Using the computer-based feedback (CBF) system to investigate the juniorphysicians's and clinical-instructors perceptions for the benefits of general medicine clinical-instructors training program

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Abstract

Background: *The purpose of this study is to examine the clinical-instructors and junior-physicians (residents and interns) perceptions for the general-medicine training program by using bi-directional interactive and self-assessments computer-based feedback (CBF) and paper-based multisource feedback assessment (PBMFA) systems for the efficiency and benefit evaluation.*

Methods: *Between 2011 January to 2013 December, junior-physicians and their clinical-instructors in the same medical team were enrolled consecutively for monitoring the CBF scores gave by each other after each clinical course. A total of 321 residents, 298 interns and 110 clinical-instructors who participated in the core competency general-medicine training program in 6-months period were included in the study. The CBF and PBMFA evaluations are undergone paralleled to gather the suggested information in different levels of Kirkpatrick evolutional theory.*

Results: *The results showed that lecturers, being 5-10 years as attending physicians, internal medicine sub-specialty clinical-instructors are most benefit from the general medicine training program. Accordingly, the CBF scores of junior-physicians was positively correlated with the times (> 3-times) of exposure to the medical teams that leaded by qualified clinical-instructors. Both clinical-instructors and junior-physicians have positive attitude to the value of the general-medicine training program. Interestingly, a good consistency was existed between residents CBF scores and PBMFA grades for their core-competency performance. Comparatively, the overall perception of clinical-instructors and junior-physicians for the general-medicine training was very positive.*

Conclusions: *Clinical-instructors and junior-physicians had positive perception of CBF and PBMFA systems which could give us different information to improve and strength the further core-competency general-medicine training program by appropriate utilization.*

Background

The health care system has encountered massive transformation over the last few decades [1,2]. Rather than the traditional concepts of injected knowledge, the urge to cultivate junior-physicians (residents and interns) into an ACGME competence doctor is the main aim in the modern effective clinical-instructors mentoring system. To guide junior-physicians effectively, clinical-instructors must possess considerable teaching skills, knowledge, patience caring and commitment [3]. Continuous training of clinical-instructors for teaching junior-physicians has been a routine in health care system. Modern challenges of the medical education are involving a change in roles of the junior-physicians and their clinical-instructors, and gear to an assumption of quality being part of a continuous improvement process. Previous study had reported a positive correlation between teaching effectiveness and their years of experience as attending physicians [4,5]. The evaluations of the feedbacks from the participants are important for program director to modify their content to meet the goal and aim of program progressively.

The rapid advancement of Information and Communication Technologies in teaching and learning has shifted paradigm from paper-based to computer-based feedback system. In general, the computer-based integral system can effectively delivery similar amount of question on papers and storage the teachers and learners responses. In other words, the link between observation and interpretation through computer-based technologies makes it possible to score and interpret multiple learners and teachers performance and compares the results against endpoints that have interpretive value [6-8].

This study aims to assess the effectiveness of our new computer-based feedback (CBF) system on the evaluation of the structures, process and outcome of the quality of the core-competency training program in "teaching" and "learning".

Methods

Background of General-medicine clinical-instructor training program in Taiwan

Taipei Veterans General Hospital (Taipei VGH) is a medical centre providing primary and tertiary care to active-duty and retired military personnel and their dependents, and is the primary teaching hospital for "General-medicine clinicalinstructor training program". Taipei VGH has continuously received support from the government Department of Health (DOH). Since 2009, Executive Yuan of Taiwan ROC had aggressively deployed teaching resources to help establish a patient-centred health care system [9]. Actually, our "General-medicine clinical-instructor training program" is similar to American model, which was developed by the ACGME (Accreditation Council for Graduate Medical Education). The expectations of our program are that junior-physicians are competent in the six-core competencies including medical knowledge, interpersonal and communication skills, system-based practice, practice-based learning and improvement, professionalism, and patient care [10]. In the past, the effectiveness of general-medicine clinical-instructor training program is mainly evaluated by paper-based multisource feedback assessment (PBMFA) system.

Computer-based feedback (CBF) system

Since 2011, the online CBF system using the perception software was established and undertook simultaneously with traditional PBMFA system. For clinical-instructors, the feedback questions were presented and marked using an optical mark recognition (OMR) in a single Web page which could scroll through to chose and change answer at will. Differently, the question-by-question delivery that user did not need to scroll through the

questionnaire, but the questions occupy more than one computer screen is occupied in junior-physicians' questionnaires. Again, they choose to answer the questions in any order, and change answers at will in the CBF system. Both for clinical-instructors and junior-physicians, there are a narrative part that giving them opportunity for bi-direction responses of their additional feedback that not including in the designed items perception about each others.

CBF system is design to on-line assessment of the courses learning and teaching performances of junior-physicians and their clinical-instructors. The items for the assessments of junior-physicians and their clinical-instructors were listed in

Additional file 1 and 2. Both junior-physicians and their clinical-instructors should complete this computer-based feedback (CBF) on-line at the end of each clinical course. The items in CBF were adapted from the teaching evaluating index from previous study [11].

CBF assessment of clinical-instructors

Between 2011 January to 2013 December in Taipei Veteran General Hospital, junior-physicians and their clinical-instructors were enrolled consecutively for monitoring the CBF scores gave by their clinical-instructors after each clinical course in the same medical team. Totally, 321 residents, 298 interns and 110 clinicalinstructors were included in our study. In order to be the qualified clinical-instructors for teaching junior-physicians, they should complete the 40-hour of general-medicine training course continuously within one-month. All clinical teachers participated in the training course voluntarily. Overall, the design of the content of general-medicine training program by Taiwan Association of Medical Education (TAME) was based on the coherent educational theory proposed by Hewson et al. [12]. Briefly, the program include video watching, mini-lecture, small-group discussions, demonstrations, role plays, and simulated teaching experiences in order to promote a change in the attitudes, values, beliefs and assumptions about teaching ability of clinical-instructors [13].

The content of our training course had been reported previously that including all the activities requested by TAME [13]. (1) Outpatient department (OPD) teaching demonstration; (2) Itinerant bedside teaching demonstration; (3) Circuit bedside teaching demonstration; (4) Physical examination (PE) teaching demonstration; (5) Case-based discussion (CbD) teaching demonstration; (6) Evidence-based medical

(EBM) teaching demonstration; (7) Objective structural clinical examination (OSCE) teaching demonstration; (8) Mini-clinical evaluation exercise (min-CEX) teaching demonstration; (9) Training workshop on "how to teach ACGME competencies?"; (10)

Video watching on "how to teach ACGME competencies?"

Thus, we compared the average computer-based feedback (CBF) score 3-month before and after general-medicine training course. Consequently, every clinicalinstructors will have four average CBF scores (CBFbefore and CBFafter) from juniorphysicians during the studied period. Briefly, these scores were named as residents to teachers [R-T-CBF before and R-T-CBFafter], or interns to teachers [I-T-CBFbefore and IT-CBFafter] CBF scores in our current study. For analysis, we transferred these scores [R-T-CBFbefore、R-T-CBFafter、I-T-CBFbefore and I-T-CBFafter] into 100% and the average were calculated. Additionally, the impacts of gender, position (professors, associated professors, assistant professors and lecturers), subspecialty and years as being the attending physicians of clinical-instructors on their core-competency teaching performance were analyzed.

CBF assessment of junior-physicians

For junior-physicians (residents and interns), they got the ACGME corecompetence CBF scores from their clinical-instructors every clinical course. Similarly, we transferred their courses core-competence CBF scores [teacher to resident (T-RCBF) and teacher to intern (T-I-CBF)] into 100% and the average of 6-courses were calculated for analysis. For each residents and interns, the baseline and post-training (6-month later) CBF scores were compared and the percentages of the improvements were calculated. Additionally, the correlation between these core-competence CBF scores and the frequency (<1, 1-3, 4-6, 6-8, >8 times) of exposure to the teaching of general-medicine qualified clinical-instructors within 6-courses follow-up was investigated.

Paper-based core-competence courses resident□s multi-source feedback assessment (PBMFA)

PBMFAs were undertaken at the end of each clinical course. The PBMFA evaluate general aspects of competence including communication skills, clinical abilities, medical knowledge, technical skills and teaching abilities that showed in Additional file 3. Twelve-item, one page PBMFA forms is made by the faculty members including chief resident (1), attending physician (1) , division chief (1) and chief nurse (1) of each services that residents rotated through monthly [14,15]. The items in Additional file 3 are designed based on core-competence for assessing the resident□s meeting and ward performance including clinical problem solving abilities, interpersonal communication skills, case presentation, and journal club participation. Totally, each resident got six PBMFA scores in internal medicine department. The average of these PBMFA scores were divided as five grades including high honors (HH), honors (H), satisfactory (S), incomplete (IC) and unsatisfactory (US). Then, the mean T-R-CBF scores were compared between mean course (PBMFA) grade category cohorts of each resident.

Subsequently, the predictability, which represented as sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV), of resident□s TR-CBF scores for their PBMFA grade were calculated at specific cut off thresholds. The definitions of these terms as applied to our study are: (1) Sensitivity: number of residents receiving the HH and H (PBMFA) grade who scored high (□90, □85, □80 or □70) on T-R-CBF scoring system (true positive)/number of residents receiving HH and H; (2) Specificity: number of residents receiving PBMFA grade of S, IC, or US who scored low (<90, <85, <80 or <70) on T-R-CBF scoring system (truenegative)/number of residents receiving PBMFA grade of S, IC, or US; (3). PPV: number of residents receiving the HH and H PBMFA grade who scored high (□90, □85, □80 or □70) on the T-R-CBF scoring system (true-positive)/number of residents scoring high (□90, □85, □80 or □70) on the T-R-CBF scoring system; and (4) NPV: number of residents receiving course PBMFA grade of S, IC, or US who scored low on the T-R-CBF scoring system (true-negative)/number of residents scoring low (<90, <85, <80 or <70) on T-R-CBF scoring system.

Paper-based self–assessment of clinical-instructors after finishing general medicine training program

For clinical-instructors, the paper questionnaires were applied before and 3months after finishing the general-medicine training course. The structured questions in part I were rated by five-item Likert scale to assess the degree of clinicalinstructor's agreement with the following questions (A) Training program is very useful for improving my teaching skills; (B) The skills learnt from training program are very applicable; (C) After implementation of the skills attained from training program in my teaching (C-1) My students (residents and/or interns) are more participatory in discussion and “patient care”, (C-2) I have a better teacher-student interaction, (C-3) My student has better medical-team relationship, (C-4) My student showed more active and success in carrier planning and self-development.

The Part II of the self-assessments by clinical-instructors was the attitudes for our CBF and PBMFA system with the following questions (1) CBF system facilitates me to assess my student in short time, (2) Using CBF system in preparing and declaring training efficiency data minimizes clerical mistakes, (3) CBF system decreases the work loading of administrators, (4) PBMFA system has high complete rate and help collect real-time information, (5) Both CBF and PBMFA system should be kept parallel.

Paper-based self–assessment by junior-physicians for the ACGME core-competency training before and after 6-courses of follow-up

In addition, the self-assessment for the general-medicine core-competency training was undergone using paper questionnaires before and 6-months after initiation of their resident-ships or internships. The structured questions were rated by five-item Likert scale to measure the perceptions of junior-physicians to the following questions (1) I consider ACGME core-competency should be learnt, (2) I am familiar with the context of core-competency, (3) I have the ability to apply core-competency in my "patient care" work, (4) Core-competency helps me in carrier planning and selfdevelopment.

Analysis

Data were shown as mean ± standard deviation (SD). Statistical analysis was performed using SPSS version 13.0 (SPSS Inc., Chicago, IL, USA). Analysis of variance (ANOVA) and unpaired t test were used to compare the means of basal characteristics of participants, mean CBF scores and PBMFA grades of clinicalinstructor and junior-physicians, and the differences in the attitudes, familiarity and teaching ability between different groups. Paired 2-samples t,s test was used to compare the performance of pre-and post-course scores of all participants during
, general-medicine training period. The degree of changes in the participants attitude and familiarity to teach and train ACGME competence after core-competency training course were analyzed using paired t-tests. An $\alpha < 0.05$ was accepted as statistically significant. The sensitivity, specificity, positive and negative predictive value of different range (from lower to high category) of T-R-CBF scores for the predictability of corresponding resident□s PBMFA grade were analyzed for the p-values of trends.

Ethics statement

This study was approved by the Ethics Committee of Taipei Veteran General Hospital and complied with the principles of the Declaration of Helsinski Guidelines. In agreement with these standards, written informed consent was obtained from each participant.

Results

Basal characteristics of all participants

In Table 1, we found that most (65%) of our core-competency qualified clinicalinstructors were within the age of 35-40 year-old. Male (70%) and assistant professor (45%) clinical-instructors are dominant in our study. Most (55%) of our qualified clinical-instructors had the mean experiences of 2-5 years as attending physicians. About the junior-physicians, the percentage of residents (51%) and interns (49%) were similar. The percentage of male junior-physicians (59.6%) is significantly higher than female junior-physicians (40.4%).

Lecturers (clinical-instructors) were more beneficial from the general-medicine training program

The baseline CBF scores that got from junior-physicians were not different between male and female clinical-instructors (Table 2). Meanwhile, the degree of the improvement of R-T-CBF or I-T-CBF scores after finishing our general-medicine training program were not different between male and female clinical-instructors. Notably, the baseline R-T-CBFbefore scores were not different between lecturers and other clinical-instructors (assistant, associated professor and professor). However, the degrees of the improvement of R-T-CBF or I-T-CBF scores were significantly higher (7.2% or 7.3%) in lecturers than other clinical-instructors.

Clinical-instructors with 5-10 years experiences as attending physicians and internal-medicine sub-specialty benefit most from general-medicine training program

Additionally, the Figure 1 displayed that the clinical-instructors that most beneficial from the training program were those with 5-10 years being as attending physicians. In other words, the percentage of increase R-T-CBF or I-T-CBF scores were most dominant (14% or13.4%) in this group of clinical-instructors who being as attending physicians for 5-10 years. In Figure 2, clinical-instructors who came from internal medicine sub-specialty benefit most (17% or 22%) from general-medicine training program than those came from others sub-specialties [including surgery, paediatrics/gynecology, emergency medicine, neurology, psychiatrics, chest medicine, rehabilitation and family medicine]

The satisfactions to the general-medicine training program were positively correlated with the years as being attending physicians of clinical-instructors

In Table 3, male clinical-instructors felt that the skills learn from training program are very applicable compared to the perception of female clinical-instructors (3.8 vs. 2.1). Otherwise, both male and female clinical-instructors agreed that the training program was very useful for improving their teaching skills (3.1 vs. 4.1). However, the good perception about the values of general-medicine training program was positively correlated with longer years of being as attending physicians. Most of the clinical-instructors reported that training program is very useful for improving their teaching skills, and the skills learnt from training program are very applicable. Most of them reported that the benefits of implementation of the skills obtained from training program including their students are more participatory in discussion and "patient care"、they have a better teacher-student interaction 、their students have better doctor-patient relationship、their students show better in carrier planning and self-development (>2 points).

On the other hands, the general perceptions about the CBF and PBMFA systems were also evaluated in our study (Table 3). Most of the clinical-instructors reported that the CBF system facilitate them to assess their student in short time, and the using of CBF system in preparing and declaring training efficiency data minimizes clerical mistakes. The agreements to above two questions were highest in clinical-instructors whose being as attending physicians for 2-5 years (>4 points). However, most of the clinical-instructors also agree that the CBF decreases the work load of administrators, PBMFA system has high complete rate and help collect real-time information. So, they suggested that both PBMFA grading and CBF systems should be kept parallel. The agreements to above three questions were highest in clinical-instructors whose being as attending physicians for 5-10 years (>4 points).

The core-competency CBF score that junior-physicians got from clinicalinstructors were positively correlated with the times of them exposure to the qualified clinical-instructors medical teams

Figure 3 revealed that the T-R-CBF and T-I-CBF scores that junior-physicians got from clinical-instructors were progressively increased during the 6-months of general-medicine training course. On the other hand, the magnitude of the improvement of CBF scores were greater (21.6% vs. 10%) in residents (T-R-CBF score) than those of interns (T-I-CBF score). During their 6-month of generalmedicine training course, the magnitude (changing percentages) of the improvement of T-R-CBF and T-I-CBF scores reached maximal (30% or 15%) when residents or interns exposure to more than 3 times of medical team leading by qualified clinicalinstructors. It seems that residents (30%) are more benefit from the increasing exposure frequency to qualified clinical-instructors than interns (15%). (Figure 3)

Junior-physicians have positive attitudes to the values of the core-competency that trained in general-medicine training program

Results of PBMFA systems in Figure 4 displayed that most junior-physicians felt that (A) core-competency should be learnt, (C) core-competency help them in carrier planning and self-development, and (B) they are familiar with the content of corecompetency after receiving 6-months of the general-medicine training program. In the 6-month follow-up questionnaire, both residents and interns reported that they have the ability to apply different aspects of core-competency in their clinical work after entering our general-medicine training program. Additionally, the resident□s and intern□s perception about the CBF and PBMFA systems were similar to their clinicalinstructors (data not shown).

Good consistency was existed between CBF score and PBMFA grade of residents

In Figure 5A, higher resident□s mean T-R-CBF scores were positively correlated with better PBMFA grades. The incremental higher percentage (40%, 52%, 60%, 80%) of residents got higher PBMFA grade [high honor (HH) and honor (H)] from their teachers (Fig. 5B) when the corresponding resident□s T-R-CBF scores were divided into four group (<70, 70-80, 80-90, >90). These results indicated that the residents who got high T-R-CBF score also got good PBMFA grade from their corresponding clinical-instructors. The figure 5C also revealed that the good predictability of resident□s T-R-CBF score for the corresponding PBMFA grade was existed especially in good performance groups (T-R-CBF score □90 and □85 groups). Overall, the CBF system has a comparative efficiency to PBMFA system for clinicalinstructors to evaluate the performance of resident's core-competency.

Discussion

Kirkpatrick has described four levels of training program outcomes that need to assess [16]. The first level is a measure of participants, initial reaction to the program. The second level is an assessment of the amount of knowledge and skill that participants learned, while the third level is an evaluation of the amount of knowledge and skills learned that participants actually use in everyday work. The fourth level is an evaluation of the impact of the program on the institution. Previously, we had already
, assessed the clinical-instructor□s perception about the levels 1 to 3 of Kirkpatrick of our program [13]. In the healthcare system, the holistic evaluation of the efficiency of our general-medicine training program should include the junior physicians (residents and interns) who will be taught by clinical-instructors for their core-competency. Accordingly, our current study is characterized by on-line computer-based bidirectional interactive assessments of the impacts of the core-competency teaching and learning abilities of the clinical-instructors and junior-physicians by each other. After 3-6 months of follow-up, the paper-based self assessment of the

efficiency of the core-competency training program and their satisfaction of training program were undergone by clinical-instructors and junior-physicians themselves. These self assessments also included clinical-instructors perceptions about the acceptability for CBF system. Meanwhile, the impacts of age, gender, position, duration of being as attending physicians, sub-specialty of participants on the efficiency of generalmedicine training program were analyzed. Finally, the predictability of CBF assessment of the resident□s core-competency for the PBMFA system was also calculated among the high- and low-grade categories.

For years, the challenge for educators is to find the cost- and time-efficient evaluation tool that providing reliable and valid data for facilitating the learning and teaching effectiveness of training program. By targeting areas of formative education, a program director is better able to make decisions regarding underdeveloped foci of the training, make adjustments rapidly, and then assess for it actual effectiveness on teacher□s (clinical-instructors) and learner□s (residents and interns) behavior.

In our study, the ultimate goal of the evaluation process is to elucidate the achievement of the competency-based learning objectives that preparing qualified physicians to meet the healthcare need of the public. Our study using the self and bidirectional interactive assessments to find whether our general-medicine training program effective cultivate qualified clinical-instructors and junior-physicians. For example, our study evaluate whether the general-medicine training program improves the overall quality of clinical-instructors who are responsible for training learners (residents and interns). Indeed, our CBF system is a bi-directional real-time system for both junior-physicians and clinical-instructors. Interestingly, the high CBF scores effectively predicted the resident□s high PBMFA grade in our current study. However, this good predictability of CBF for the PBMFA grade was loss in lower scoring category. It has been reported that the identification of lowest scoring categories provides important information to a program director for effectively training learners as a group. So, this is an important limitation of our study that needs to be improved in the future.

Most of our learners and clinical-instructors reported that the process of selfassessment facilitated the self-awareness and actual behavioural improvement of themselves. Additionally, both our CBF and PBMFA grading evaluations allow written comments in addition to numerical ratings [18-21]. Timely handling and constructive response to these additional comments from clinical-instructors and learners by the program director and supervisors can assists individual in managing their own performance and career [18-21]. Using the CBF system can help the program director to response these additional comments or problems on line
efficiency.

Traditionally, paper-based questionnaires were developed by different department according to the contexts the curriculum that design by their departments including internal medicine, surgery, paediatrics/gynecology, emergency medicine, neurology, psychiatrics, chest medicine, rehabilitation and family medicine in our medicine centre. Both for clinical-instructors and junior-physicians, they need to fill all these evaluation forms and questionnaires under the strict eyes of teaching assistant of different departments. In this case, it will difficult for them to give real narrative rewards in the limiting time and uncomfortable environment. Meanwhile, clinical-instructors and junior-physicians will absent from the conference or meeting due to busy clinical works which making unsatisfactory response rates. Among all the department of our medical centre, the core concept of the general-medicine training program is similar. However, it is still difficult for the committee to unify the evaluation form without the computer-based system. Finally, the variation of the items in questionnaire and evaluation form make curriculum or program designer difficult to analyze and compare the efficiency of training in different departments. Moreover, the paper-based system will difficult to known simultaneously whether all clinical-instructors and junior-physicians complete the questionnaire precisely at the end of each training course. It had been reported the delay and retrospective filling of the evaluation form have the risk of recall bias due to progressive forget the impression about the effectiveness of training program.

This is the reason that a computer-based questionnaire assessment (e-assessment) was designed in our system that wish to provide guidance for further teaching and learning feedback system development. The advantages

of e-assessment include providing opportunities for self and peer evaluation, increased opportunity for timely and detailed formative feedback, flexibility with regard to behaviours examined and ratters involved, monitoring of progress for both student and mentor, and helping subset analysis with an opportunity to improve the corresponding skills of users. During the mature process, the e-assessment can add new rating groups and new to be examined, and allow the mentor to adapt teaching responsively. Meanwhile, the benefits of computer-based feedback are well-documented for staff. They are include rapid turnaround of formative feedback to students, establishing an electronic database that is ease to documented and rapid access, reduced work loading of staffs and creating a closer match between the evaluation and learning environments. Disadvantages of e-assessment include hardware/software costs, potential for information overload, selective bias, discoverability, and the potential for less-thanhonour feedback [21].

Our clinical-instructors reported that the presentations that require changing page are less acceptable than those in which feedback questions are presented one at start in one page. So, appropriate screen design is perhaps the most important factor for the success of the online feedback evaluation system [18]. Probably, the two greatest physical differences between computer-based and paper-based feedback system involve perceived interactivity and physical size of the display area. The amount of information comfortably presented in a computer display is only about one-third of the presented by a standard piece of paper. It had been reported that when feedback questionnaire associated with the question requires more than one page, computer administration yielded lower satisfactory, complete and positive response rate than paper-based feedback questionnaire. This observation apparently is due to the difficulty of reading the extended content of feedback questionnaire on computer screen. When the items and content of feedback questionnaire need more than one page to display, the students can rapidly scan all of the questions and items on one paper page and can easily flip backward or forward to other pages (a form of interactivity). Conversely, the large amount of items on the feedback questionnaire should display on several computer screen and students must physically act to move from screen (item) to screen (another form of interactivity). This difference likely leads to greater “focus” and closure with each computer-based item. Thus computerbased items (relative to paper) may increase transition time and possibly lose their temper to complete all items within limited time due to heavy clinical loading.

We are sure that each new application system may have both positive and negative consequences. Finally, user acceptance is decisive for its success. In our CBF system, the general negative response by junior-physicians might come from the difficulty of interacting with the feedback software because of the way that it was presented on the computer screen. Intending to mimic a paper-based feedback in which all questions are presented to students at the start, they can scroll through the pages might improve the positive response and answer rates.

Over the 10 years, more medical facilities and practices are including multiple source feedback assessment (MSFA) as an essential part of both performance evaluation and professional development. Especially, MSFA have been widely used in several medical and surgical residency training programs with their usefulness being very positive [19, 20]. In our system, both computer-based and paper-based evaluation system were persevered for clinical-instructors to evaluation the juniorphysicians and general-medicine training program. In this circumstance, it will be difficult for data manager to decide which data they should believe when facing inconsistent results by computer-based and paper-based assessment system of residents. Especially, our data revealed that the predictability of low scoring category CBF scores was poor for PBMFA grade. According to previous reports, the MSFA grade might be more reliable than our developing CBF system in this inconsistent condition [14-15, 17-20]. Indeed, MSFA focuses on multiple perspectives and levels of evaluation leading to results that are considered to be highly credible and a powerful tool to change behaviour and competency. In contrast, the CBF system is a traditional peer review process for residents and physicians used as the only ratters.

Conclusions

According to our study, lecturers, clinical-instructors with 5-10 years experiences as attending physicians and internal-medicine sub-specialty got most benefit from general-medicine training program. The satisfactions to the general-medicine training program were positively correlated with the years as being attending physicians of clinical-instructors. The core-competency CBF score that junior-physicians got from clinical-instructors were positively correlated with the times of them exposure to the qualified clinical-instructors medical teams. Junior-physicians have positive attitudes to the values of the core-competency that trained in general-medicine training program. Good consistency was existed between CBF score and PBMFA grade of residents.

In practice, appropriate utilization of these feedback information obtained in this article might improve and strength the further core-competency training program. The follow-up questionnaires indicated a positive influence of bi-direction and interactive feedback system between clinical-instructors and junior-physicians for general-medicine core-competency development.

Competing interests

The authors declare that they are no competing interests.

Authors' contributions

CCH, CCH, YYY conceived and developed the study. LYY, HCH, YYY completed all the fieldwork, participant intervies and de-identification of data prior to the analysis. HMC, CLC, WSL provide comments on the initial data analysis and assisted with the early drafts of manuscript. CCC, CHC, STH provided expert advice about the research method and comments on the final draft of the manuscript. CCH, FYL, LYY, YYY contributed substantially to the intellectual substance of the manuscript and are in full agreement regarding its content.

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Figure Legends

Figure 1. **The impacts of years of being as attending physicians of core-competence qualified clinical-instructors on the computer-based feedback (CBF) scores got from junior-physicians [(A) residents and (B) interns] of the same medical team.** R-TCBFbefore/after/I-T-CBFbefore/after: average residents (interns) to teachers (clinicalinstructors) CBF score before and after general-medicine training program. #$P < 0.05$ vs. other corresponding groups.

Figure 2. **The impacts of sub-specialty of core-competency qualified clinical-instructors on the computer-based feedback (CBF) score got from junior-physicians [(A) residents and (B) interns] of the same medical team.** #$P < 0.05$ vs. other corresponding groups.

Figure 3. **(A) The percent changes of junior-physician□s computer-based feedback (CBF) score got from clinical-instructors; (B) Impact of times of residents or interns exposure to of medical team leading by qualified clinical-instructors in the 6-month of follow-up**. T-R-CBF/T-I-CBF: average teachers (clinical-

instructors) to residents (interns) CBF score.*P<0.05 vs. 1stmonth CBF scores, #P < 0.05 vs. other corresponding groups.

Figure 4. **Self-assessment of junior-physicians to the core-competency training before & after 6-month of follow up.** #P < 0.05 vs. baseline T-I-CBF or T-R-CBF scores. MK: medical knowledge; ICS: interpersonal and communication skill; SBP: systems-based practice; PBLI: practice-based learning and improvement; P: professionalism; PC: patient care

Figure 5: **Higher teacher to resident computer-based feedback (T-R-CBF) score positively correlated with better resident□s paper-based multi-source feedback assessment (PBMFA) grade (A) resident□s mean T-R-CBF scores between different PBMFA grades; (B) the distribution (%) of different level of residents T-R-CBF scores between different PBMFA grade groups; (C) the predictability of PBMFA grade for TR-CBF scores.** #P < 0.05 vs. other corresponding groups. HH: high honors, H: honors, S: satisfactory, IC: incomplete, US:unsatisfactory course grade.

Table 1 - Basal characteristics of all participants

Percentage of ages of enrolled core-competency qualified clinical-instructors	**< 35 years** 10% (n=11)	**35-40 years** 65%* (n=72)	**40-45 years** 15% (n=17)	**>45 years** 10% (n=10)
Gender of enrolled core-competence qualified clinical-instructors	**Male** 70%* (n=77)		**Females** 30% (n=33)	
Position of enrolled core-competence qualified clinical-instructors	**Professor** 15% (n=17)	**Associated professor** 15% (n=17)	**Assistant professor** 45%* (n=49)	**Lectures** 25% (n=27)
Mean years of clinical-instructors as attending physicians	**<2 years** 15% (n=17)	**2-5** 55%* (n=60)	**5-10** 15% (n=17)	**>10 years** 15% (n=16)
Percentage of levels enrolled junior-physicians	**Residents** 51% (n=321)		**Interns** 49% (n=298)	
Mean ages of enrolled junior-physicians	**Residents** 25±6		**Interns** 23±9	
Gender of enrolled junior-physicians	**Residents**		**Interns**	
	males 62%* (n=199)	**females** 38% (n=122)	**males** 57%* (n=170)	**females** 43% (n=128)

*$P < 0.05$ vs. other corresponding groups.

Table 2 - The Impacts of genders /position of clinical-instructors on the CBF scores got from junior-physicians of same medical teams

	Genders of clinical-instructors		**Position of clinical-instructors**			
	Female (n=77)	**Male (n=33)**	**Professor (n=17)**	**Associated professor (n=17)**	**Assistant professor (n=49)**	**Lectures (n=27)**
R-T-CBF $_{before}$	81.2±0.9	79.3±0.4	78.3±0.5	82.5±0.4	81.6±0.7	83.4±0.6
R-T-CBF $_{after}$	83.1±0.6	82.6±0.7	82.6±0.3	85.6±0.7	84.5±0.8	89.3±0.7
R-T-CBF $_{percent\ changes}$	2.5%	3.7%	5.1%	3.6%	3.7%	7.2%*
I-T-CBF $_{before}$	84.3±0.6	82.6±0.5	79.3±0.4	85.6±0.6	84.3±0.7	82.7±0.6
I-T-CBF $_{after}$	86.4±0.5	83.4±0.3	81.7±0.5	86.5±0.4	86.8±0.6	89.4±0.7
I-T-CBF $_{percent\ changes}$	2.4%	1.2%	2.5%	1.2%	2.4%	7.3%*

R-T-CBF before、R-T-CBF after: residents to teacher CBF score before and after clinical-instructors receiving the general medicine training program) and intern to teacher (I-T-CBF)]; #P < 0.05 vs. other corresponding groups.

Table 3 -Paper-based self-assessment by clinical-instructors after finishing the training program (core-competency, general-medicine)

	Female (n=33)	Male (n=77)	years of being as attending physicians < 2 yrs (V_2) (n=17)	2-5 yrs (V_{2-5}) (n=60)	>5yrs (V_5) (n=34)
A. Training program is very useful for improving my teaching skills	4.1±0.2	3.1±0.7*	2.8±0.2	3.6±0.4**	4.5±0.1**
B. The Skills learnt from training program are very applicable	2.1±0.9	3.8±0.5*	2.3±0.1	2.8±0.3	4.2±0.3**
C. After implementation of the skills obtained from training program					
1. students are more participatory in discussion and "patient care"	2.5±0.1	2.6±0.2	2.9±0.4	4.0±0.5*	4.8±0.2*
2. have a better teacher-student interaction	2.9±0.2	2.8±0.3	2.1±0.5	3.1±0.2	3.9±0.2*
3. my student have better doctor-patient relationship	2.3±0.1	2.5±0.1	2.2±0.3	4.1±0.3*	4.5±0.6
4. my student show more action in carrier planning and self-development	2.8±0.2	3.3±0.2	2.4±0.5	3.9±0.2*	4.1±0.3
General perception about the computer-based feedback (CBF) and paper-based feedback multi-source feedback assessment (PBMFA) system	**Female (n=33)**	**Male (n=77)**	**Years of being as attending physicians < 2 yrs (V_2) (n=17)**	**2-5yrs (V_{2-5}) (n=60)**	**>5yrs (V_5) (n=34)**
1. CBF system facilitate me to assess my student in short time	4.1±0.2	3.1±0.7	3.7±0.5	4.4±0.2*	3.5±0.6
2.Using CBF system in preparing and declaring training efficiency data minimizes clerical mistakes	4.1±0.6	3.8±0.4	2.3±0.1	4.2±0.4*	3.7±0.5
3. CBF system decreases the work loading of administrators	3.9±0.5	3.6±0.8	2.8±0.3	2.3±0.1	4.2±0.3*
4. PBMFA system has high complete rate and help collect Real-time information	3.6±0.7	3.3±0.5	3.2±0.5	2.8±0.6	4.3±0.8#
5. Both CBF and PBMFA system should be kept parallel	3.9±0.8	4.2±0.3	2.9±0.4	4.0±0.5#	4.8±0.2

#P < 0.05 vs. other corresponding groups, **: 584 P <0.05 of P value for trend.

Additional files

Additional file 1– Context of computer-based feedback (CBF) system on-line questionnaires for clinical-instructors to evaluate the core competency performance of junior-physicians (residents and interns)

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1.Patient care					
Interviewing; Council and educate patients and families; Physical examination;					
Preventive health service; Informed medical and surgical decision making					
2.Medical knowledge					
Investigatory and analytic thinking; Knowledge and application of basic science					
3.Interpersonal and communication skills					
Creation of therapeutic relations with patients; Listening skills					
4.Practice-based learning and improvement					
Analyze own practice for needed improvement; Use evidence from scientific					
studies(EMB); Use of information technology					
5. Systems-based practice					
Understand interaction of their practice with the larger system; Advocate for patient					
within the health care system; Knowledge of practice and delivery system					
6.Professionalism					
Respectful, altruistic; Sensitive to cultural, age, gender, disability issues					

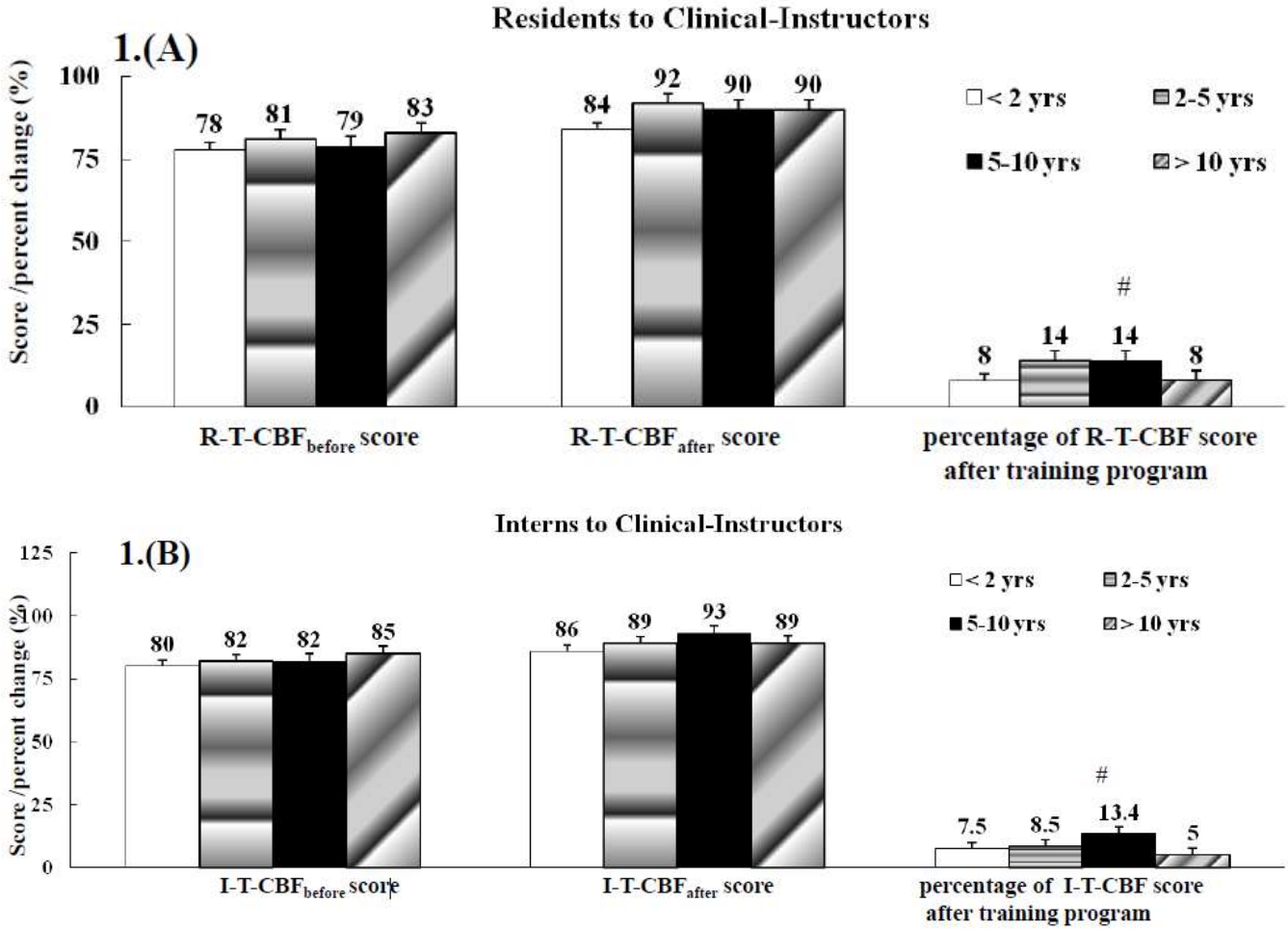
Additional file 2- Context of on-line computer-based feedback (CBF) questionnaires for junior-physicians (residents and interns) to evaluate the teaching ability of core-competency of their clinical-instructors

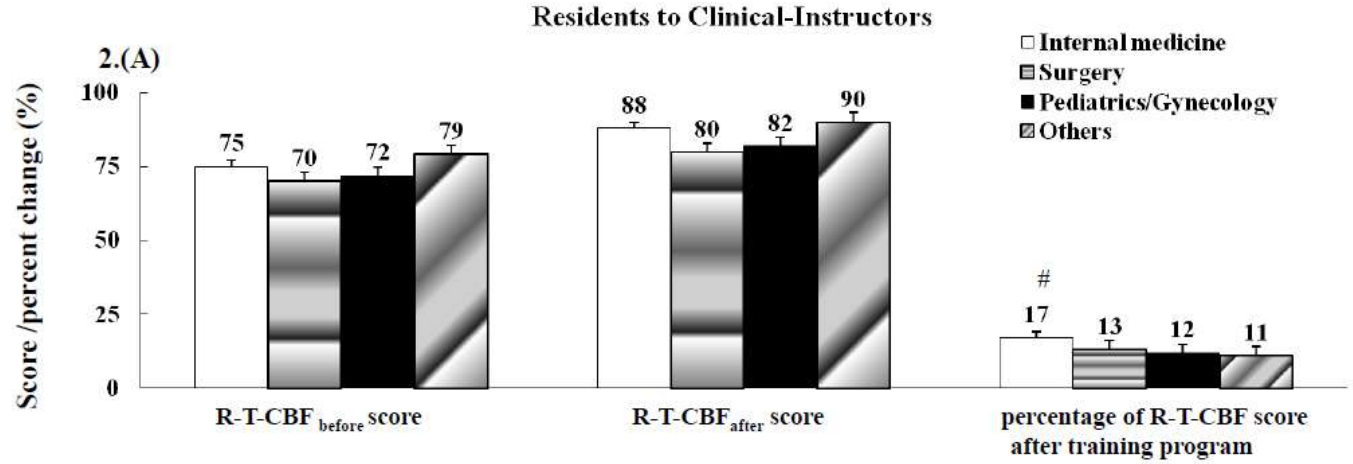
Cluster	Characteristic	Description	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Professionalism	Commitment	Commitment to do everything possible for each student and enable all students to be successful					
	Confidence	Belief in one's ability to be effective and to take on challenges					
	Trustworthiness	Being consistent and fair; keeping one's word					
	Respect	Belief that all persons matter and deserve respect					
Thinking/reasoning	Analytical thinking	Ability to think logically, break things down, and recognize cause and effect					
	Conceptual thing	Ability to see patterns and connections, even when a great deal of detail is present					
Expectations	Drive for improvement	Relentless energy for setting and meeting challenging targets, for students and the school					
	Information-seeking	Drive to find out more and get to the heart of things; intellectual curiosity					
	Initiative	Drive to act now to anticipate and pre-empt events					
Leadership	Flexibility	Ability and willingness to adapt to the needs of a situation and change tactics					
	Accountability	Drive and ability to set clear expectations and parameters and hold others accountable for performance					
	Passion for learning	Drive and ability to support students in their learning and to help them become confident and independent learners					

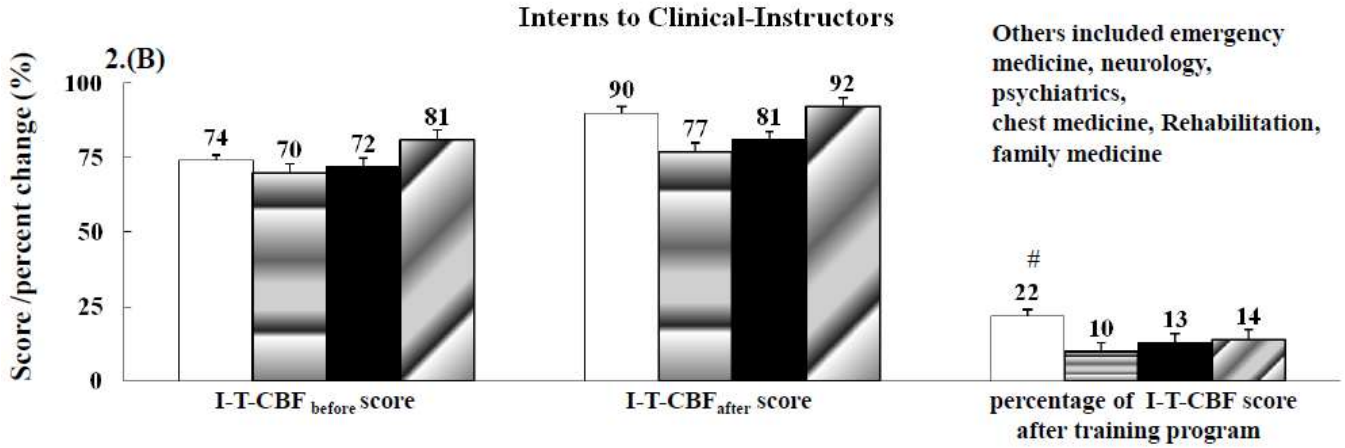
Source: Adapted from Hay McBer (2000) by Anderson (2004), p.15.

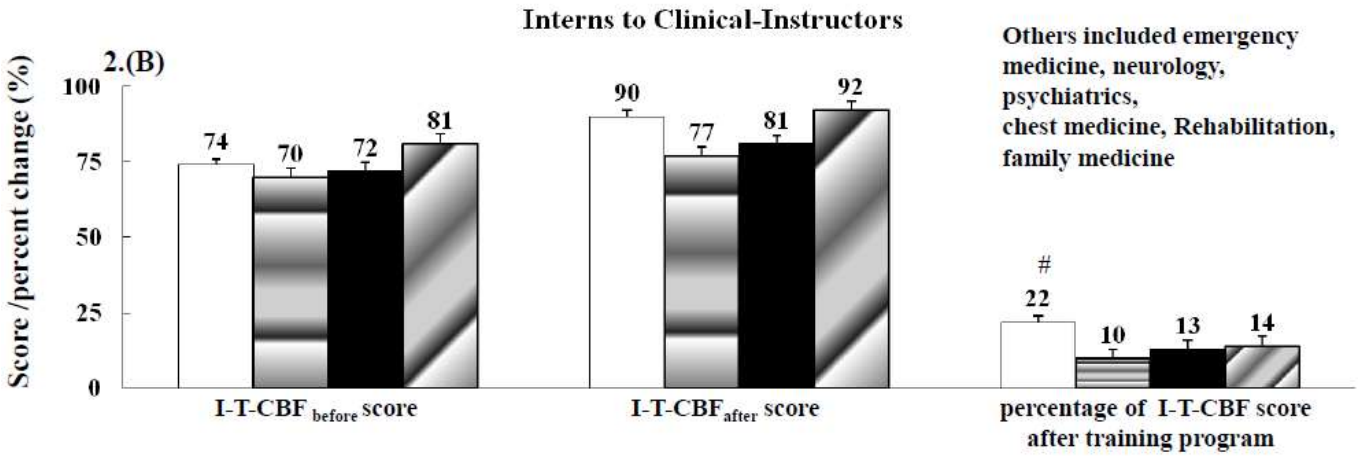
Additional file 3- Description for each item of paper-based multi-source feedback assessment (PBMFA) of residents

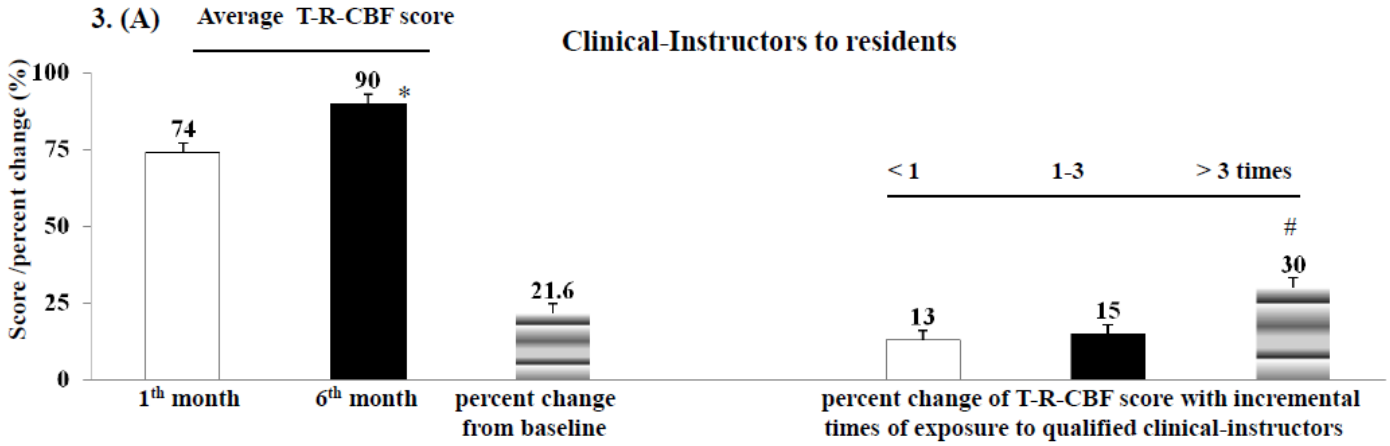
Item in the checklist	*Description*
1.Caring behaviours	Demonstrates caring and respectful behaviour with patients and families
2.Effective questioning and listening	Elicits information using effective questioning and listening skills
3.Effective counselling	Effectively counsels patients, families, and/ or care gives
4.Demonstrates ethical behaviour	Demonstrates ethical behaviour
5.Advocates for quality	Advocates for quality patient care, assists patient in dealing with system complexities
6.Sensitive to age, culture, gender and/ or disability	Sensitive to age, culture, gender, and/ or disability
7.Communicates well with staff	Communicates well with staff
8.Work effectively as team member/ leader	Works effectively as member/leader of teams understands how own actions affect others
9.Work to improve system of care	Work to improve system of care
10.Participate in therapies and patient education	Participate in rehabilitation therapies, intervention and patient education
11.Committed to self-assessment/ Uses	Committed to self-assessment; uses feedback for self-improvement
12.Teaches effectively	Teaches students and professionals effectively

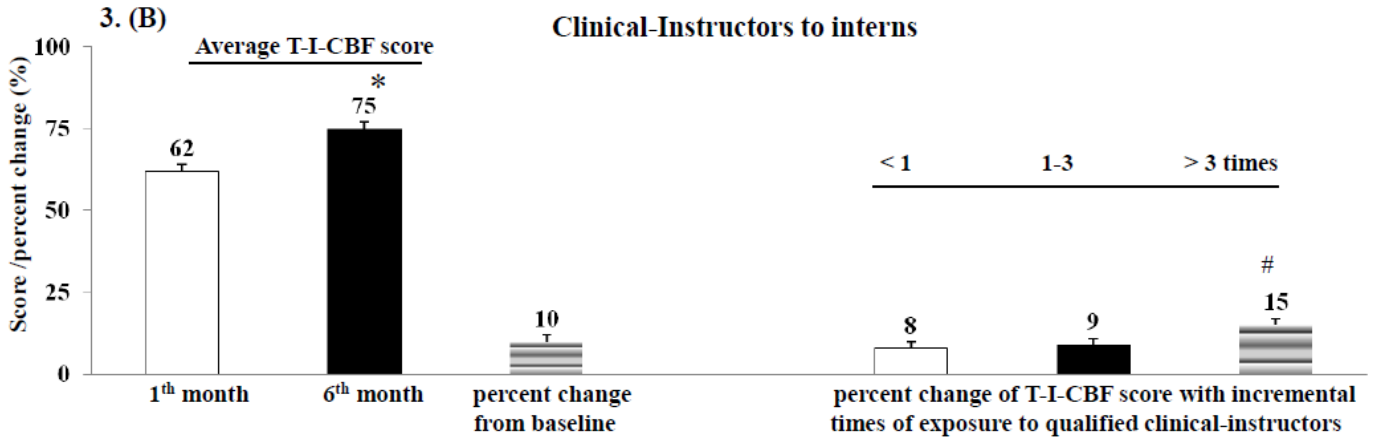


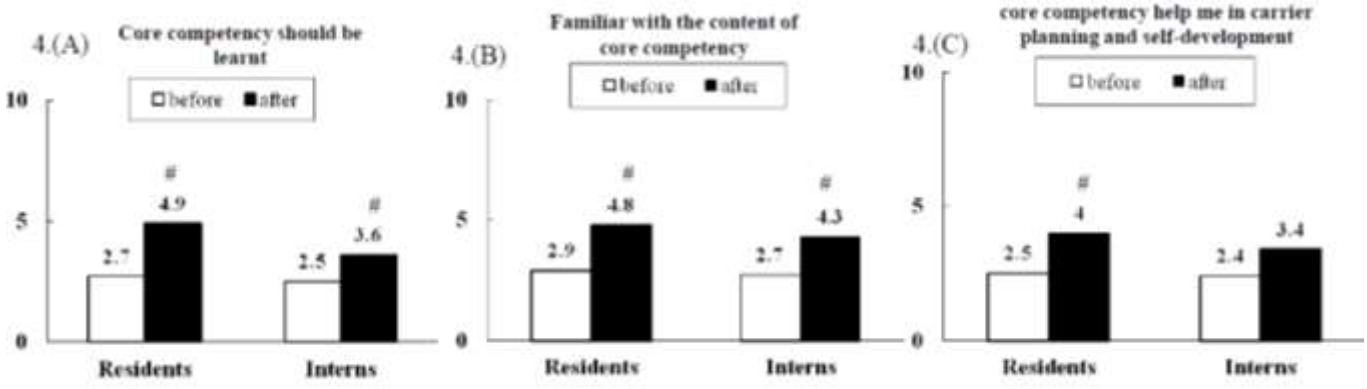

Residents to Clinical-Instructors
2.(A)
Score /percent change (%)
100
75
50
25
0
75
70
72
79
88
80
82
90
#
17
13
12
11
Internal medicine
Surgery
Pediatrics/Gynecology
Others
R-T-CBF before score
R-T-CBFafter score
percentage of R-T-CBF score after training program

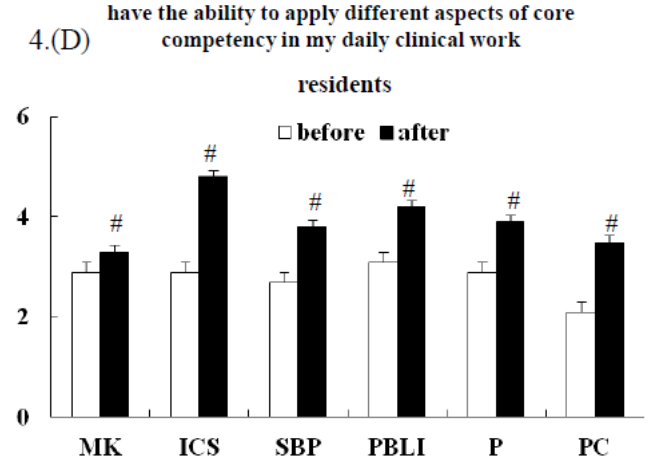

Interns to Clinical-Instructors
2.(B)
Score /percent change (%)
100
75
50
25
0
74
70
72
81
90
77
81
92
#
22
10
13
14
Others included emergency medicine, neurology, psychiatrics, chest medicine, Rehabilitation, family medicine
I-T-CBF before score
I-T-CBFafter score
percentage of I-T-CBF score after training program

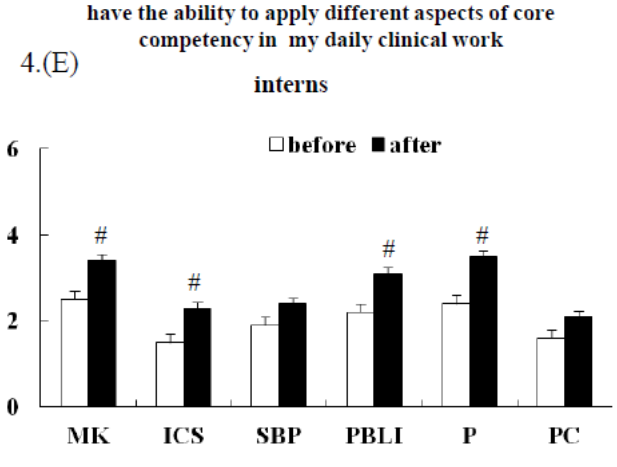

Interns to Clinical-Instructors
2.(B)
Score /percent change (%)
100
75
50
25
0
74
70
72
81
90
77
81
92
#
22
10
13
14
Others included emergency medicine, neurology, psychiatrics, chest medicine, Rehabilitation, family medicine
I-T-CBF before score
I-T-CBFafter score
percentage of I-T-CBF score after training program


3. (A)
Average T-R-CBF score
Clinical-Instructors to residents
Score /percent change (%)
100
75
50
25
0
74
90
*
21.6
< 1
1-3
> 3 times
#
13
15
30
1th month
6th month
percent change from baseline
percent change of T-R-CBF score with incremental times of exposure to qualified clinical-instructors

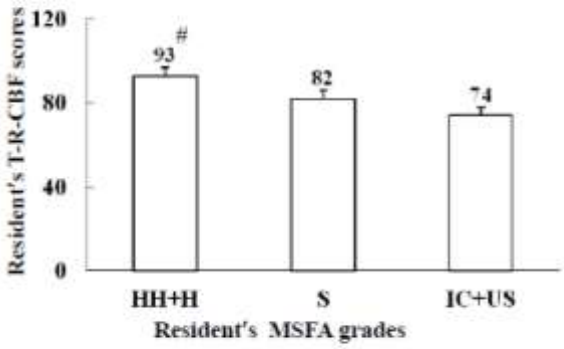

3. (B)
Average T-I-CBF score
Clinical-Instructors to interns
Score /percent change (%)
100
75
50
25
0
62
*
75
10
< 1
1-3
> 3 times
#
8
9
15
1th month
6th month
percent change from baseline
percent change of T-I-CBF score with incremental times of exposure to qualified clinical-instructors


4.(A)
Core competency should be learnt
before
after
10
5
0
2.7
4.9
2.5
3.6
Residents
Interns
4.(B)
Familiar with the content of core competency
2.9
4.8
2.7
4.3
4.(C)
core competency help me in carrier planning and self-development
2.5
4
2.4
3.4

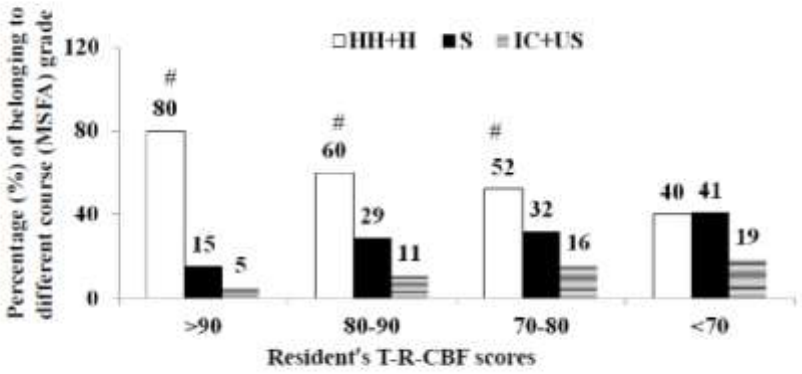

4.(D)
have the ability to apply different aspects of core competency in my daily clinical work
residents
before
after
6
4
2
0
MK
ICS
SBP
PBLI
P
PC


4.(E)
have the ability to apply different aspects of core competency in my daily clinical work
interns
before
after
6
4
2
0
MK
ICS
SBP
PBLI
P
PC

(5A).Comparison of resident's mean T-R-CBF scores between different MSFA grades



(5B).Correlation between the distribution (%) of different level of residents T-R-CBF scores between different MSFA grading groups



HH: high honors. H: honors, S: satisfactory, I: incomplete, US: unsatisfactory course (MSFA) grade

(5C). The predictability of resident's T-R-CBF scores for MSFA grade