

# Effects of Nationwide Training of Multi-Professional Trauma Teams in Norwegian Hospitals

Short title:

## Nationwide Training of Trauma Teams

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## **Abstract**

### *Background:*

Norway has 50 trauma hospitals serving a geographically disperse population (4.6 million) and many have low trauma case-loads. We showed that personnel find functioning as a team especially challenging, and developed a one-day training course, arranged locally at each hospital, focused on team training in communication, leadership, and co-operation during simulated patient treatment. This study evaluates the effects of training on participants' knowledge, confidence, and perceived trauma team performance, controlling for hospital size and the participants' previous experience.

### *Methods:*

Anonymous, written questionnaires were answered by 4,203 participants (28% physicians, 55% nurses) in 44 hospitals before and immediately after training courses, and by 1,368 trauma team members in 26 of the hospitals 6 months after their last training course. Outcome measures were knowledge and confidence concerning the respondent's own role, and evaluation of trauma team performance in live trauma resuscitations.

### *Results:*

There was a significant increase in self-reported knowledge and confidence among all participants. Community hospitals and participants without recent trauma experience had the lowest pre-intervention scores, but reached levels comparable to participants at the other hospitals after training. The effects increased after 6 months, with trauma team performance evaluated as having improved, even by team members who had not participated in the training.

*Conclusions:*

Practical team training in hospitals improved the participants' perceived knowledge and confidence, which continued to increase for 6 months after training independent of participants' experience level, suggesting that small hospitals may reach levels comparable to major hospitals.

*Key Words:*

Education, Trauma, Simulation, Quality improvement, Team work, Rural trauma

## INTRODUCTION

Norway is a sparsely populated country (4.6 million inhabitants, mean population 13.8/km<sup>2</sup>) with a coast line of 2650 kilometers and 50 hospitals responsible for emergency trauma care. Most trauma victims will initially be cared for at the nearest hospital due to geography and weather conditions. The experience in trauma treatment gained by the hospitals through the daily case load is insufficient to develop and maintain trauma team performance, as well as the team members' knowledge and confidence in trauma care. This problem is not limited to Norway, as described in a recent review (1). Several attempts to overcome this limitation by the use of simulators have been described (2-4). However, these simulators have been restricted to larger centers and are more or less immobile. In addition, other didactic alternatives are lacking. The ATLS courses were established in Norway as late as in 2004, and the annual training capacity is limited.

In Norway, with large distances and the expense of traveling, we had to develop a solution which could be more easily distributed. A group of anesthesiologists, surgeons, and a medical educationalist developed a program to improve trauma care at hospitals of different levels throughout the country (the BEST-project - BEST: Better & Systematic Trauma Care). This program has been described in detail elsewhere (5). The program comprises a one-day, multi-professional course arranged locally at each hospital, including simulation sessions (Table 1). Additionally, we developed a damage control surgery training course for surgical teams using a live animal model, and a network between the hospitals involved where procedures, experience, and training cases are exchanged.

We have previously shown that trauma team members in Norwegian hospitals considered communication, leadership, and prioritization to be the main problems they

encountered during their latest trauma team experience (5). Good communication, leadership, and co-operation are prerequisites for optimal team work (6-9). The use of simulation has been used successfully to teach team work (10, 11). The intention of this training was, therefore, to improve team work through local training at each hospital, using the participants' regular emergency rooms and equipment for practical simulations. By leaving the educational material and providing training cases for hospitals to subsequently arrange their own local training, our intention was to encourage simulated trauma team training locally at each hospital. Because of the supportive format, the program was not intended to formally assess competencies at the hospitals by the use of pre- and post-course testing or simulations with testing as an objective.

This study evaluates whether a one-day course in a complex and multi-professional setting in the emergency department of a hospital can improve trauma team performance and increase knowledge and confidence among health professionals. We also wanted to assess the long term effects in each hospital. Finally, hospital size and previous trauma experience was evaluated to determine whether these factors influenced the effect of the training course.

## **MATERIALS AND METHODS**

During an 8 year period (April 1997 to April 2005), 44 (88%) of Norway's 50 trauma hospitals were given one or more identical one-day courses. The hospitals included were at all levels, ranging from university hospitals with a regional trauma referral function, to small community hospitals serving 15,000 inhabitants. In terms of the categorization by the American College of Surgeons, these hospitals would range from level I through III (12). All personnel involved in trauma resuscitation at the actual hospital participated in a 3.5 h theory session based on case discussions. The course focused on accepted treatment principles

similar to the Advanced Trauma Life Support (ATLS®) course, and emphasized team skills like communication, co-operation, and leadership. The educational goals are listed in Table 1. Adjustments to the didactic content of practical procedures and treatment principles were achieved throughout the eight year period in accordance with internationally accepted changes in treatment policies.

Two trauma teams, composed according to their practice at the actual hospital, participated in two simulations each. The simulations were conducted in the hospitals' designated trauma room using a simple mannequin as a simulated patient. A standardized approach was used, with similar patient cases for each hospital. The training session was video recorded, and the entire team was debriefed after each simulation using a structured format. Each team participated in two consecutive simulations with subsequent debriefings. The challenges in patient treatment increased in a standardized fashion between simulation one and two, but the cases could be adjusted to compensate for differences in team skills. All courses were given by two to four instructors from a core instructor group of seven instructors who were specialized physicians.

The participants answered an anonymous, written questionnaire before and immediately after the course. The two questionnaires were coded and could subsequently be related without compromising anonymity. Questions included information about professional training and participation in trauma resuscitations during the 6 months prior to the training day. In addition, all participants reported their perception of their own personal knowledge of the correct order of procedures during resuscitation of trauma victims, their degree of confidence in their own role, and the perceived quality of care during the last trauma resuscitation they had participated in. A 10 cm visual analogue scale (VAS) was used for the respondents' judgment of their competence, confidence, and quality of care.

In total, 4,203 health care providers at 44 hospitals participated in the theoretical part of the training. Due to limited time and trauma room availability, only 1,767 of these providers participated in the simulated patient management.

We distributed a third questionnaire 6 months after the training course, to be answered by all participants in each hospital's trauma teams at the time of the survey, independent of whether the respondent had actually participated in the training course. This questionnaire contained questions similar to those in the previous questionnaires, but could not be related to the previous questionnaires on an individual basis. This questionnaire was answered by 1,368 trauma team members at 26 hospitals.

A subgroup consisting of 13 of the 44 hospitals had more than one training course, and additionally delivered answers to the questionnaire 6 months after the last training course. For these hospitals, comparisons of outcome measures could be performed for 3 time intervals: before the first course, before the last course, and 6 months after the last course.

In the questionnaire distributed 6 months after the last training course, trauma team members were asked to evaluate whether the training course had improved the over-all treatment offered to trauma victims at their institutions.

Outcome measures were self-reported changes in knowledge and confidence by the participating health professionals; evaluation of team performance in the last trauma resuscitation the respondent had participated in prior to the day of answering; and the respondents' evaluation of changes at their institutions.

Data were analyzed with the SPSS 11.0. T-test, and the one-way analysis of variance (ANOVA) with Bonferroni's correction was used for comparisons of means. The Kruskal Wallis test was used to compare groups with non-normal distributions. A p-value of less than 0.05 was considered significant. Means are given with the corresponding 95% confidence intervals (95% CI).

## **RESULTS**

Professional background and experience of the participants is described in Table 2. Recent experience handling multiple injured patients was reported by 55 % of the participants, with a median exposure to 1 (interquartile range 0-2) patients during the previous 6 months. The exposure to trauma victims differed significantly between hospital levels, with a median value and interquartile range of 0 (0-1) for community hospitals, 1 (0-2) for central hospitals, and 2 (1-5) for university hospitals ( $p < 0.0005$ ).

There was a significant increase in the respondents' reported knowledge of the correct order of trauma resuscitation procedures and degree of confidence in their own role after the course (Figure 1). For confidence in the respondents' own role, the self-reported assessment before the course was significantly different between all hospital levels, with primary hospitals scoring lowest. For knowledge of correct order of procedures, the primary hospitals were significantly lower than the two other levels on the pre-course response, while secondary and tertiary hospitals showed no significant differences. On the self-reported assessment after the course, all hospital levels significantly increased their scores. The community hospitals had the largest increase in both variables. For knowledge of correct order, respondents from the tertiary hospitals assessed themselves higher than respondents at the other two levels

(mean difference 0.23, 95% CI of difference 0.1 to 0.35,  $p < 0.0005$ ). For confidence in the respondents' own role, the tertiary hospitals again reached a higher level compared with the two other hospital levels (mean difference 0.33, 95% CI of difference 0.21 to 0.46,  $p < 0.0005$ ).

The development in perceived quality of care, knowledge about the order of procedures, and the respondents own role was assessed in hospitals with 3 independent assessments, as illustrated in Figure 2. The perceived quality of care increased significantly between the assessments made at the start of the first training course, at the start of the last training course, and 6 months after the last training course (mean difference 0.52 and 0.91 respectively, 95%CI of differences 0.19 to 0.85 and 0.65 to 1.16, and  $p = 0.001$  and  $p < 0.0005$ , respectively). Between the assessment before the first training course and the assessment made six months after the last training course, knowledge about the order of procedures and the respondents own role increased significantly (difference 1.16 and 1.42, respectively, 95% CI of differences 0.88 to 1.43 and 1.15 to 1.68, respectively,  $p < 0.0005$  for both comparisons).

Before the first training course in each hospital, the participants' evaluation of quality of care during their last trauma resuscitation was consecutively compared over the eight years the 44 hospitals entered the program. No linear trend was demonstrated using a one-way ANOVA test for linear trends ( $p = 0.364$ ).

Six months after the last training course, the respondents reported a mean score of 7.0 (95% CI 6.8 to 7.1) when evaluating whether the training course had improved the over-all treatment offered to trauma victims at their institutions. Scoring was done in a 10 cm VAS where 0 indicated "unchanged" and 10 "improved". No significant differences were observed

between hospital levels. To assess whether participation in the training course influenced the evaluation in the questionnaire that was distributed 6 months after the last training course, the respondents were grouped according to whether they participated in the training course. We found that evaluation of the last trauma resuscitation the respondent had participated in was similar in both groups (difference 0.1, 95% CI -0.1 to 0.3,  $p = 0.50$ ), while knowledge of the correct order of procedures and confidence in the respondents own role during resuscitation was higher in the group that took part in training (differences 1.0 and 0.5, respectively, 95% CI 0.7 to 1.8 and 0.3 to 0.7, respectively,  $p < 0.0005$  for both comparisons).

#### *Subgroups with and without recent experience*

The material was divided according to whether or not the respondents had participated in handling multiple injured patients during the previous 6 months. Before the training course, there was a significantly lower perceived knowledge about the correct order of procedures and confidence about the respondents' own role in the group without recent experience (Figure 3). Both groups increased their knowledge to a comparable level after the course, although the group with recent experience remained significantly above the group without such experience.

## **DISCUSSION**

This study demonstrates that a one-day training course, arranged locally in hospitals, with practical team training improves the participants' reported knowledge of treatment procedures, confidence in their own professional roles, and the perceived quality of care. Even non-participants evaluated the quality of care in their hospital as having improved 6 months after their colleagues participated in training.

This group of health care professionals is seldom exposed to severe trauma patients. Only 55 % had been engaged in the management of trauma victims during the 6 months prior to training. Regionalization of trauma care has been shown to improve trauma outcome in Canada (13). Geography and demography makes regionalization difficult in Norway, and improvements in trauma care will have to come from training. From the questionnaires, leadership and communication, two vital parts of team-performance, seemed to be the most common obstacles to proper trauma care as perceived by these professionals (5). A training course, therefore, has to cover these topics in theory and in practice, as has been shown previously (9, 14). Simultaneously, targeted individual skills and competency training, as the ATLS and similar courses, has to take place in parallel with team training. In Norway, these training modalities are seen as complementary, and not competitive (15).

If this training provides lasting results in hospitals, and not just to individuals, we would expect that quality of care during trauma treatment would be evaluated as better at later times in the same hospital, which actually happened. As the respondents in later courses did not participate in the primary course, this improvement has to be caused by other effects in the hospital per se. We consider that this indicates that improved team performance is transferred to the hospital as an organization. On the other hand, the knowledge of the correct order of procedures and the personnel's knowledge of their own role does not differ between respondents from the first training course in a hospital, to new participants at later training courses in the same hospital. We consider that these individual skills are not transferred in the organization as the collective effects of the team training are, and thus individual skills training must be conducted repeatedly. It was remarkable that the impact of this training seemed to be independent of the starting point. The subgroup of participants without recent

experience considered their starting point to be poorer compared with those who had recent experience. In the present study, both the experienced and the inexperienced reported that they achieved approximately the same level of both knowledge and confidence after training. Hence, recent experience did not appear to be a prerequisite for individuals to profit from this training course.

This team training course was intended to empower community hospitals to care for trauma patients with a quality comparable to major centers. The minor hospitals scored significantly lower on individual variables, but reached a level comparable to colleagues from university hospitals after the one-day course. Further training by local initiatives at each hospital was encouraged. All hospitals were invited to participate in a network. A recent study documented that hospitals that participated in this network have significantly better procedures, trauma team composition, and paging criteria compared with other Norwegian trauma hospitals (16). The existence of trauma teams, trauma manuals, and paging criteria have been shown to correlate well with improved trauma care when measured as mortality or length of stay in hospital (17-21).

The use of perceived quality of trauma care as an outcome measure is a limitation to this study. In an intervention taking place during a time span of 8 years, a simultaneous, independent development would be expected (13). The participants in our training courses were generally well experienced professionally. When they were asked to evaluate the quality of the last resuscitation they participated in, there was no significant development over time when consecutively enrolled hospitals were compared. If trauma care had improved generally over the time span, one might have expected a positive trend in this variable.

This study used self-reported variables as measures of effect, which is appropriate when the major problems during trauma resuscitation are perceived to be communication, leadership, and prioritizing (22, 23). The benefit of team training for communication and leadership has been shown previously (2, 24-26). The final proof of effect of the training program should ideally have been reduced mortality or real-time observations of defined actions during patient treatment. Unfortunately, no systematic nationwide trauma registration is undertaken in Norway, which excludes the possibility of evaluating the present trauma care by comparison with international standards.

In conclusion, this study shows that a one-day course arranged locally at each trauma hospital using multi-professional simulation can significantly improve self-reported knowledge about, and confidence in, initial trauma treatment. The course seems to give lasting results in quality of care as evaluated by trauma team members. The study indicates that minor hospitals with low case-loads of severe trauma patients can increase their personnel's perceived knowledge and confidence in trauma care. Minor hospitals seem to be able to improve perceived quality of care as much as the major hospitals, through this training.

## REFERENCES

1. Cryer HM. The future of trauma care: at the crossroads. *J Trauma* 2005;58:425-436.
2. Yee B, Naik V, Joo H, et al. Nontechnical skills in anesthesia crisis management with repeated exposure to simulation-based education. *Anesthesiology* 2005;103:241-248.
3. DeVita MA, Schaefer J, Lutz J, et al. Improving medical emergency team (MET) performance using a novel curriculum and a computerized human patient simulator. *Qual Saf Health Care* 2005;14:326-331.
4. Marshall R, Smith J, Gorman P, et al. Use of a human patient simulator in the development of resident trauma management skills. *J Trauma* 2001;51:17-21.
5. Wisborg T, Brattebo G, Brattebo J, et al. Training Multiprofessional Trauma Teams in Norwegian Hospitals using Simple and Low Cost Local Simulations. *Education for Health* 2006;19:85-95.
6. Davies JM. Team communication in the operating room. *Acta Anaesthesiol Scand* 2005;49:898-901.
7. Sexton JB, Thomas EJ, Helmreich RL. Error, stress, and teamwork in medicine and aviation: cross sectional surveys. *Bmj* 2000;320:745-749.
8. Wilson KA, Burke CS, Priest HA, et al. Promoting health care safety through training high reliability teams. *Qual Saf Health Care* 2005;14:303-309.
9. Sugrue M, Seger M, Kerridge R, et al. A prospective study of the performance of the trauma team leader. *J Trauma* 1995;38:79-82.
10. Holcomb J, Dumire R, Crommett J, et al. Evaluation of trauma team performance using an advanced human patient simulator for resuscitation training. *J Trauma* 2002;52:1078-1085; discussion 1085-1076.
11. Grogan EL, Stiles RA, France DJ, et al. The impact of aviation-based teamwork training on the attitudes of health-care professionals. *J Am Coll Surg* 2004;199:843-848.
12. American College of Surgeons, Committee on Trauma. *Resources for the optimal care of the injured patient*: Chicago, IL: American College of Surgeons; 1999.
13. Liberman M, Mulder D, Lavoie A, et al. Implementation of a trauma care system: evolution through evaluation. *J Trauma* 2004;56:1330-1335.
14. Cooper S, Wakelam A. Leadership of resuscitation teams: 'Lighthouse Leadership'. *Resuscitation* 1999;42:27-45.
15. Brattebø G, Wisborg T, Brattebø J, Brinchmann-Hansen Å. [Better trauma care– BEST or ATLS?] *Tidsskr Nor Lægeforen* 2001;121:505-6.

16. Isaksen MI, Wisborg T, Brattebo G. [Organisation of trauma services--major improvements over four years]. *Tidsskr Nor Laegeforen* 2006;126:145-147.
17. Esposito T, Sanddal T, Reynolds S, et al. Effect of a voluntary trauma system on preventable death and inappropriate care in a rural state. *J Trauma* 2003;54:663-669; discussion 669-670.
18. Piontek F, Coscia R, Marselle C, et al. Impact of American College of Surgeons verification on trauma outcomes. *J Trauma* 2003;54:1041-1046; discussion 1046-1047.
19. Olson C, Arthur M, Mullins R et al. Influence of trauma system implementation on process of care delivered to seriously injured patients in rural trauma centers. *Surgery* 2001;130:273-279.
20. Simons R, Eliopoulos V, Laflamme D, et al. Impact on process of trauma care delivery 1 year after the introduction of a trauma program in a provincial trauma center. *J Trauma* 1999;46:811-815.
21. McDermott F, Rosenfeld D, Laidlaw Jet al. Evaluation of management of road trauma survivors with brain injury and neurologic disability in Victoria. *J Trauma* 2004;56:137-149.
22. Maiuro RD, Vitaliano PP, Sugg NK, et al. Development of a health care provider survey for domestic violence: psychometric properties. *Am J Prev Med* 2000;19:245-252.
23. Weller JM, Robinson BJ, Jolly B, et al. Psychometric characteristics of simulation-based assessment in anaesthesia and accuracy of self-assessed scores. *Anaesthesia* 2005;60:245-250.
24. Awad SS, Fagan SP, Bellows C, et al. Bridging the communication gap in the operating room with medical team training. *Am J Surg* 2005;190:770-774.
25. Morey J, Simon R, Jay G et al. Error reduction and performance improvement in the emergency department through formal teamwork training: evaluation results of the MedTeams project. *Health Services Research* 2002;37:1553-1581.
26. Shapiro MJ, Morey JC, Small SD, et al. Simulation based teamwork training for emergency department staff: does it improve clinical team performance when added to an existing didactic teamwork curriculum? *Qual Saf Health Care* 2004;13:417-421.

Table 1.

## Didactic and skill elements in the training course

<b>Didactic components</b>	<b>Goal</b>	<b>Method</b>
Treatment priorities, ABCDE-format principles	Reach a common understanding for prioritizing	Interactive lectures based on cases
How to create optimal teamwork	To provide knowledge of leadership, distribution of workload, crosschecking, and adaptability as prerequisites for teamwork	Interactive lecture with illustrations
Communication pitfalls	To increase awareness of obstacles to good communication	Lectures based on cases using experience from the participants
Change in hospitals	To provide tools for understanding how to achieve change in complex organizations	Lecture with examples from other change processes
Efficient communication	How to improve communication by using closed-loop, clear orders, and low noise level	Training by simulation and debriefing based on knowledge given through lectures
Well-functioning co-operation	Communicates, listen, offers assistance, supportive	Simulation and debriefing
Leadership	Distributes workload, oversees patient care, crosschecks information, shares information, assesses patients status, takes responsibility	Simulation and debriefing

Table 2.

Demographics of health professionals participating in the trauma team training course  
(complete information available on 3,765 of the 4,203 participants)

<b>Profession</b>	<b>n</b>	<b>% of all</b>
Physicians	1,044	28
Registered nurses	2,096	55
Other professionals	643	17
<b>Professional experience</b>	<b>n</b>	<b>% of all</b>
0-4 years	1,052	28
5-9 years	724	19
10+ years	1,989	53

## Legend to figures

### Figure 1a and b

Trauma team members' self evaluation of the degree of confidence in their own role and their personal knowledge of the correct order of procedures during the resuscitation of trauma victims, based on a visual analogue scale before, and after, a one-day training course. Team members are grouped after hospital level (primary, secondary, and tertiary hospitals).

\* Denotes significant difference from other hospital categories. Values are expressed as the mean and 95% CI.

### Figure 2

Trauma team members' evaluation of the last trauma resuscitation they participated in, and their perceived knowledge of the correct order of procedures and their own role during trauma victim resuscitation. Data are provided from hospitals that had more than one training course, and that delivered answers 6 months after the last training course. The number of valid answers varies between 279 and 761 to each variable. \* Denotes significant difference from first training course. Values are expressed as the mean and 95% CI.

### Figure 3

The increase in perceived knowledge of the correct order of procedures during trauma resuscitation and the perception of respondents own role during treatment after a one-day training course according to real-life trauma team experience in the 6 months prior to answering. The differences between groups before and after training, and within groups before and after training, were all significant. Values are expressed as the mean and 95% CI.

Figure 1a and b

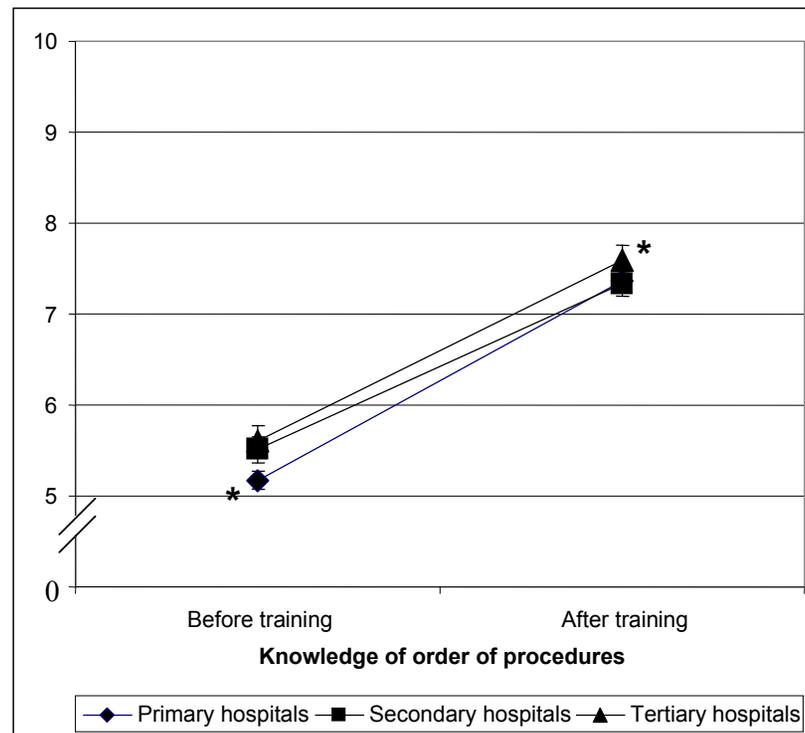
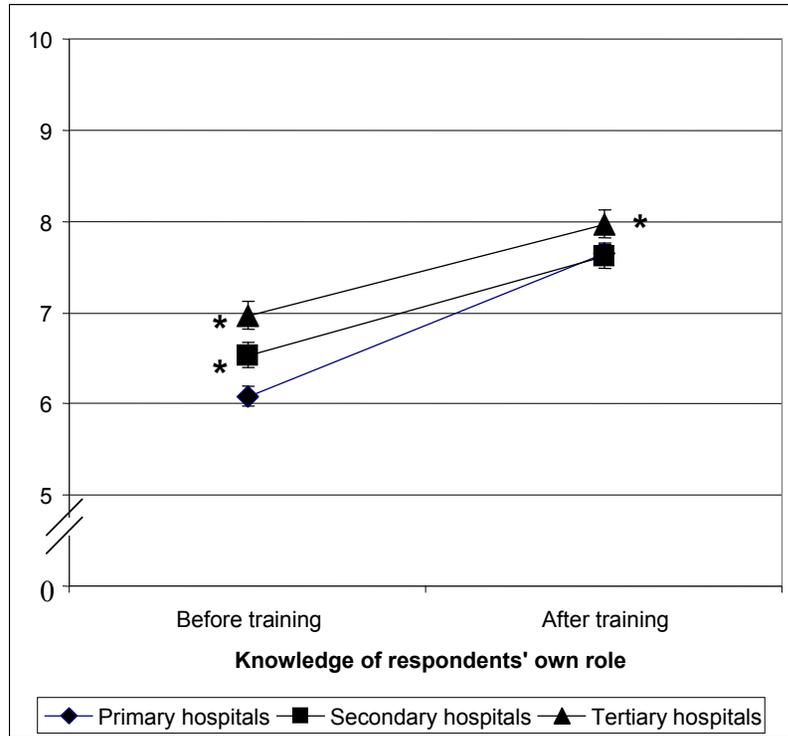


Figure 2

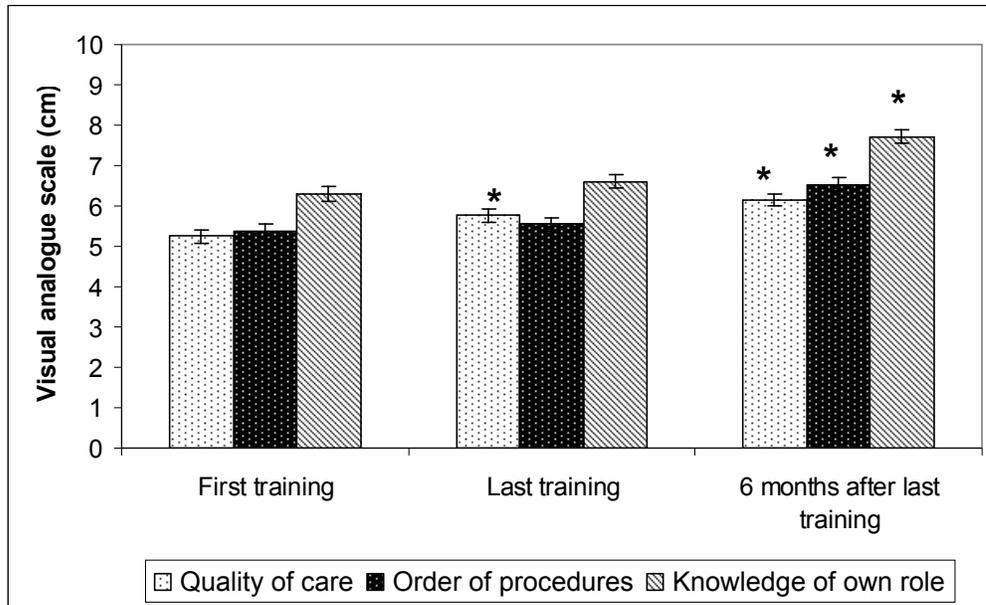


Figure 3

