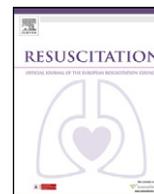




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Clinical paper

Impact of essential surgical skills with an emphasis on emergency maternal, neonatal and child health training on the practice of doctors: A cluster randomised controlled trial in Pakistan[☆]

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ABSTRACT

Introduction: Majority of studies on evaluation of emergency management courses have focused on outcomes such as knowledge and skills demonstrated in non-clinical or traditional testing manner. Such surrogate outcomes may not necessarily reflect vital changes in practice. The aim of this study was to determine if and to what extent, specific training in the management of life threatening emergencies resulted in an increased in compliance with established care guidelines of doctors working in the emergency departments of public sector hospitals in Pakistan.

Methods: A cluster randomised controlled trial was conducted in three districts hospitals in three cities (Khairpur, Vehari and Peshawar) of Pakistan. Thirty-six doctors, 18 in intervention (trained in ESS-EMNCH training) and 18 in control (untrained), were enrolled and 248 life threatening emergency events, 124 in each group, were observed for the correct use of the Airway, Breathing, Circulation (ABC) structured approach. The outcome measure was structured approach defined a priori. Data was analysed by using STATA software.

Results: At individual level, 79 (63.7%) life threatening episodes were managed according to the structured approach in the intervention group and 46 (37.1%) were managed according to the structured approach in controls (OR 2.98, 95%CI 1.78–4.99, p -value = 0.0001). At cluster level, the mean percentage (95% CI) of the structured approach used by doctors in the intervention group [62.9% (50.4–75.3%)], was significantly higher than those in the control group, [36.3% (26.3–46.4)] (p -value = 0.001).

Conclusions: 5-day training of ESS-EMNCH significantly increased the compliance with established care guidelines of doctors during their management of life threatening emergency episodes in the public sector hospitals in Pakistan.

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1. Introduction

Since the early 1960s, a number of life support training programmes have been developed to assist healthcare workers in improving the outcome of critically ill or injured patients.¹ Numerous studies have provided evidence of general acceptance and confidence in these programmes by healthcare professionals as well as by lay persons.^{2–5} Health institutions in most developed countries now require their employees to successfully complete life

support courses to manage cardiac arrest.⁶ This is also true for paediatric health institutions where employees training in paediatric life support is compulsory for employment.⁷

The quality of management in the first few hours, known as the ‘golden hours’,⁸ of the presentation of general, obstetric, neonatal and paediatric emergencies is a major determinant of the eventual outcome. If the vast majority of the potentially avoidable deaths and long-term or permanent morbidity are to be avoided, a particular emphasis on golden hour management has to be established.⁹ Research has shown that structured life support trainings can help in reducing mortality and morbidity during the emergency phase in a cost effective manner.¹⁰

The frontline healthcare workers in resource poor countries like Pakistan lack necessary skills and training to manage emergency episodes in general, obstetric, neonatal and child health units. Therefore, it is mandatory to upgrade their knowledge in both

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recognizing and managing common emergency situations.⁹ However, the evaluation of course participants poses a major problem, because it is rarely possible to develop a perfect testing method, and awareness of the inherent limitations of evaluation methods used in life support courses is important.¹¹ The majority of studies on evaluation have focused on outcomes such as knowledge and skills¹ demonstrated in non-clinical or traditional testing manner. Such surrogate outcomes may not necessarily reflect vital changes in practice, which may be a more useful and direct way of measuring the effectiveness of training.¹

The aim of this study was to determine if and to what extent, specific training in the management of general, obstetric, neonatal and paediatric emergencies resulted in an increased in compliance with established care guidelines of doctors working in the emergency departments of public sector hospitals in Pakistan.

2. Methods

2.1. Study sites and population

The current cluster randomised control trial (CRCT) was carried out in three public sector hospitals in three districts of Pakistan. The Children Hospital in Peshawar is a tertiary care hospital for the paediatric age group while, the District Headquarter (DHQ) Hospitals in Khairpur and Vehari are general hospitals having paediatric, obstetric, adult medical and surgical units. Doctors working in emergency departments and labour room responsible for emergency management of general, obstetric, neonatal and child health were included in the trial. The trial was conducted with the permission of hospital management of each participating hospital and ethical approval was obtained from the Institutional Review Board before the commencement of study. The trial was also registered with ClinicalTrials Registry (registration # NCT00880204).

Before the commencement of trial, a team of investigators, not directly involved either in conduction of ESS-EMNCH trainings or in training of observers, conducted a baseline assessment survey of various public sector hospitals. On the basis of findings of the baseline assessment survey only those hospitals were selected where: (a) no previous emergency management training was conducted; and (b) majority of doctors working in those hospitals were regularly involved in the management of life threatening emergency events. However, it is pertinent to mention here that the curriculum of undergraduate medical studies in Pakistan also does not cover the emergency management training of doctors. Moreover, we also collected the information about the work experiences of doctors both in intervention and control group and no statistically significant difference ($p = 0.149$) was observed in work experience of doctors in intervention group (12.93 years) compared o doctors in control group (11.75 years).

2.2. Randomisation scheme

Each participating hospital provided a list of all doctors working at the hospital. A computer generated randomisation scheme was developed for each hospital by a person not directly involved either in providing the training or in the observation of the doctors' practices. The selected doctors were randomly divided into two groups – an intervention group and a control group.

2.3. Intervention

Doctors in the intervention group received a 5-day training in Essential Surgical Skills with an emphasis on Emergency Maternal, Neonatal and Child Health (ESS-EMNCH). The ESS-EMNCH programme in Pakistan has the unique distinction of being the first

structured life support courses targeted for frontline healthcare workers in resource poor countries. A similar programme has now been undertaken by us in The Gambia.¹² The training activities of ESS-EMNCH are based on two training methodologies modified for Pakistan – 'Advanced Paediatric Life Support' and 'Management of Obstetric Emergencies and Trauma'. The training comprises theoretical and practical sessions for skills development. The lectures are delivered in a classroom format and the practical sessions are taught on skill stations and in "real-life" scenarios using simulated life size infant and adult manikins, essential emergency equipment, animal material specimens and anatomical dummies. The teaching material has been structured according to Advanced Life Support Group, United Kingdom (ALSG-UK) certified teaching protocols.¹³ Doctors working in the DHQ Hospital, Vehari and the Children Hospital, Peshawar were trained in May 2009, while doctors in the DHQ Hospital, Khairpur were trained in June 2009. All these training programmes were executed by ALSG certified instructors. The course participants were informally assessed on daily basis throughout the course and those finding difficulties were supported with formative mentoring. At the end of the 5-day training, participants were assessed using a multiple-choice questionnaire and a formal simulated test scenario evaluating practical skills.

2.4. Procedures

After the completion of training, the data were collected regarding the skills of doctors for the management of life threatening emergency episodes in a true clinical setting during the next 4–6 weeks. The life threatening emergency was closely defined as conditions of Airway, Breathing, Circulation or Conscious level that would likely lead to death or severe brain damage in 6 h if not given immediate and appropriate emergency treatment.¹⁴ Three observers (junior nurses) and a supervisor (doctor) were hired for each site and a one day training with role-play and scenarios was given to observers in order to record the process of emergency management on a standardized form which was used and validated in a previous study.¹⁵ The observers remained in the hospital 24 h a day, 7 days a week to observe each emergency episode. The observers were blinded to the training status of the doctors and were instructed not to try to ascertain doctors' training status. Further, data collection was started immediately after the completion of training to minimize the contamination. The observers collected the data until the estimated number of observations required by our sample size was achieved.

2.5. Outcome measures

Primary outcome for the trial was the proportion of life threatening emergency episodes managed according to the structured approach as recommended in the ESS-EMNCH training. The structured approach practice is a system of simultaneous evaluation and resuscitation. The structured approach includes evaluation and progressive resuscitation of Airway, Breathing and Circulation (ABC) actions (Panel I) as they are undertaken in a patient with life threatening emergency event, all steps in a same sequence. These practices should occur within the first 10–15 min of any emergency management making rapid assessment of correct practice possible for an observer. After this, actions should depend on whether breathing and subsequently an adequate heart rate are detected, information not necessarily available to an observer. We, therefore, concentrated on the early steps (Panel I) as our primary outcome, because these steps are universal, readily observable and objective.

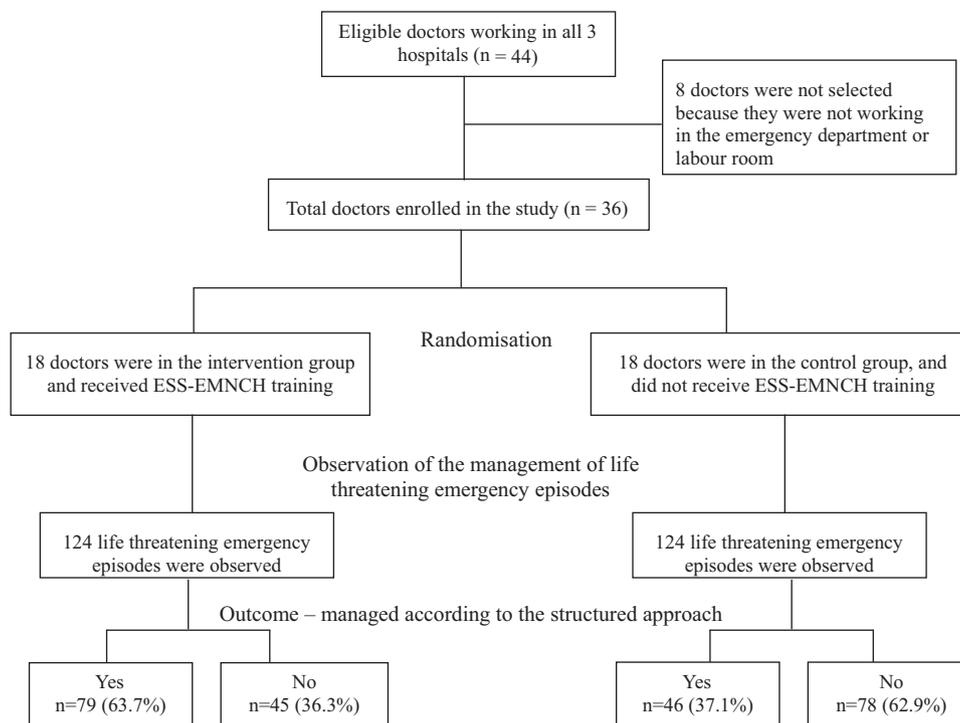


Fig. 1. Trial profile.

2.6. Sample size

Based on routine hospital practice, we estimated that 5–7 observations could be made per doctor over a period of 4–6 weeks. In the absence of previous studies in similar clinical settings, it was assumed that baseline level of practical skill to manage life threatening emergency episodes according to the ABC structured approach among doctors working in general, obstetric, neonatal and child health units of the participating hospitals was around 50% and after training skill improved to 70%. Further, assuming average intraclass correlation coefficient of 0.15,¹⁶ a two-tailed test at 5% significance level and power of 80%, the estimated sample size was 36 doctors, 18 in each group.¹⁷ Hence, a total of 252 emergency episodes, 126 in each group, was estimated to be observed during the study period of 4–6 weeks.

2.7. Data analysis

Information collected on standardised forms was entered by using MS Excel software and data analysis was carried out by using Stata software. The proportion of life threatening emergency episodes managed according to the structured approach was calculated in both groups and compared by individual and cluster level analyses between the two groups. For individual level analysis, *Chi-square* test was used and odds ratio with 95% confidence interval (95% CI) and *p*-values were reported. For cluster level analysis, Student's *t*-test was used and mean percentage and mean difference with 95% CI as well as *p*-values were reported. The level of significance was considered at 5%.

3. Results

A total of 44 doctors were working in the three participating hospitals, and out of these, 36 doctors were included in the trial. Eight doctors were excluded because they were either on leave, or not working in the emergency department. Dur-

ing the study period 36 doctors (18 in each group) managed 248 life threatening emergency episodes (124 in each group) (Fig. 1).

3.1. Basic characteristics

A total of 110 life threatening emergency episodes were managed by 16 doctors (8 in each group) in DHQ Hospital, Khairpur, 42 episodes were managed by 6 doctors (3 in each group) in the Children Hospital, Peshawar and 96 episodes were managed by 14 doctors (7 in each group) in the DHQ Hospital, Vehari. No difference was observed in the proportion of life threatening emergency episodes presented in the morning, evening and night shift between the two groups. Similarly, an equal proportion of general, obstetric, neonatal and child health emergency episodes were presented in the two groups (Table 1).

Table 1
Basic characteristics of all the life threatening emergency episodes in the two study groups (n = 248).

Characteristics	Intervention group (n = 124)	Control group (n = 124)
Study site		
DHQ Hospital, Khairpur	54 (43.6%)	56 (45.2%)
Children Hospital, Peshawar	21 (16.9%)	21 (16.9%)
DHQ Hospital, Vehari	49 (39.5%)	47 (37.9%)
Shifts		
Morning shift	48 (38.7%)	47 (37.9%)
Evening shift	27 (21.8%)	32 (25.8%)
Night shift	49 (39.5%)	45 (36.3%)
Type of patients		
Adults	30 (24.2%)	32 (25.8%)
Children	33 (26.6%)	33 (26.6%)
Neonates	9 (7.5%)	10 (8.1%)
Pregnant women	44 (35.5%)	45 (36.3%)
Newborn needing resuscitation at birth	8 (6.5%)	4 (3.2%)

Table 2
Comparison of proportion of outcome measures between the two study groups by basic characteristics – individual level analysis ($n = 248$).

Characteristics	Intervention group		Control group		OR ^a (95% CI) ^b	p-Value
	Structured approach used	Structured approach not used	Structured approach used	Structured approach not used		
Study site						
DHQ Hospital, Khairpur ($n = 110$)	35 (64.8%)	19 (35.2%)	14 (25.0%)	42 (75.0%)	5.5 (2.3–13.8)	0.0001
Children Hospital, Peshawar ($n = 42$)	16 (76.2%)	5 (23.8%)	13 (61.9%)	8 (38.1%)	2.0 (0.4–9.3)	0.31
DHQ Hospital, Vehari ($n = 96$)	28 (57.1%)	21 (42.9%)	19 (40.0%)	28 (59.6%)	2.0 (0.8–4.8)	0.10
Shifts						
Morning shift ($n = 95$)	26 (54.2%)	22 (45.8%)	15 (31.9%)	32 (68.1%)	2.5 (1.0–6.4)	0.03
Evening shift ($n = 59$)	20 (74.1%)	7 (25.9%)	12 (37.5%)	20 (62.5%)	4.8 (1.4–17.2)	0.005
Night shift ($n = 94$)	3 (67.3%)	16 (32.7%)	19 (42.2%)	26 (57.8%)	2.8 (1.1–7.2)	0.01

^a OR – odds ratio.^b CI – confidence interval.

3.2. Impact on observed practices – individual level analysis

Out of 124 episodes observed in the intervention group, 79 (63.7%) episodes were managed according to the structured approach, while in the control group, out of 124, 46 (37.1%) were managed according to the structured approach (OR 2.98, 95%CI 1.78–4.99, p -value=0.0001). Site-wise analysis showed that in the DHQ Hospital, Khairpur, a significantly higher proportion of emergency episodes [35 (64.8%)], were managed according to the structured approach in the intervention group compared to control group [14 (25.0%)]. No statistically significant differences were observed between the two groups in the DHQ Hospital, Vehari and the Children Hospital, Peshawar (Table 2).

3.3. Impact on observed practices – cluster level analysis

The mean percentage (95% CI) of the structured approach used by doctors in the intervention group [62.9%(50.4%–75.3%)], was significantly higher than those in the control group, [36.3%(26.3–46.4)] (p -value=0.001). Site-wise analysis showed that in the DHQ Hospital, Khairpur, the doctors in the intervention group used the structured approach significantly more frequently compared to doctors in the control group. No statistically significant differences were observed between the two groups in the DHQ Hospital, Vehari and the Children Hospital, Peshawar. During the morning and evening shifts, doctors in the intervention group managed emergency episodes significantly more according to the structured approach compared to

doctors in the control group. No statistically significant difference was observed between the two groups during the night shift (Table 3).

4. Discussion

We demonstrated the effectiveness of the ESS-EMNCH training in improving the practical skills of doctors in the management of life threatening emergency episodes in public sector hospitals in Pakistan. The findings of our CRCT, both at individual and at cluster level analyses, suggest that the provision of a comprehensive 5-day training programme of the ESS-EMNCH in Pakistan may improve the practices of doctors when faced with an emergency in public sector hospitals for the management of emergency episodes in general, obstetric, neonatal and child health compared to the practices of untrained doctors working in the same specialties in the same hospital. The difference between the control and intervention groups' performance was similar, regardless of the nature of the nature of emergency (data not shown). Moreover, no previous emergency management trainings were conducted in these hospitals and the work experience of doctors in intervention and control group was same.

Our findings are comparable with other similar direct observations of the practices of healthcare workers after they have received training in emergency care such as in the management of neonatal care in hospitals.^{18,19} Thus, Senarath and co-workers conducted a study in 5 hospitals in Sri Lanka to evaluate the effectiveness of a

Table 3
Comparison of mean percentage of outcome measures between the two study groups by basic characteristics – cluster level analysis ($n = 36$).

Characteristics	Intervention group		Control group		Mean difference (95% CI) ^a	p-Value
	Structured approach used	Structured approach not used	Structured approach used	Structured approach not used		
Study site						
DHQ Hospital, Khairpur ($n = 16$)	75.0%	25.0%	35.4%	64.5%	39.6% (18.2–61.1)	0.001
Children Hospital, Peshawar ($n = 6$)	76.2%	23.8%	61.9%	38.1%	14.3% (23.1–51.7)	0.34
DHQ Hospital, Vehari ($n = 14$)	59.6%	40.4%	42.9%	57.1%	16.7% (11.6–45.1)	0.22
Shifts						
Morning shift ($n = 95$)	57.5%	42.5%	25.6%	74.4%	31.8% (5.4–58.2)	0.02
Evening shift ($n = 59$)	74.5%	25.5%	34.2%	65.7%	40.3% (8.1–72.4%)	0.02
Night shift ($n = 94$)	65.2%	34.8%	46.8%	53.2%	18.3% (8.6–45.4)	0.17

^a CI – confidence interval.

4-day training programme for the healthcare workers in obstetric units in improving practice of essential newborn care. The investigators directly observed the practices of healthcare workers in delivering essential newborn care after birth in the labour room. They reported that the training programme of the essential newborn care significantly improved the trained healthcare workers' practices of cleanliness at delivery, thermal protection, preparedness for resuscitation and neonatal assessment in the labour room compared with their practices before the training and with the untrained workers.²⁰ In Kenya, investigators evaluated the impact of a 1-day training of newborn resuscitation on the practices of healthcare workers in a public sector hospital. The investigators found that there was a significant improvement in healthcare worker's practices after the training compared with untrained healthcare workers working in the same hospital.²¹ All these findings suggest that there is a need for the training of healthcare workers to strengthen their practical skills in managing emergencies in public sector hospitals in resource poor countries.

In the current CRCT, site-wise analysis showed that a significantly higher proportion of emergency episodes in the intervention group was managed according to the structured approach compared to control group **only** in the DHQ Hospital, Khairpur. We can only speculate on why this happened. First, perhaps some of the doctors in the control groups of the other two participating hospitals had learnt and practiced the structured approach by observing the compliance with the structured ESS-EMNCH process of those who had undergone the training course (though our baseline survey findings highlighted that no other emergency management trainings were conducted in these institutions previously). Secondly, in the DHQ Hospital, Khairpur, the appropriate equipment for the management of emergency episodes was present unlike the situation in the other two hospitals where much essential emergency equipment was missing, which is an important component of ESS-EMNCH programme as highlighted recently in The Gambia.¹² Thirdly, less emergency episodes occurred at the Children Hospital, Peshawar, while relatively a higher number of emergency episodes were presented at the DHQ Hospital, Khairpur. Lastly, though our trainings are standardized, different instructors might have imparted the training to the doctors of the three participating hospitals with varying degrees of effectiveness.

Our cluster level analysis showed that during the night shift there was no significant difference in the management of emergency episodes according to the structured approach between the two groups. This could be due to the fact that during the morning and evening shifts, a higher number of healthcare workers are usually present in hospitals to help the duty doctor compared to the night shift. Moreover, senior doctors (physicians, surgeons and paediatricians) are also available during the day time.

There are three types of studies which can evaluate the impact of the life support training and all of these vary in their usefulness for determining effects on patient outcome. Studies of mortality and morbidity might provide the most direct information. The next best answer might be found in studies examining changes in practice behaviour among life support course participants. The weakest source of information is that derived from studies of knowledge and skill retention demonstrated in non-clinical or traditional testing manner. The available literature is heavily skewed towards the last approach.¹ Hence, we consider our current CRCT is in its methodology a better way to evaluate the impact of the ESS-EMNCH training in Pakistan.

Our study has some strong points. Firstly, the sample size of this trial was appropriate to investigate the study outcome. Secondly, there was a low risk of contamination (that is control also perform better by observing the practices of trained doctors) as only one doctor was usually present during the duty hours and we started to observe practices soon after the completion of training.

Finally, we conducted a round-the-clock, 7 days a week, observation at each hospital and therefore, we did not miss out on any emergency episode.

However, like any other study, this CRCT has some limitations. Firstly, it was quite difficult to blind our observers to the training status of the doctors they were observing. Secondly, we did not consider other factors, such as the presence of senior staff. Thirdly, the presence of an observer at the time of an emergency episode might have posed a limitation by influencing the compliance with structured process of the doctors in the emergency towards a favourable direction. Finally, we only observed doctors for a short period of time after the training and were unable to provide any information on the longer term duration of the effects of training on the compliance of structured process. Some studies have reported that the duration of emergency management skills deteriorated to pre-training levels after one year.^{22–25}

In conclusion, our study suggests that 5-day training of ESS-EMNCH significantly improves the compliance with the structured process of doctors during their management of life threatening emergency episodes in the public sector hospitals in Pakistan. In this current study we evaluated the impact of ESS-EMNCH training on the practices of doctors, however, it might be better to try and examine the impact of this training on maternal, neonatal and childhood mortality. Therefore, we suggest that a larger sample size, multicentred CRCT should be considered in the future to evaluate the impact of this training on mortality.

Conflict of interest

As a corresponding author and principal investigators, I declared no conflict of interest for all authors.

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References

- Jabbour M, Osmand MH, Klassea TP. Life support courses: are they effective? *Ann Emerg Med* 1996;28:690–8.
- Billi JE, Membdno GE. Education in adult advanced cardiac life support training programs: changing the paradigm. *Ann Emerg Med* 1993;22:475–83.
- All J, Howard M. The advanced trauma life support program in Manitoba: a 5-year review. *Can J Surg* 1993;36:181–3.
- Atkins JM. Training in resuscitation: is it worthwhile? *Chest* 1986;89:474.
- Collicot PE. Advanced trauma life support (ATLS): past, present, future. Sixteenth stone lecture, American Trauma Society. *J Trauma* 1992;33:749–53.
- Bilg JE. The educational direction of the ACLS Training Program. *Ann Emerg Med* 1993;22:484–8.
- Seidal JS, Henderson DP, Spencer PE. Education in pediatric basic and advanced life support. *Ann Emerg Med* 1993;22:489–94.
- Advanced Life Support Group. The practical approach. In: *BMJ books*. 4th ed. London: Blackwell Publishers; 2005.
- Hafeez A, Zafar S, Rifaq F, et al. Achieving health millennium development goals through capacity building of health workers-ESS-EMCH strategy. *Pak Paedr J* 2006;30:3–9.
- Bhutta Z. Maternal and child health in Pakistan. Challenges and opportunities. London: Oxford Press; 2004.
- Kane MT. The assessment of professional competence. *Eval Health Prof* 1992;15:163–82.
- Cole-Ceasay R, Cherian M, Sonko A, et al. Strengthening the emergency health-care system for mothers and children in The Gambia. *Reprod Health* 2010;7.
- Mackway-Jones K, Walker M. Pocket guide to teaching for medical instructors. London: BMJ Books; 1999.
- Zafar S, Hafeez A, Qureshi F, et al. Structured training in the management of emergencies in mothers, babies and children in a poorly resourced health system log-books to document skill use. *Resuscitation* 2009;80:449–52.

15. Childhealth Advocacy International. Programme for essential surgical skills with emphasis on emergency maternal and child health (ESS-EMCH). Islamabad: Childhealth Advocacy International; 2007.
16. Rowe A, Lama M, Onikpo F, et al. Design effects and intraclass correlation coefficient from a health facility cluster survey in Benin. *Int J Qual Health Care* 2002;14:521–3.
17. Hayes RJ, Bennett S. Simple sample size calculation for cluster-randomized trials. *Int J Epidemiology* 1999;28:319–26.
18. Vidal S, Ronfani L, da Mota Silveira S, et al. Comparison of two training strategies for essential newborn care in Brazil. *Bull World Health Org* 2001;79:1024–31.
19. Harris J, Yates B, Crosby W. A perinatal continuing education program: its effects on the knowledge and practices of health professionals. *JOGNN* 1995;24:829–35.
20. Senarath U, Fernando DN, Rodrigo I. Effect of training for care providers on practice of essential newborn care in hospitals in Sri Lanka. *JOGNN* 2007;36:531–41.
21. Opiyo N, Were F, Govedi F, et al. Effect of newborn resuscitation training on health worker practices in Pumwani Hospital, Kenya. *PLoS* 2008;3:e1599.
22. Carbine D, Finer N, Knodel E, et al. Video recording as a means of evaluating neonatal resuscitation performance. *Pediatrics* 2000;106:654–8.
23. Berden H, Willems F, Hendrick J, et al. How frequently should basic cardiopulmonary resuscitation training be repeated to maintain adequate skills? *BMJ* 1983;306:1576–7.
24. Jewkes F, Phillips BM. Resuscitation training of paediatricians. *Arch Dis Child* 2003;88:118–21.
25. McKenna S, Glendon A. Occupational first aid training: decay in cardiopulmonary resuscitation (CPR) skills. *J Occup Psychol* 1985;58:109–17.