Focus should shift to "avoid-a-code" approaches and training

Cost/Benefit Analysis of Cardiopulmonary Resuscitation: A Comprehensive Study — Part II

by MARY C. VRTIS

In the last issue of *Nursing Management*, Mary Vrtis provided a historical review of cardiopulmonary resuscitation (CPR). This article details a 21-month study done at Riverside Regional Medical Center (RRMC), a 576-bed community hospital located in Newport News, Virginia. The medical center is a teaching hospital which has a family practice residency program. RRMC has a comprehensive cardiopulmonary resuscitation program which includes:

- Basic Life Support (BLS) classes
- Advanced Cardiac Life Support (ACLS) classes
- Neonatal Advanced Life Support (NALS) classes
- Pediatric Advanced Life Support (PALS) classes
- Various basic and advanced cardiopulmonary resuscitation reviews and other educational opportunities

Both type of arrest and initial rhythm affected survival outcomes.

- A Code Blue committee with 17 members, including RN managers and educators, physicians, the Pharmacy Director and the Director of Pastoral Care
- An evaluation system to examine short-term survival for all cardiopulmonary resuscitation attempts

Although some of the instructor time for advanced life support programs was unpaid volunteer labor, this was time that could have been used for other purposes, so costs were included in this study. Advanced life support courses sometimes included Newport News Fire Department Emergency Medical Technicians (EMTs) and although that time does not cost RRMC directly, these costs are paid by the taxpayers through compensatory time and paid education days. Therefore, this information also was included in the calculations. Statistical analysis was carried out using descriptive statistics and Student's t (alpha = 0.05).

All adult, inpatient cardiopulmonary resuscitation attempts that occurred over a 21-month period between January 1, 1989 and September 30, 1990 were studied retrospectively using "Code Blue" records and "Code Blue" evaluations completed by nurse managers. During this period, RRMC admitted a total of 34,745 adult patients for 232,444 patient days and there were 432 adult resuscitation attempts on 336 patients aged 16 and over. Thus, 0.97 percent of patients "coded" during their hospital stay, with 0.0019 resuscitation attempts per patient day. Resuscitation attempts were successful initially for 46.1 percent of codes called and survival diminished with time. (See Exhibit I.)

The 33 crash carts were idle 99.9 percent of the time.

The mean length of stay after the first code for the initial survivors who died before discharge was 9.9 days ±2.6, with post-code hospitalization times ranging from 0.5 to 236 days. For survivors to discharge, the mean post-first code to discharge length of stay was 20.3 ±3.3 days. The average cost per hospital day at RRMC in February 1990 was $957.19.[1] Thus, costs for post-resuscitation hospitalization for those who survived initially but died before discharge averaged $9,476.18 per patient, or a total of $1,099,236.90 during the study period. For the survivors, post-resuscitation hospitalization cost $19,430.96 per person or $757,807.32 during the study period. Charges for use of the crash cart — Code Blue charges — ranged from $50 to $100 per event,

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depending on the unit. At an average charge of $75, the total for the 432 resuscitation attempts was $32,400.

The mean age for all patients coded during this time period was 67.4 ±0.8 and 67.8 ±0.8 for those who died prior to discharge. As can be seen in Exhibit I, 78.0 percent of all patients coded and 79.5 percent of patients who died prior to discharge were over age 60. Although the age difference for survivors versus nonsurvivors was not statistically significant, 17.6 percent of those aged 16 to 59 survived to discharge while only 9.9 percent of those 60 or over survived long enough to be discharged home.

As can be seen from Exhibit II, the type of arrest and initial rhythm are both variables that appeared to affect outcome. In addition to the data of Exhibit II, there were 39 cases of bradycardia (excluding cases which occurred secondary to respiratory arrest) with one 70-year old person surviving. Of the 42 patients experiencing EMD, only one 61-year old survived. Of the 39 patients who survived to hospital discharge, one patient had more than one resuscitation attempt. A breakdown of these patients' types of arrests is given in Exhibit III.

EXHIBIT I

POST CODE-BLUE OUTCOMES
(N = 336)

A. Survival

Time After Code	Total Deaths	Survivors No.	Survivors %
Immediately	181	155	46.1
24 hours	240	96	28.6
72 hours	252	84	25.0
7 days	265	71	21.1
14 days	280	56	16.7
30 days	290	46	13.7
60 days	294	42	12.5
After 60 days/ before discharge	297	39	11.6

B. Age

Group	Survived to Discharge (%)	Mean Age (Yrs) Died	Mean Age (Yrs) Survived	Survived to Discharge (%) Under 60	Survived to Discharge (%) Over 60
A	48.0	69.9	61.6	83.3	36.8
B	16.7	70.7±2.6	60.8±5.9	40.0	12.0
C	20.9	70.6±1.5	67.5±2.9	38.5	18.2
D	3.4	67.3±1.7	54.7±7.6	2.2	1.2

EXHIBIT II

TYPE OF ARREST AND INITIAL RHYTHM

Age Group	A. Respiratory Only/ or with Bradycardia Total	Survived No.	Survived %	B. Respiratory Failure Cardiopulmonary Arrest Total	Survived No.	Survived %
16-19	0	0		0	0	
20-29	1	1	100.0	1	0	
30-39	2	1	50.0	0	0	
40-49	2	2	100.0	1	1	100.0
50-59	1	1	100.0	3	1	33.3
60-69	9	2	22.2	9	2	22.2
70-79	4	2	50.0	10	1	10.0
80-89	6	3	50.0	6	0	0.0
90-99	0	0		0	0	

Survived to Discharge: 48.0%

Survived to Discharge: 16.7%

Age Group	C. Ventricular Fibrillation/ Pulseless V. Tachycardia Total	Survived No.	Survived %	D. Asystole Total	Survived No.	Survived %
16-19	0	0		0	0	
20-29	1	0	0.0	2	0	0.0
30-39	2	0	0.0	5	0	0.0
40-49	5	3	60.0	6	1	16.6
50-59	6	2	33.3	8	1	12.5
60-69	22	1	3.0	21	1	4.8
70-79	38	10	26.3	27	0	0.0
80-89	14	2	14.3	17	0	0.0
90-99	0	0		2	0	0.0

Survived to Discharge: 20.9%

Survived to Discharge: 3.4%

EXHIBIT III

TYPES OF ARREST AND INITIAL RHYTHM FOR SURVIVORS

Type of Arrest	Initial Rhythm	No. Survivors
Respiratory only	—	7
Respiratory to cardiac	Bradycardia	5
Respiratory to cardiac	V. tac	2
Respiratory to cardiac	Asystole	2
Respiratory to cardiac	Unknown	1
Cardiac	V. tach/ V. fib	16
Cardiac	Bradycardia	1
Cardiac	EMD	1
Cardiac	Asystole	1
Cardiac	Unknown	3

EXHIBIT IV

SALARY INFORMATION

Classification	Hourly Wage
RN Staff	$ 13.15
RN Educator/Manager	14.79
CRNA	20.38
LPN	8.73
House staff MD	12.50
Attending MD	99.39
Respiratory Therapist	12.27
Radiology Technician	10.69
Occupational Therapist	16.15
Physical Therapist	16.25
EMT (Fire Dept.)	14.20
Secretary	6.00
Chaplain	8.55

Cost of resuscitation attempts

The mean time for resuscitation attempts was 25.0 minutes (0.42 hours), so Code Blue resuscitations consumed a total of 2,071.7 person hours during the study period. The average resuscitation team included 4.1 house staff, 4.5 nursing staff, 2.0 respiratory therapists, 0.9 CRNAs and one chaplain. Using the salary information in Exhibit IV, the mean cost of personnel attending resuscitation attempts totaled $96.51 per ar6rest. For the 432 resuscitation attempts, the total personnel cost was $41,692.32. Corrected to include 18.5 percent benefits, total costs were $49,405.40.[2]

RRMC has 33 crash carts and 25 defibrillators located in the inpatient and outpatient areas. In addition to the defibrillators dedicated to crash cart use, the Emergency Trauma Center (ETC) also has nine monitor/defibrillators which are used for routine monitoring. Replacement costs for all crash carts in the hospital (not including the ETC defibrillators) totaled$198,445.30. Since the carts were in use 432 times for a mean of 0.42 hours, the crash carts were idle 99.9 percent of the 504,504 crash cart hours of the study period (637 days x 24 hours x 33 carts = 504,504 crash cart days).

The Code Blue committee met a total of 16 times during the study period. These meetings consumed 62 nurse manager and educator hours, 17 attending physician hours and 19 department director hours, for a cost of $3,035.83. (See Exhibit IV.) Adding benefits, the total cost was $3,596.83. This calculation did not include costs of producing memos and minutes, doing utilization studies or collecting routine statistics.

During the study period, there were 197 classes focusing on CPR, with a total of 20,486 participant and instructor hours. Participants included RNs, LPNs, physicians, respiratory therapists, radiology technicians, various other hospital personnel, and emergency medical technicians from local fire departments. The salary costs for educational program attendance during the study period was $259,067.34, including the BLS instructor trainer's time. With benefits, costs totaled $306,994.79. (See Exhibit V.) These figures do not include ACLS affiliate faculty time or any additional training that house physicians obtain through the medical education department.

CPR and ACLS classes require a great deal of equipment. RRMC has an adequate supply of training equipment with a total replacement value of $39,643.13. Food provided for ACLS classes added an additional cost of $1,500. Revenue is produced through tuition for ACLS and CPR instructor classes, book sales, rental fees for manikins used outside the hospital, and BLS roster fees. This income totaled $9,584.50, of which $6,479.00 was tuition for ACLS paid by RRMC nurses and technicians, some housestaff physicians and outside EMTs. RRMC does not charge for other resuscitation courses.

Crash cart checking policies varied from once per shift to once daily depending on unit policy. On average, crash carts were checked three times daily to determine that the defibrillator was operating properly and that the locks on the cart were intact. Approximately once a week, the cart was opened and checked for completeness of contents. Time needed for checking a cart depended on how familiar the nurse was with the equipment. Time-motion study generated a mean of 1.9 minutes for checking a locked cart and defibrillator and 8.3 minutes for check-

EXHIBIT V

COST OF EDUCATIONAL OFFERINGS (Jan. 1, 1989 to Sept. 30, 1990)

Courses	No. of Classes	Costs
BLS provider and instructor	113	$183,236.14
NALS provider	5	13,277.47
ACLS provider and instructor	9	91,976.92
Miscellaneous RRMC classes	70	18,504.26
Total	197	$306,994.79

EXHIBIT VI

TOTAL COSTS OF THE RRMC CPR PROGRAM

	Amount
Code Blue participation	$49,405.40
Code Blue committee meetings	3,596.83
Education, salary and benefits*	293,717.32
Tuition for ACLS	6,479.00
Crash cart checking rituals	34,881.99
Crash cart replacement/21 months	69,455.85
Training equipment/21 months	13,875.10
Miscellaneous food costs	1,500.00
Post-resuscitation care:	
died before discharge	1,099,236.90
survived to discharge	757,807.32
Code Blue resuscitation charges (432 resuscitation attempts)	32,400.00
Income from courses, rosters, rentals	–69,584.50
Total Costs	$2,352,771.10

*This figure does not include NALS costs as neonatal codes were not included in total codes.

ing an open cart completely. During the study period, 67.8 hours per cart were consumed by these checking rituals (20 checks x 1.9 minutes + (8.3 minutes) x 88 weeks/ 60 minutes/hour). This totaled 2,238.5 hours. Although the defibrillator is checked by a nursing assistant on some floors, the crash cart is most often checked by an RN. At an average hourly salary of $13.15, this totaled $29,436.28 in salary costs. Adding benefits, total costs for crash cart checking rituals came to $34,881.99.

The total cost per survivor was over $60,000.

Total costs of the RRMC cardiopulmonary resuscitation program are shown in Exhibit VI. Replacement costs for crash carts and educational equipment have been divided by 60 months to reflect usage for five years, as this equipment lasts for several years (this figure was then multiplied by 21 to reflect the costs of use during the 21 month study period). All equipment used on the crash carts and that used for education is subject to wear and tear and often is out of date within three to five years. Medication and IV expiration dates tend to fall within a three- to five-year range as well. Standard depreciation methods were not used as it was decided that they would not be an accurate representation of costs.

Thus, the CPR program at RRMC cost a total of $2,352,771.10, or $7,002.29 per patient coded. The total cost per survivor was $60,327.46.

Discussion and recommendations

Many argue that it is impossible to attach a value to a human life. However, as a society, we do in fact attach value to human life each time decisions regarding social and medical program funding are made. When those who provide and deliver medical care fail to make cost-conscious decisions regarding care delivery, those decisions are made by legislators. For the most part, the focus of the American medical institution is on pathology-oriented rather than health-oriented medicine.

As this study demonstrates, pathology-oriented care is an expensive way to go about *saving lives*. It is impossible to determine whether or not the hospitalization costs for this patient population would have been lower if they had not required resuscitation. It is likely, however, as mean post-code hospitalization times exceeded the average length of stay for all RRMC clients (6.7 days) by 3.2 days for those who survived initially but died before discharge and by 13.6 days for those who survived to discharge.

An important finding was that the highest success rates were found with patients who suffered a respiratory arrest that did not progress to a cardiac arrest (48.0 percent). Only 16.7 percent of patients who suffered respiratory failure ultimately resulting in cardiac arrest survived, although this is higher than that for all patients who arrested (11.6 percent). Thus, it would seem that early intervention in respiratory failure may lead not only to higher post-resuscitation success rates, but also to prevention of cardiopulmonary arrest in some cases — especially when end stage lung pathology is absent. This suggests strongly that investment in educational programs which focus on early intervention in respiratory failure would be not only cost efficient, but truly life saving.

With the exception of NALS, the educational programs discussed in this study do not address early intervention in respiratory failure. Rather, the emphasis is on performing CPR according to American Hospital Association (AHA) and RRMC standards. Perhaps it is time to change direction and focus on "Avoid-a-Code" programs instead.

The second highest success rate was found with pulseless ventricular tachycardia and ventricular fibrillation (20.9 percent). ACLS classes focus on defibrillation and pharmacologic treatment for these and other dysrhythmias, whereas BLS classes do not. Defibrillator safety classes and recertification programs focus on rapid recognition and intervention with ventricular dysrhythmias. The vast majority of RNs and LPNs in the hospital setting are not trained in dysrhythmia recognition and defibrillation, as they attend only BLS programs. Since rapid defibrillation appears to be a key to survival in this study and those cited in Part I, it would perhaps be wiser to focus resuscitation classes on ventricular dysrhythmia recognition and defibrillation rather than standard BLS techniques as outlined by the American Heart Association (AHA).

There are 614 RNs and 206 LPNs at RRMC. Providing a basic, two-hour ventricular dysrhythmia recognition/defibrillation certification class to each RN would involve a minimum of 41 classes of 15 students each at a cost of $17,360.98 annually. The cost would be approximately $197 per patient and $965 per survivor. On the other hand, only 0.25 percent of all RRMC hospital admissions suffered ventricular dysrhythmias during the first arrest, which suggests that teams trained to respond quickly to such an emergency would be far more cost effective than training all RNs in these techniques.

Since only one percent of all hospital clients suffer cardiopulmonary arrest and there are only 0.0019 resuscitation attempts per patient day, it seems appropriate to reevaluate whether or not the entire nursing staff really needs to be trained in CPR. Returning to the old concept of a "code team" trained to do all CPR would be much more cost-effective. Except in acute and reversible processes, such as acute respiratory failure and some ventricular dysrhythmias, this study shows that CPR techniques are of minimal benefit and enormous expense.

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If the findings of this study can be generalized, then one percent of all patients admitted to hospitals (330,838 patients) will arrest nationally every year. If 46 percent survive initially, but only 11 percent survive to discharge, then 142,304 will die on average 10

days post-code. Taking into account all the variables studied here, it will cost the nation $2,195,436,900 to save 36,392 people post-cardiac arrest every year (secondary analysis).[3] Is the benefit *really* worth the cost?

Early intervention in respiratory failure could be truly "life-saving."

As a result of this study, we recommend that:

1. All CPR-related certification recommendations should be reevaluated, including those of JCAHO and AHA. All state affiliates of AHA should change BLS certification to every two years and consider changing requirements nationally to every four years. ACLS, PALS and NALS certifications should be changed to every four years.
2. The old concept of a CPR team trained in ACLS should be reconsidered.
3. Multi-disciplinary, multi-organization, cost/benefit analyses of CPR are needed.
4. Hospital educators and management teams should evaluate critically all current CPR programs and eliminate those that result in marginal benefit while still conforming to JCAHO recommendations. Educational programs should begin to focus on arrest avoidance, rather than resuscitation techniques.
5. Educational and crash cart equipment that is not utilized on a regular basis should not be purchased or replaced. *Avoid-a-code* classes and/or cardiopulmonary arrest prevention classes should be developed. Equipment which is in place should be used for *avoid-a-code* classes.

References

1. Virginia Health Services Cost Review Council, *Annual Survey of Charges for Virginia Hospitals and Nursing Homes, 1990*, (Richmond, VA: VHSCRC, 1990).
2. American Hospital Association, *Hospital Statistics 1989-1990*, (Chicago, IL: American Hospital Association, 1990).
3. U.S. Department of Commerce, *Statistical Abstracts of the U.S., 1989*, (Washington, DC: U.S. Government Printing Office, 1990).