

# Barriers to effective in-hospital resuscitation: lessons learned during implementation of a hospital-wide code system

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## Abstract

**Aims and objectives:** To understand the barriers involved in effecting a hospital-wide code system and overcoming them during implementation.

**Background:** Improving survival after in-hospital cardiac arrest involves standardization of both defibrillation equipment and staff's abilities during codes.

**Design:** Observational descriptive study.

**Methods:** Observational study of the situation existing before implementation of an effective in-hospital resuscitation system and description of the implementation process. Descriptive statistics were used.

**Results:** Prior to intervention, defibrillators were unstandardized, misused and often inaccessible. Basic and advanced life support training was suboptimal and poorly overseen. Codes were attended by curious bystanders and inappropriate staff; there was lack of clarity regarding roles and key interventions. A standard defibrillator model was purchased and gradually deployed throughout the hospital; these were configured to meet the unique requirements of each department. Training was restructured. Standard op-

erating procedures were created for all resuscitations while an oversight mechanism was installed. Code teams were created by taking departmental workloads and clinical skills into consideration. A nurse resuscitation coordinator was appointed per department and a hospital-wide culture was fostered where nurses were responsible for the quality of CPR. Major limiting issues such as distrust of device accuracy and safety, knowledge gaps and problems at the device-user interface were identified and bridged.

**Conclusions:** Creation of an effective in-hospital code system requires thorough research into the culture and requirements of various hospital departments. Multiple barriers must be overcome to set this process into motion.

**Relevance to clinical practice:** Implementation of change requires more than a declaration from supervisors; it requires deep understanding of the existing culture of different departments to take effective root. Awareness of these often unacknowledged issues combined with the willingness to confront and overcome them are keys to success.

**Key words:** Resuscitation, task performance and analysis, health services administration, defibrillators, electric countershock.

## Introduction

Nurses are the most likely professionals to discover a patient in cardiac arrest; (1) this fact added to the training that nurses undergo in basic and advanced life support (BLS and ALS) techniques as well as in

defibrillator operation make nurses essential to the code team. However, in order for a team to have a chance at achieving the successful resuscitation of a patient, many factors need to be properly aligned. These include the effective assemblage of the team, the expectation that all team members know what their roles are and how to perform them and the fact that necessary equipment is both at hand and its operation is familiar to all involved. If anything is lacking or if staff stress impedes the team's actions, the effectiveness of the code may be less than satisfactory. (2)

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## Background

Investment in extensive BLS and ALS training for staff and introduction of costly resuscitation equipment into most hospital wards should theoretically create ideal conditions for timely shock delivery, as one-quarter of in-hospital cardiac arrests present with a shockable rhythm; (3,4) however, approxi-

mately one-third of patients with a shockable rhythm undergo defibrillation more than 2 minutes after their arrest. (5) While a general trend towards improvement in survival to hospital discharge has been observed after in-hospital resuscitation, (6) this progress seems largely unrelated to the treatability of the initial cardiac arrest rhythm by defibrillation. (7) In an effort to overcome this issue, the American Heart Association (AHA) has recently published consensus recommendations for strategies aimed at improving survival after in-hospital cardiac arrest. (8) Within these recommendations, much emphasis is placed both on the need to standardize defibrillation equipment across the institution and on the ability of the attending staff to properly activate it. Potential barriers to effective in-hospital resuscitation that must be acknowledged and overcome include health care providers' knowledge gaps, (8) their hesitation to initiate cardiopulmonary resuscitation (CPR) and perform defibrillation, (9) and even their reluctance to implement evidence-based change. (10)

The current study describes the lessons learned during the process of creating a code team and implementing a hospital-wide defibrillation system in a single resuscitation center. We identified several key issues which may hinder or even thwart the implementation of this process and successfully applied strategies designed to overcome these potential impediments in our institution.

## **Methods**

The Shaare Zedek Medical Center (SZMC) is an 800-bed university-affiliated acute-care hospital with 51 adult and 21 pediatric emergency department (ED) beds, 23 adult and 4 pediatric intensive care beds and 159 internal medicine beds. This hospital was the first in the country to implement targeted temperature management; this fact, combined with the hospital's ability to provide all cardiology and cardiac surgery services along with its proximity to the city centre, have led to SZMC's informal embracement by the Jerusalem district Emergency Medical System (EMS) as the referral center for post-resuscitation care after out-of-hospital cardiac arrest. The current study was waived Institutional Review Board review by the local committee.

Following publication of Israeli Ministry of Health (MOH) directives regarding resuscitation training and equipment in 2010, a physician resuscitation officer was appointed to study the state of resuscitation within the hospital in order to determine whether changes needed to be implemented to meet the new requirements. As a result, staff training and existing equipment deployment throughout the hos-

pital were mapped. The initial findings (see below in Results) prompted complete revamping of the hospital's entire resuscitation and defibrillation process. The current report is limited to information collected during initial system mapping and during the course of the first year of system transition and implementation (1 Jan 2012 to 31 Dec 2012).

## *Study endpoints*

The study endpoint included an organized description of the transition. The main objectives met through documentation of this process were (1) identifying the steps comprising the process of creating an effective code response system, (2) identifying the key factors hindering and/or thwarting successful code team implementation and defibrillator deployment and use, and (3) mapping the strategies employed to overcome potential impediments to effective cardiopulmonary resuscitation within the hospital.

## *Data collection and statistical analysis*

Descriptive statistics (e.g. numbers and percent) were used to describe the equipment and training existing before and after the intervention. Questions, knowledge gaps and professional issues raised by the staff during training were first documented and tabulated using Microsoft Office Excel 2007™ (Microsoft Corp, Redmond, Washington, USA) and then coded for thematic penetrance by the authors. Problems pervading the entirety of the hospital were separated from those appearing to represent local (usually departmental) culture.

## **Results**

### *Baseline*

The conditions for performing resuscitation in the hospital prior to implementation of the program are presented below.

### The hospital code system

Codes were being called via an overhead public address system, resulting in the attendance of curious bystanders and a surplus of untrained staff, whereas those trained in ALS often did not appear. There was an overall lack of clarity regarding roles during code performance, as well as poor adherence to updated resuscitation algorithms by the staff involved. Resuscitation reports were usually poorly written (**Table 1**); they were not in accordance with Utstein Guidelines and often lacked a description of the presenting rhythm and a physician's signature.

### Staff training

BLS was being taught by one nurse and ALS by

three AHA-accredited ED physicians. At first impression, attendance at training sessions seemed acceptable. In-depth investigation revealed that attendance was neither enforced nor audited. In addition, only ALS providers were being empowered to perform defibrillation.

#### Equipment

There were 63 resuscitation trolleys stationed throughout the hospital; only two-thirds (40/63) of these carried a defibrillator. In several places, the resuscitation trolley and the defibrillator were separate and in others there was no defibrillator. Twelve distinct defibrillator models were randomly deployed throughout the hospital (**Table 2**); within the Heart Institute, eight different defibrillator models were being used in parallel. In several departments, defibrillators were being regularly used in lieu of monitors. Only one-third (13/40) of the defibrillators were <10 years old, biphasic and included an integrated automated external defibrillator (AED) mode. There were also three AEDs which had been placed in the cardiac rehabilitation unit, the hospital outpatient clinic area and the pre-operative assessment clinic. The latter two were kept in locked cupboards during evening and night shifts, the keys to which were on the morning shift nurse managers' key chains, thus rendering these devices inaccessible at least two-thirds of the time.

The yearly number of resuscitations in SZMC averages 450 cases and almost half of the code calls are to the internal medicine wards. In 2012 there were 511 deaths among the 4195 admissions to these wards. The rates of return of spontaneous circulation (ROSC) and survival to hospital discharge after in-hospital resuscitation were similar to those observed in previous years; 42% and 14% respectively.

The above findings were presented to the hospital administration together with detailed recommendations for improvement.

#### *Intervention*

The intervention was comprised of several components.

#### Creation of standard operating procedures and local administration

The MOH recommendations for resuscitation were adapted by two nurses and the medical resuscitation officer to the hospital structure and function. The adapted standard operating procedures (SOPs) were posted on the hospital website; every relevant staff member was required to provide signed verification that these documents had been read. Contrary to the

more general MOH instructions, the adapted SOPs included a description of the code team and its function, delegation of code team members and a description of the specific roles and responsibilities of each team member during and after the code. Additional SOPs for activating an adult or pediatric code team via the dedicated cell phone of the designated on-duty staff were also written for the hospital switchboard staff. A nurse resuscitation coordinator was appointed within each department to oversee maintenance of resuscitation cart equipment and a single resuscitation nurse was appointed to oversee all department coordinators. In addition to the quarterly hospital Resuscitation Committee meeting, monthly progress meetings were also initiated with the office of the nursing director. Relevant nursing staff was invited to join the previously physician-dominated Resuscitation Committee.

#### Creation of the code team

Appropriate code team members were selected through a series of meetings with the chairs of the departments that were deemed potential contributors to the code teams. The workload of each department throughout a typical workday was mapped; the added workload of the code team was consensually divided by these departments per shift in accordance with best staffing availability and the existence of said staff's appropriate clinical skills. The resultant code team created consisted of an anesthesiologist (all codes), a cardiologist/intensive care physician (depending on shift) and two experienced nurses from selected departments on a rotating basis (i.e. the ED and the cardiac, general and cardiothoracic ICUs). In pediatric codes, the cardiologist/intensivist was replaced by a pediatrician. Selection of specific ALS-trained staff members designated to function as code team members was left to the discretion of the department chairs.

#### Switchboard

In order to minimize delays, the switchboard software was programmed to simultaneously text and call all relevant code team members at the push of a button and to prioritize calls placed to the hospital-wide dedicated code number over other incoming calls. Since all code team members were already carrying hospital cellphones, specific ringtones were assigned to differentiate regular calls from codes.

Due to an initial widespread distrust towards the reliability of a "quiet" code call (i.e. one that did not utilize the overhead public address system as per previous policy), during a period of 6 months all codes were called through both systems. The

switchboard staff was trained to call all code team members at the beginning of each shift and document the names of those individuals responsible for the code response. Code team member non-response to the switchboard call and/or non-response to a code call were reported by the hospital switchboard director to the resuscitation officer who dealt with each case individually.

#### Staff training

Retraining was initiated from top to bottom. Both the physician resuscitation officer and the resuscitation nurse underwent an Advanced Resuscitation Training course in addition to their existing ALS training.

In order to improve both the collaboration and the performance of the nursing staff, a decision was made to use the code to empower the nurses to create a hospital-wide culture where they would be responsible for the quality of CPR. The resuscitation officer rewrote the existing BLS training program with the assistance of an ALS-trainer emergency medical technician-paramedic (EMTP). This program substituted a 4-hour course consisting of theoretical knowledge and a focused 90-minute hands-on workshop. Five nurse BLS trainers, assisted by the EMTP, divided staff training into adult, pediatric and neonatal workshops; all workshops included training nurses in delivering defibrillation. Additional talks and hands-on simulations were delivered by the EMTP at 26 nursing staff meetings and 19 doctors' meetings. During less than half a year, a total of 551 nurses and 219 doctors underwent BLS and defibrillation re-training by an EMTP in addition to conventional ALS training (**Figure 1**).

Certified ALS training was transferred to an out-of-hospital contractor (the Israel National EMS). This training is delivered by EMTP instructors in accordance with AHA guidelines. The responsibility for timely periodic summoning of nurses and doctors to ALS courses, as well as documentation of attendance and certification, was transferred to the hospital Human Resources department.

#### Deployment of defibrillators

Thirty defibrillators were purchased and deployed throughout the hospital. The model chosen was one that would enable continuous data collection on defibrillator maintenance and function, as well as on the quality of CPR during real events. Data transfer was designed to be continuous via a secure in-hospital Wi-Fi system.

Defibrillators were first deployed to the adult ED, ICUs and cardiology ward based on the assumption that staff in these departments would adapt quickly

due to their code team roles and their relatively frequent defibrillator use. The second round of deployment was to include all internal medicine wards due to their high frequency of code calls; however, one internal medicine ward was excluded due to the negative attitude of the nurse manager towards both the defibrillator itself and the decision to lock all defibrillators to the resuscitation trolleys in order to prevent their use as monitors. This ward received a defibrillator in the third and final round of deployment together with the surgical wards. By that time, the staff of the previously excluded ward was requesting a device "similar to the one everybody else has". During the defibrillator deployment process, the EMTP ensured that every staff member in each department underwent hands-on training and extraordinary efforts were made to minimize the number of changes made to existing protocols. For example, although most of the defibrillators were multi-parametric, during initial device deployment neither pulse oximetry nor capnography were installed on the devices. Pads were substituted for paddles only after the device had been used for a few months by the wards during a second round of hands on-training and capnography was similarly introduced during a third round two months later.

At an early stage of defibrillator deployment, it became clear that many departments had developed local protocols for defibrillator use in accordance with the specific needs of their patient populations. Regular meetings with the medical resuscitation officer and nurse were conducted in order to determine how best to address these needs through defibrillator configuration while avoiding deviations from the universal protocol. A list of these problems and their solutions is presented in **Table 3**. Additional problems came up in the device-user interface; these too were addressed during the above-mentioned meetings and incorporated into the training process (**Table 4**).

Spontaneous within-departmental question-and-answer sessions developed during the defibrillator training sessions. Staff concerns that emerged were varied. Some were basic resuscitation concerns regarding the breaking of ribs, the safety of hand placement over the defibrillator pads during charging, the accuracy of automated defibrillator instructions and the location of chest compression in the presence of anatomical anomalies. Some issues required a knowledge upgrade for the staff, for example educating the ward physicians in the potential role of capnography in assessing ROSC and in methods for assessing CPR quality (other than via the artifact on the unfiltered ECG strip), as well as teaching nurses the conductance advantage of elec-

trode gel versus wet pads or ultrasound gel. Ethical issues also arose; the nurses expressed particular concern regarding the legality of nurse-delivered defibrillation and the suffering of their patients due to external pacing. The BLS course was subsequently adapted to address these and other issues that had arisen.

#### Monitoring of defibrillator maintenance and function

At the outset, there seemed to be an inordinately high occurrence of technical device malfunctions. Every such event was reported to the resuscitation officer and the deployment specialist. The Wi-Fi recording of the technical status of the device in question was first checked and then the device itself was tested. It shortly became clear that these events were not device malfunctions but rather problems at the device-user interface. In order to create a culture of personal responsibility regarding device function and charging, the charge nurse of every shift on every ward was directed to sign a form confirming device status and the nurse manager of each ward was designated to receive direct mail notification from the defibrillator/s in their department regarding technical issues (e.g. incorrect pad connection, prolonged disconnection from an electricity source, etc.). We have now also begun showing individual end-users recordings of their actions during real events.

#### **Discussion**

The current study shows that major issues may frustrate efforts to mount an effective in-hospital code response. Code team availability, lack of clarity regarding institutional SOPs and individual roles, communication issues at the switchboard-code team interface, incomplete course attendance when both training and certification are internal, distrust towards the reliability of the "quiet" code call, lack of nurse empowerment to act independently of physician orders and nurse trainers' reluctance to focus on the practicalities of hands-on training in BLS are some of the issues that may hinder delivery and performance of BLS and ALS. Use of defibrillators as monitors, negative attitudes towards a new device, differences in departmental defibrillation culture, concerns regarding defibrillator safety and accuracy, significant knowledge gaps that remain unaddressed in standard BLS and ALS training and major problems at the defibrillator-user interface likely hinder timely delivery of defibrillation.

While the theory of "how to implement a code system within hospital" has been discussed, (11) to the best of our knowledge, only one paper described the

process of implementing a code system and standardizing defibrillation within a hospital. (12) Although we had anticipated some of the issues that we faced, (e.g. staff reluctance to change), others surprised us (e.g. the difference in departmental defibrillation culture, the unaddressed knowledge gaps in existing BLS and ALS courses, and defibrillator-user interface problems). Nursing issues with defibrillation have been described by others (13,14) but these did not include concerns regarding either the legal aspects of nurse defibrillation or the accuracy of automatic rhythm analysis. Lack of time, knowledge, mentors and organizational support have been factors previously cited by nurses regarding barriers to implementing evidence-based practice; (10) all of these factors were meticulously acknowledged in this study and addressed in its implementation. Our findings correlate with the poor performance of BLS by trained ward staff observed by the lead author in another hospital. (15) Critical incidents during CPR that had been reported to the Danish Patient Safety Database included problems with the code team call and failed defibrillation, (16) a finding similar to our own. Defibrillation errors were also found to be relatively common (19%) in the US Get with the Guidelines National Registry. (17) Performance issues related to the device-user interface could explain both the variation (4) and some of the delay in the defibrillation time observed by others in hospital. (5,18) Legal issues with defibrillation and distrust towards device treatment recommendations may explain the lack of benefit observed with the use of AEDs in hospital. (19-21) Although the proportion of hospitals reporting the occurrence of defibrillation outside intensive care units prior to arrival of the code team is rising, (22) high resolution analysis of the in-hospital resuscitation process is required if a true change in the culture of in-hospital defibrillation is to be implemented.

The current study presents no quantitative measurement of the effect of our intervention on patient outcomes. This was not our study endpoint and we are still in the process of determining how best to learn from both the technical reports and the CPR quality data files. However, initial data review suggests that there remains much room for improvement.

#### **Conclusions**

While we wholeheartedly embrace both the code system and institution-wide standardization of defibrillators, this paper emphasizes the importance of accompanying the implementation of these processes with thorough research into the existing norms, sub-cultures and requirements of the various

hospital departments. Without such in-depth adaptation to local needs, the process will reap suboptimal results at best.

### **Relevance to clinical practice**

The current paper describes the lessons learned in a single institution. If such an array of issues and diversity of needs exists in one place, our findings likely reflect just the tip of the iceberg of potential obstacles in others. Implementation of change requires more than receiving a command from supervisors; it requires deep understanding of the existing cultures of different departments to overcome potential resistance to change and to take effective root. Awareness of these often unacknowledged is-

sues combined with the willingness to confront and overcome them are keys to success.

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#### *Disclosure*

The authors have no relevant financial information or potential conflicts of interest to disclose.

**Table 1.** Documentation of a single drug (intravenous dopamine drip for maintenance of blood pressure after ROSC) taken from the resuscitation reports prior to the revamping of the resuscitation and defibrillation process

20 mg 10 cc/iv
20 mg/h
24 mg/h
25 cc/hr
30 cc/hr
30 cc
40 ml/h
40 cc/iv
60 mg/hr
80 mg/h
15 cc/hr > 30 cc/hr
18 cc/hr > 40 cc/hr
10 cc/hr
12 cc/24 mg
17 cc/h
1 mg
20 cc/hr
20 mg/hr

Legend: ROSC=return of spontaneous circulation.

**Table 2.** The defibrillator models deployed throughout the hospital prior to revamping of the resuscitation and defibrillation process throughout the hospital

Make	Model	Year of make	n devices	Location
Medtronic	Lifepak 20	2008	1	Cardiology (1)
Medtronic	Lifepak 1000	2008	3	Cardiac rehabilitation unit (1), outpatient clinic area (1), pre-operative assessment clinic (1)
Siemens	Unknown	1975	1	Echocardiography suite (1)
Mennen	604H	1975	2	In vitro fertilization unit
Mennen	Cardio-pak 2000	1986	5	Delivery room (1), Gastroenterology suite (1), Urology day-care (1), PACU (1), surgical day-care (1)
Zoll	ZMI	1985	1	General and vascular surgery (1)
Zoll	200	1982	1	Coronary care unit (1)
Zoll	PD 1200	1988	1	Cardiac surgery ICU (1)
Zoll	M Series	2004	5	Electrophysiology laboratory (1), ED (3), internal medicine C (1)
Phillips	M1723B Code Master (HP)	1990	4	Adult dialysis unit (1), hematology day-care clinic (1), pregnancy complication ward (1), internal medicine B (1)
Phillips	CodeMaster XL (HP)	1994	11	Coronary care unit (1), coronary catheterization laboratory (2), cardiology (1), cardiac surgery ward (1), cardiac surgery ICU (1), cardiac surgery operating room (2), hematology-oncology ward (1), radiology suite (1), general operating room (1)
Phillips	Heartstart XL	2009	4	Geriatrics A+B (1), orthopedic surgery (1), pediatric ED (1), nuclear medicine (1)
Phillips	43120A (HP)	1980	1	General intensive care unit (1)

Legend: PACU=Postanesthesia Care Unit; ICU=intensive care unit; ED=emergency department

**Table 3.** Defibrillator configuration to conform to local department requirements

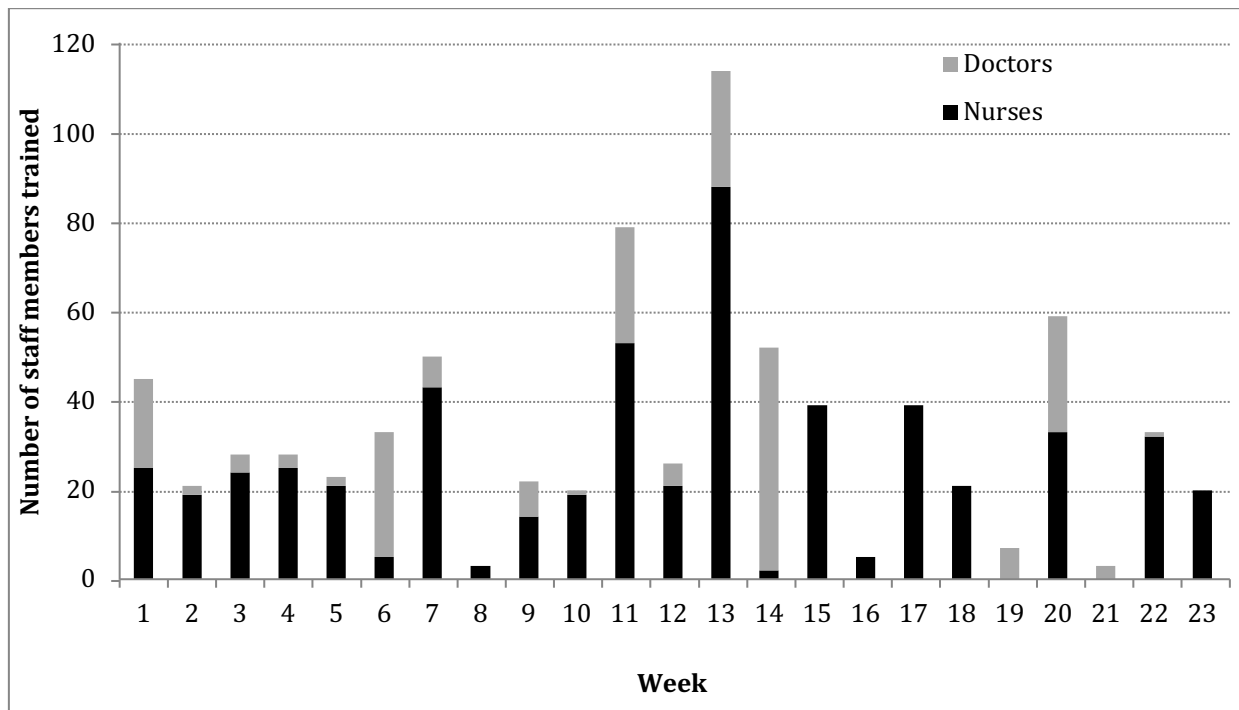
Department	Problem	Solution
Internal medicine	The attending doctors insisted they must see lead II in order to differentiate between atrial arrhythmias with hemodynamic compromise and non-perfusing rhythms and thus developed a local culture of connecting the three chest leads first unless arrest is clear. They also thought that in order to observe the rhythm via the 3 leads after a shock the device must be switched from defibrillator mode to monitor mode (and seek lead II) and in order to deliver a shock, and vice versa.	Defibrillator configured to show lead II whether on monitor mode or on pad. Staff training instructions include turning the device on in defibrillator mode even if leads are connected.
Cardiology	Daily defibrillator use for elective/semi-elective cardioversions.	Placement of two devices on the ward: The one on the resuscitation cart dedicated to resuscitation and constantly connected to pads. The one on a separate cart dedicated to cardioversion and connected to paddles or cardioversion pads. Staff trained accordingly.
Coronary care unit and post cardiac surgery ICU	Common use of defibrillator for pacing.	Placement of two devices on the ward: both configured similarly.
Catheterization laboratory	Most common arrhythmia is ventricular fibrillation. Patient often requires only rapid defibrillation.	Paddles for quick look rather than pads (a. no need for depth and rate assessment, b. patient already connected to monitor). Defibrillator configured to switch on to "lead" paddles.
Post cardiac surgery ICU	Atrial fibrillation very common after surgery. Defibrillator default is to return to unsynchronized mode after each shock. This delays repeat synchronized shock delivery in patients with atrial fibrillation who are hemodynamically unstable and potentially ischemic.	Defibrillator configured to remain on synchronized mode after shock. Staff training instructions include turning the device on in defibrillator mode even if leads are connected. Once the "synchronize" button is pressed the defibrillator remains in synchronized mode. If the "synchronize" button is not initially pressed, the default mode remains unsynchronized.
Pediatric Intensive Care Unit	Need to adapt for treating children rather than adults	Default defibrillator settings are 50 J for the first shock, 75 J for the second, and 100 J for every additional shock

Legend: ICU=intensive care unit.

**Table 4.** Problems observed in the device-user interface

Problem	Result	Troubleshooting
Improper placement of defibrillator paddles in seats	Automatic device check not passed	Retraining
Automatic device check occurring during at the same time the external pacemaker is pacing a patient	Automatic device check not passed	Creation of a list of possible alerts and their causes. Education.
Staff do not press on both paddles simultaneously during defibrillation	Device does not deliver shock	Retraining
Use of poor quality lead stickers	Device showing "leads off" in monitor mode	Purchase of different type of lead stickers
Poor pad adhesion (poor placement, hirsute patient, dressings placed over the chest post breast, thoracic and cardiac surgery)	Device showing "leads off" in defibrillator mode	Placement of shaving knives in resuscitation cart. Education and retraining.
Connection of simple pads (no CPR sensor) made by the same company	Defibrillation and pacing enabled. Monitoring not enabled. Device showing "leads off".	Elimination of simple pads from hospital shelves
Inverse connection of pads (also see picture)	Device showing "check pads" in defibrillator mode. Automatic device check not passed.	Retraining. Photograph of correct and incorrect connection hung on all resuscitation carts.

**Figure 1.** Physicians and nurses trained by the EMTP in BLS and defibrillation during the first 23 weeks of the project



Legend: This number of trainees was covered within 23 weeks during which the EMTP spent approximately 2 workdays in the hospital. In addition to hands-on training of staff on the wards, this includes training at 26 nursing staff's meetings and 19 doctors' meetings; EMTP=emergency medical technician-paramedic; BLS=basic life support.

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