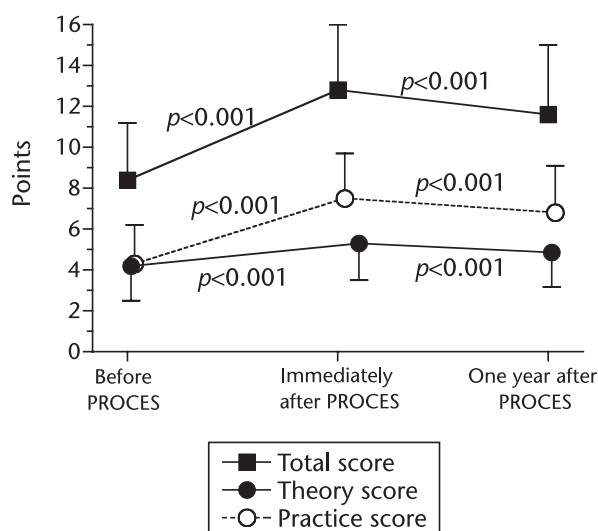


Figure 2. Scores obtained in each of the three tests (before, immediately after and one year after taking PROCES) undertaken by the students.

ent, positive and significant association with learning persistence only when PROCES was completely developed by teachers of secondary schools (both the theory and practical work) and when the students did not have subjects pending from previous years.

Discussion

The present study reports the experience in teaching basic CPR to ESO students carried out over 5 consecutive years by emergency care and emergency medicine physicians. The tool used to develop this study was PROCES, a programme based on AHA principles but which is specifically designed for students of ESO in Catalonia. The results demonstrate two important facts. The first was high rates of satisfactory learning after receiving the course of 58% which were significantly associated with belonging to private centres, the centre being located in low income per capita neighbourhoods, PROCES having been completely performed by teachers of the secondary centres and the student not having subjects pending from previous years. The second fact was the persistence of knowledge one year after having taken PROCES of a not irrelevant 42%, despite a decrease in the percentage of students maintaining satisfactory learning. This percentage is independently related only to PROCES having been completely developed by the teachers of the secondary centres and to the student not having subjects pending from the previous year.

Table 2. Factors associated with immediate satisfactory learning after PROCES

| Variable | Students with satisfactory learning N (%) | Students without satisfactory learning N (%) | OR (CI 95%) univariate | p | OR (CI 95%) multivariate | p |
|---|--|---|---------------------------|---------|-----------------------------|---------|
| Type of school | | | | | | |
| Public | 411 (56) | 321 (44) | 1 (reference) | 0.01 | 1 (reference) | 0.001 |
| Private | 244 (63) | 143 (37) | 1.37 (1.06 a 1.70) | | 1.80 (1.28 a 2.53) | |
| Income per capita of the neighbourhood of the centre | | | | | | |
| Above mean of Barcelona | 225 (50) | 228 (50) | 1 (reference) | < 0.001 | 1 (reference) | < 0.01 |
| Below mean of Barcelona | 430 (64) | 245 (36) | 1.78 (1.40 a 2.27) | | 1.53 (1.12 a 2.11) | |
| Course in which PROCES taken | | | | | | |
| 3 rd ESO | 567 (58) | 405 (42) | 1 (reference) | 0.64 | – | – |
| 4 th ESO | 88 (60) | 59 (40) | 1.09 (0.76 a 1.5) | | | |
| Type of instructor for the practical part of PROCES | | | | | | |
| Emergency service and emergency medicine personnel | 436 (56) | 346 (44) | 1 (reference) | < 0.01 | 1 (reference) | < 0.001 |
| Secondary school teacher | 219 (65) | 118 (35) | 1.47 (1.13 a 1.92) | | 2.28 (1.52 a 3.41) | |
| Age | | | | | | |
| Less than 15 years | 371 (64) | 211 (36) | 1 (reference) | < 0.01 | 1 (reference) | 0.88 |
| Greater than or equal to 15 years | 264 (55) | 219 (45) | 0.70 (0.54 a 0.89) | | 0.98 (0.71 a 1.35) | |
| Sex | | | | | | |
| Male | 314 (55) | 259 (45) | 1 (reference) | < 0.01 | 1 (reference) | 0.19 |
| Female | 322 (64) | 188 (36) | 1.43 (1.12 a 1.82) | | 1.23 (0.90 a 1.67) | |
| Previous first aid courses | | | | | | |
| No | 445 (64) | 252 (36) | 1 (reference) | 0.43 | – | – |
| Yes | 41 (59) | 29 (41) | 0.82 (0.50 a 1.35) | | | |
| Previous subjects pending | | | | | | |
| No | 287 (72) | 111 (28) | 1 (reference) | < 0.001 | 1 (reference) | < 0.001 |
| Yes | 225 (55) | 184 (45) | 0.46 (0.35 a 0.62) | | 0.43 (0.31 a 0.59) | |
| Intention to study healthcare sciences | | | | | | |
| No | 419 (62) | 252 (38) | 1 (reference) | 0.35 | – | – |
| Yes | 88 (66) | 45 (34) | 1.20 (0.81 a 1.78) | | | |

Table 3. Factors associated with the persistence of satisfactory learning one year after having done PROCES

| Variable | Students with satisfactory learning N (%) | Students without satisfactory learning N (%) | OR (CI 95%) univariate | p | OR (CI 95%) multivariate | p |
|--|--|---|---------------------------|---------|-----------------------------|--------|
| Type of school | | | | | | |
| Public | 62 (33) | 126 (67) | 1 (reference) | 0.001 | 1 (reference) | 0.15 |
| Private | 116 (48) | 124 (52) | 1.90 (1.28 a 2.82) | | 1.64 (0.84 a 3.20) | |
| Income per capita of the neighbourhood | | | | | | |
| Above mean of Barcelona | 78 (45) | 96 (55) | 1 (reference) | 0.26 | – | – |
| Below mean of Barcelona | 100 (39) | 154 (61) | 0.80 (0.54 a 1.18) | | | |
| Course in which PROCES was taken | | | | | | |
| 3 rd ESO | 174 (42) | 242 (58) | 1 (reference) | 0.56 | – | – |
| 4 th ESO | 4 (33) | 8 (67) | 0.69 (0.21 a 2.47) | | | |
| Type of instructor for practical of PROCES | | | | | | |
| Emergency service and emergency medicine personnel | 114 (36) | 202 (64) | 1 (reference) | < 0.001 | 1 (reference) | < 0.01 |
| Secondary school teacher | 64 (57) | 48 (43) | 2.36 (1.52 a 3.66) | | 3.08 (1.46 a 6.50) | |
| Age | | | | | | |
| Less than 15 years | 92 (50) | 90 (50) | 1 (reference) | < 0.01 | 1 (reference) | 0.84 |
| Greater than or equal to 15 years | 54 (36) | 148 (64) | 0.55 (0.37 a 0.82) | | 0.93 (0.48 a 1.82) | |
| Sex | | | | | | |
| Male | 72 (34) | 142 (66) | 1 (reference) | 0.001 | 1 (reference) | 0.11 |
| Female | 105 (50) | 105 (50) | 1.97 (1.33 a 2.92) | | 1.59 (0.90 a 2.81) | |
| Previous first aid courses | | | | | | |
| No | 100 (52) | 91 (48) | 1 (reference) | 0.997 | – | – |
| Yes | 13 (52) | 12 (48) | 1.01 (0.44 a 2.34) | | | |
| Previous subjects pending | | | | | | |
| No | 78 (56) | 60 (44) | 1 (reference) | 0.01 | 1 (reference) | < 0.01 |
| Yes | 36 (40) | 54 (60) | 0.51 (0.30 a 0.80) | | 0.40 (0.21 a 0.74) | |
| Intention to study healthcare sciences | | | | | | |
| No | 102 (49) | 104 (51) | 1 (reference) | 0.78 | – | – |
| Yes | 15 (47) | 17 (53) | 0.90 (0.43 a 1.90) | | | |

If it is taken into account that PROCES was generally applied to all the alumni of the participating centre, with no distinction based on predisposition, expectancies, physical or intellectual capacity, the 58% of learning achieved after concluding the programme should be considered as satisfactory. Training courses for laypersons carried out in other settings and countries have achieved percentages of success of between 40% to 77%^{12,13}. Certain improvements in PROCES aimed at increasing the success in the centres or among students who have demonstrated a significantly inferior performance may be possible, allowing an increase in the final percentage of students who acquire the knowledge. Thus, the last years have shown a growth in investigative activity aimed at finding the best methodology to introduce the teaching of basic CPR in the curricula of obligatory education¹⁴⁻¹⁹.

The persistence of the knowledge of basic CPR is another central issue of the societies involved in its diffusion²⁰⁻²². It has been shown that the retention of knowledge and skills for its application rapidly descends, making recap and consolidation courses necessary. In the case of PROCES, the reduction from 58% to 42% in students with satisfactory learning one year after having taken the course means that the knowledge has been main-

tained in 72% of the students. In similar studies, the persistence of knowledge has been very variable and thus, while in some an important loss in knowledge has been observed after 6 months²³, in others a significant persistence has been observed even 17 months after having received the course²⁴. A more prolonged follow up of the PROCES participants is necessary, although the percentage will probably have descended sufficiently after 2 years to justify, also with this specific programme, the need for a refresher course. Nonetheless, this adds another degree of difficulty at the time of achieving the objective of universal knowledge of basic CPR since the scarce resources provided by the administration should not only be destined to the teaching of CPR in the basic population but should also be used to maintain this knowledge. Regardless of the investigation undertaken in search of the best pedagogic, educational and logistic strategy, without a decided proposal from the administration, this objective will not be achievable in either the mid- or long-term²⁵.

Our experience in the distribution of basic CPR through PROCES has shown that schools in general and particularly secondary school students are the target population. This is true not only in regard to the global performance of the pro-

gramme but also with respect to the degree of student and teacher involvement. The latter have made their generally good disposition to develop this type of programmes very clear and their contributions should be taken into account if this path is to be followed. Thus, in a survey carried out in all the educational centres in the city of Barcelona, the heads of study reported their preferences for this type of program to be undertaken completely by healthcare professionals (although more than two thirds would be willing to assume the programmes after having received previous training), preferentially without the students having to leave the centre and with a length of no more than 5 hours to be completely developed over no more than one week at no cost to the student²⁶. Based on this line of work, some countries such as Canada currently have national programmes which allow annual training in basic CPR to thousands of students²⁷⁻²⁹.

The limitations of this study include the non randomised selection of the participating centres which were chosen based on their interest in developing a programme such as PROCES. Thus, there may be a bias of selection towards these centres being especially motivated. On the other hand, this study has been exclusively performed in a large urban nucleus such as Barcelona making it impossible to determine the grade of acceptance and the performance which other areas may have (rural or semirural) in which the possibility of having to assist a CPR is lower, and therefore, the motivation of the population, the teachers and/or students may not be the same. Finally, the evaluation of the learning was undertaken using a test and not by a practical exercise. Although many studies have demonstrated the validity of substituting the assessment with a practical exercise with a test on theory³⁰⁻³², this does not prevent these tests over- or under-evaluating determined students based on physical or psychological characteristics.

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Programa de Reanimación Cardiopulmonar Orientado a Centros de Enseñanza Secundaria (PROCES): Conclusiones tras 5 años de experiencia

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Objetivo: Describir la experiencia adquirida tras 5 años de realizar formación en reanimación cardiopulmonar básica (RCP-b) a alumnos de enseñanza secundaria obligatoria (ESO), el porcentaje de aprendizaje satisfactorio inmediato y transcurrido un año desde la finalización del programa y los factores asociados a un buen aprendizaje.

Método: El programa utilizado para este fin fue el *Programa de Reanimación Orientado a Centros de Enseñanza Secundaria* (PROCES). Se incluyeron a todos los alumnos que han completado el curso desde 2002 a 2007. Como instrumento de medida del aprendizaje satisfactorio se utilizó un test con 10 preguntas teóricas y 10 preguntas prácticas, el cual se contestó antes de realizar el PROCES e inmediatamente y un año después de concluirlo. Se estudió la influencia en el rendimiento de variables independientes relacionadas con el centro (titularidad, renta del barrio en el que se ubica), con el curso (curso curricular en el que se realiza, personal que desarrolla las clases prácticas) y con el alumno (edad, sexo, intención de estudiar ciencias de la salud, asignaturas pendientes de cursos previos y realización previa de un curso de socorrismo).

Resultados: Durante estos 5 cursos académicos, han realizado el PROCES 1.501 alumnos. De ellos, 1.128 completaron el test antes y después del PROCES y 428 al cabo de un año. El porcentaje de aprendizaje satisfactorio inmediato fue del 58%, en tanto que la persistencia del mismo al cabo de un año fue del 42%. El estudio multivariado demostró que los centros privados, los centros situados en distritos de baja renta *per cápita*, el desarrollo del PROCES íntegramente por profesores del centro y la ausencia de asignaturas pendientes de cursos previos por parte del alumno se relacionaron de forma independiente con un mejor rendimiento inmediato, en tanto que sólo los dos últimos factores guardaron una relación significativa con la persistencia del aprendizaje.

Conclusión: El PROCES, en manos de médicos especialistas en urgencias y emergencias, es una herramienta excelente para difundir los conocimientos en RCP entre los alumnos de ESO. Su afianzamiento durante los próximos años, así como su incorporación al currículo, pasa necesariamente por una apuesta clara y decidida de las administraciones públicas implicadas. [*Emergencias* 2008;20:229-236]

Palabras clave: Reanimación cardiopulmonar. Estudiantes. Enseñanza. Escuela.