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Stepwise inter-professional educational intervention with post-simulation DAA debriefing plus benchmarking-sharing cultivates trainees as inter-professional collaboration's seed instructors: a prospective comparative study

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ABSTRACT

Objectives: Continuous inter-professional education (IPE) is crucial to building inter-professional collaboration (IPC) attitude/skills of health professionals and providing holistic patient care. This interventional IPE program aims to evaluate whether pre-simulation training and benchmarking-sharing strategy were able to successfully cultivate seed instructors for improving their team members' IPC attitudes.

Design: Prospective, pre-post comparative cross-sectional study.

Setting/participants: Voluntary 34 physicians, 30 nurses and 24 pharmacists were trained as seed instructor by 3.5-hr preparation and 3.5-hr simulation workshops. Then, participants (n=88) drew lots to decide 44 presenters (group 1), half of each profession, in benchmarking-sharing, formed group 1, while remaining participants formed group 2. Facilitator-assessment was used to measure the transference and sustainability of the learnt IPC skills based on the benchmarking-sharing presentation.

Results: For three professions, improvement in IPC attitude was identified by sequential increase in the post-course (2^{nd} month, T_2) and end-of-study (3^{rd} month, T_3) interdisciplinary education perception scale (IEPS) and Attitudes Towards Health Care Teams Scale (ATHCTS) scores compared to pre-courses (1^{st} month, T_1) scores. The degree of improvement in IPC attitude was higher among nurses and pharmacists than physicians. The post-training benchmarking-sharing was found to further improve the IPC attitude of the group 1 participants. The instructor's assessments indicated better transference and sustainability of IPE intervention-trained "coordination, communication, teamwork, and leadership" skills among group 1 nurses and pharmacists than group 1 physicians. The post-intervention randomly sampling survey (6^{th} month, T_{post}) found that the IPC attitude of three professions had undergone significant improvement after on-site IPC skills promotion by this step-wise program-trained seed instructors within their teams.

Conclusions: Addition of pre-simulation training and benchmarking-sharing to conventional simulation-based IPE courses significantly enhances attitude, self-reflection, transferences and sustainability of newly trained seed IPC instructors. Furthermore, this continuous intervention led to improvements in IPC attitudes within teams across all three professions.

Keywords: nurses, pharmacists, inter-professional collaboration, interdisciplinary education perception, attitudes towards health care teams

Strengths and limitations of this study

- This study describes the experiences of a prospective cross-sectional cohort of voluntary physicians, nurses and pharmacists who receiving stepwise simulation-based IPE for cultivating them as seed instructors to improve team members' IPC attitude.
- Facing unsolved problem of previous simulation-based IPE, pre-simulation training plus benchmarking-sharing are implemented to provide participants a well preparation, self-reflection and continuous assessment's training.
- Serial Kirkpatrick 1-4 levels–based assessments in this study help to thoughtfully evaluate the effectiveness of this new IPE intervention.
- In addition to consecutive assessments of self-efficiency by participants, facilitators evaluate the transference and sustainability of learnt skills regarding IPC to workplace from their benchmarking-sharing.
- However, lack of control group, un-blinded assessment by instructoss and self-assessment/survey make this research susceptible to responder bias.
- Voluntary participants with high motivation are easier to be successfully cultivated as proficient seed instructors but it will also results in some degree of selection bias.
- These results are limited to experience in one institution; the degree to which this can be extrapolated to IPE training in other institutions is not known.

INTRODUCTION

Inter-professional education (IPE) aims to improve the coordination, communication, teamwork, leadership skills of health professionals.[1] Simulations provide unique experiences that should to improve the above mentioned collaboration skills of the trainees. The power of simulations lies in their fidelity and interactivity; these reach beyond didactic learning and lead to more sustainable effects on the participants. Health care simulations are recognized as an ideal vehicle for IPE.[2] Today's patients have complex chronic health issues that need inter-professional collaboration (IPC) in order to delivery well-coordinated, high-quality and patient-centered care.[3 4] Simulation-enhanced IPE helps the development of a health professional's IPC skills and these are very important when managing critical clinical situations.[5] Post-simulation debriefing is a forum by which bedside team members engage and have the opportunity to carry out thoughtful communication, the aim of which is to make patient care safer. The inclusion of all relevant medical professions in the debriefing process reinforces the unique role and contribution of each team member when developing improvements to a given system.

Simulation-based IPE prepares future health professionals, including medical students, nursing students and residents, for a collaborative models of healthcare delivery.[6] The high degree of effectiveness of a 2-hour cardiac resuscitation/intravenous access simulation-based IPE was confirmed via various quantitative questions abstracted from an interdisciplinary education perception scale (IEPS) survey completed immediate after the participants had finished their training.[6] Using multidisciplinary simulation-based crisis scenarios, a good training efficiency was obtained in relation to the technical and non-technical safety skills required by surgical teams and this was confirmed by post-course trainee and trainer assessments.[7] Another high-fidelity, simulation-based, 3-hour interdisciplinary operating room IPE was found to improve significantly the trainees' post-session self-assessed teamwork competences scores compared to their pre-session scores.[8] Single point 5 semi-urgent situations simulation-based IPE was found to significantly improve the “patient safety and teamwork” skills of pharmacy student's.[9] This study's findings were confirmed in term of the effectiveness of simulation-based IPE by comparing pre- and post-scores obtained using a “team building and interprofessional communication survey tool” , the latter scores being obtained immediately after the participants had completed training.[9]

In another study, extensive IPC training was given to professionals covering the core elements related to caring tracheostomy patients with speaking valves.[10] The participants in this study by Estis *et al.* suggested that pre-simulation training and more structural interaction during the debriefing phase were likely to enhance

effective of the IPE.[10] The Watters et al. study partially solve above mentioned limitation by implementing Diamond, following description-analysis-application steps, interactive debriefing, during a 1-day simulation course.[11] Significantly, this strategy was found to increase the "communication and teamwork" skills of the professional participant's as assessed by comparing pre-course self-assessements with post-self-assessements.[11] The unsolve problems associated with the results of Watters et al. study include a lack of follow-up assessment that examines the transference and sustainability of the learned IPC skills over time and a lack of opportunity to ask the participant to reflect back on the training after a period of time, which would allow the clinical implications of IPC training to be examined.

Taken together, previous simulation-based IPE studies[6-11] have lacked pre-simulating and/or post-course continuous training; in addition, there is an absence of long-term follow-up that allows the transference and sustainability of IPC practice to be assessed. Furthermore, there is an absence in these studies of opportunities for the participants to reflect on their training after a period of clinical IPC practice. In other words, the effectiveness of the previous single-point simulated-enhanced IPE studies was assessed immediately after the training session rather than there being a sequential follow-up over time. As a result, it has become important to develop feasible continuous IPE and IPC strategies that allow self-reflection through benchmarking-sharing during the monitoring of newly trained health professionals. When trying to improve each health professional's IPC attitude, in order to save resource, including the time needed to carry out the training etc., the number of faculty members needed to run the training and the facilities needed for the training, each newly trained participant acted as a seed instructor within their team, which resulted in profession-wide IPC promotion and attitude remodeling.

In 2014, a random sampling survey of three professions at our institution revealed that the IPC attitudes of physician, nurses and pharmacists need to be improved (fig. 1). Accordingly, the education committee targeted these three professions and organized the development of a simulation-enhanced IPE plus Diamond debriefing intervention; this include stepwise pre-simulation training, post-course continuous training, and immediate plus delay IPC attitude assessments. Additionally, an e-learning platform, together with post-training benchmarking-sharing, was also included in order to examine the participants' self-reflection. Intentionally, this pilot intervention was implemented in such a way as to include all three of the above mentioned professions; this allowed these new health professionals to be involved in cultivated IPC within their team as seed IPC instructor.

METHODS

Participants and setting

Health professionals having longer than 1-year but less than 4-years clinical work experience were invited to participate this study (figure 1). The voluntary participants (n=94) were invited to join the 2015 preliminary simulation-enhanced IPE courses to improve their IPC attitude. After excluding six participants due to incomplete questionnaires, a final total of n=88 individuals were included in this study. They consisted of physician (n=34), nurse (n=30) and pharmacists (n=24). After a brief introduction to the intensive simulation-enhanced IPE courses, at the beginning of intervention, the participants were asked to complete the pre-course (T_1) on-line IPC attitude assessment that consisted of interdisciplinary education perception scale (IEPS) and the Attitudes Toward Health Care Teams Scale (ATHCTS) (supplement table 1-2). Each on-line self-assessment was numbered so that participants remained anonymous but their numbers could be used to match their pre-course (T_1) self-assessment with post-course (T_2) and end-of-study (T_3) self-assessment (figure 1). All participants continued with their usual professional clinical routine throughout the 3-month interventional study.

Taipei Veterans General Hospital (TVGH) is a 3000-bed medical center providing primary and tertiary care to active-duty and retired military personnel and their dependent; in addition TVGH is the teaching hospital for several medical universities in Northern Taiwan. Between January 2015 and May 2016, we conducted a prospective cross-sectional comparative study at the high-fidelity clinical simulation and interactive learning centre of TVGH; this centre trains around 2500 staff each year. Ethical approval was obtained from the Ethics committee of our institution and care was taken to apply the World Medical Association Declaration of Helsinki principles to the research.

Simulation-enhanced IPE courses

Each enrolled participant attended a 3.5-hour preparation workshop (T_1) at the beginning of this study (first month). Subsequently, a 3.5-hour simulation workshop was arranged for the participants during the second month (T_2). At the end of this 3.5-hour simulation workshop, the participants drew lots to decide whether they were to be members of group 1 (Gr. 1), who needed to prepare for post-course benchmarking-sharing during the third months (T_3) after entering the study. In order to keep the fix ratio (34:30:24) among the three professions, half of the physicians, nurses and pharmacists were selected by lot to prepare for benchmarking-sharing. In other words, there were 17 physicians, 15 nurses and 12 pharmacists in group 1 and a similar number in group 2 (figure 1). All instructors, whose involving in this IPE

intervention program, attended serial training sessions that included extensive training in how to use the Diamond DAA debriefing strategy to facilitate participants and how to assess the transference and sustainability of the trained "coordination, communication, teamwork, and leadership" skills regarding IPC by participants.

7-hour preparation and simulation workshop

-Preparation workshop (T_1). Two workshops (n=44 in each room), each with a fixed ratio (17:15:12) of physician, nurse and pharmacists, were held as two sessions in two consecutive days. The initial 3.5-hour workshop included a lecture (1-hour), IPE-specific video watching (0.5-hour, three 10-minute clips), post-video watching small group discussion (0.5-hour), and instructor-facilitated discussion with all participants (1.5-hour). These three clips consisted of simulated examples of IPC-based care. They were firstly, a simulation of a distracted wife and a 61-year-old dyspnea male who suffered from recurrent asthmatic attacks due to inappropriate home medication, secondly, a simulation of a 35-year-old anxious family including a pregnant nausea/vomiting/abdominal pain female who need the selection of suitable antiemetics and a pediatrics/gynaecalogy consultation in an ER setting and, finally, a simulation of a 57-year-old chest pain male with a distracted son who had the wrong allergy and ID labeling on his arm band, as well as unlocked bed in ICU setting. These 10-minutes clips provided a basis for post-video watching discussion that were led by two inter-professional educators (1-hour); these target the role and value of the IPC healthcare team involved in patient care. Importantly, the instructor-facilitated discussion was followed a Diamond D-A-A debriefing for IPC performance by all participants in relation to each profession involved in the simulated clinical scenarios presented in the three video. The "description" step involving 'agreed description' of the fact rather than emotion concerning video scenario, the more challenging "analysis" and "application" steps involving 'how did participants feel about three video scenario?' and "how participants may apply the learnt knowledge in their own clinical practice".[11,12]

-simulation workshop (T_2). In our simulation centers, four small groups (n=22) with fixed ratio, either 9:7:6 or 8:8:6, of physician to nurse to pharmacists, were held as four sessions within in two consecutive days (figure 2). Using the clinical scenario outlined below, these workshops were facilitated by well-trained IPE instructors and faculty members from dietetics, social workers and respiratory therapists professions. A patient scenario involving Mr. Jason was developed collaboratively by the faculty members of the above mentioned professions. Participants were given the following information. Mr. Jason has a history of chronic obstructive pulmonary disease (COPD), smokes 60 packs per year of cigarettes and has hypertension, diabetes, coronary artery disease and atrial fibrillation. He has been admitted for acute

exacerbation of his COPD five times in the past one year. Home medication includes aspirin, a calcium channel blocker, mycolytic agents, inhalation corticorsteroid/bronchodilator and subcutaneous administrated insulin. Mr. Jason was admitted 3 weeks ago for emergent coronary artery bypass grafting surgery. Although there has been aggressive management with regular chest percussion, he had had difficulty being weaned from a ventilator due to poor sputum expectation and malnutrition. The primary care teams are now considering a tracheostomy and intensive chest/nutrition therapy. His family members are at the bedside. During the simulation, a pre-set intubated high-fidelity SimMan® 3G simulator acted as the patient and standardized patients (SPs) were used as his family.

In this 3.5-hour workshop, there were six key phases; these were the first simulation (30 min.), the first debriefing (40 min.), the second simulation (30 min.), the second debriefing (40 min.), the third simulation (20 min.), and the final debriefing/ending (50 min.). Randomly, a fixed ratio (3:2;2, 3:2:2, or 3:3:2) of physician: nurse and: pharmacists participated in the three simulations phases and Diamond debriefing phases based on a procedure involving a Description (D), Analysis (A) and Application (A) structure, as in the debriefing phase of preparation workshop. These were carried out by the three professions alternatively (fig. 2).[11,12] Before the beginning of the simulation, the participants were presented with above mentioned case's name, age, gender, admission diagnosis and current medication/management. In the three simulation phases, the participants involved were expected to carry out assessment (1st simulation), treatments (2nd simulation), and general care (3rd simulation) of the patients, collaboratively. Then, the participants began the post-simulation debriefing phase and reflected on the challenges, pitfalls, and successes that occurred within the simulation.

The IPC benchmarking-sharing (T_3) of the Group 1 participants. As mentioned above, 17 physicians, 15 nurses and 12 pharmacists formed group 1 and these participants underwent benchmarking-sharing. Randomly, four small groups (n=11) with ratio (4:4:3, 4:4:3, 4:4:3 and 5:3:3) of physician to nurse to pharmacists were presented as four sessions in two consecutive days. During benchmarking-sharing, the transference and sustainability of each participant's learned "coordination, communication, teamwork, and leadership" skills IPC regarding over time were rated by the same well-trained IPE instructors of the preparation and simulation workshops. Presenters were asked to give their examples of beside IPE/IPC in order to assess the transference and sustainability of their learned IPC skills. In total, 4 hours (240 minutes) were needed for 11 presenters to complete their 20-minutes presentation/discussion in each session. The whole presentation process of each individual was recorded as a video by teaching assistants (TAs) to help with

continuous IPC promotion. With the agreement of presenters, the TAs uploaded edited versions of the video to the e-learning platform. The Group 2 participants were asked to join this end-of-study (T_3) benchmarking-sharing.

-*e-learning platform.* Both the group 1 and the group 2 participants were invited to use a common IPE e-learning platform containing the above mentioned scenario, various power points presentations, the video used in preparation/simulation workshop and the video from the benchmarking-sharing. The aim being freely to encourage self-directed learning.

IPC attitudes measurements

- *Interdisciplinary education perception scale (IEPS):* To measure the participants' attitudes towards IPC, we used the IEPS. This is a 18-items scale that uses 6 Likert point measures ranging from "strongly disagree (1 point) to strongly agree (6 point)" [13,14] Each of the 18 IEPS items has been classified into four subscales that add up to the values of the individual items of the corresponding factor. Subscale 1, labeled as "Competency and Autonomy" (items 1, 3, 4, 5, 7, 9, 10 and 13; minimum score: 8; maximum score: 40), measures how highly students respect their profession, in the sense that it is well taught and contributes significantly to improving the healthcare field, as well as to what extent they believe that other professions are respected in a similar fashion. Subscale 2, "Perceived Need for Cooperation" (items 6 and 8; minimum score: 2; maximum score: 10), reflects the responders' perceptions of the need for teamwork, which typically includes respecting and working well with other professions. Subscale 3, "Perception of Actual Cooperation" (items 2, 14, 15, 16 and 17; minimum score: 5; maximum score: 25), aims to reveal the responders' perception of how their profession typically respects and works well with other professions. Subscale 4, "Understanding Others' Values" (items 11, 12 and 18; minimum score: 3; maximum score: 15), aims to reflect the degree of respect the responder has for contributions from all healthcare professions.[14,15]
- *Attitudes Toward Health Care Teams Scale (ATHCTS):* The original ATHCTS is a 20-item tool that consists of quality of care/process (14 items) and physician centrality (6 items) subscales' this use a 5-point scale.[16] In our study, only the 14-item that form the quality of care/process assessment was used to measure the self-efficiency. The quality of care/process subscale measures the perceptions of team members regarding the quality of care delivered by health care teams and the quality of teamwork needed to accomplish this. In fact, there are three components, these are "quality of care delivery"; "patient-centered care" and

"team efficiency" within the quality of care/process subscale. A higher ATHCTS scores represents more positive attitudes toward teamwork.

- *Open-ended items*: participants were asked freely to provide qualitative feedback by answering question "*what is the one thing you are going to take away with you at the end of this course?*" in the online post-courses self assessment (T_3). This question was designed to prompt a participant to reflect on their own learning during the course and allowed us to gather evidence on which elements within the courses seemed to be contributing the most to the learning experience.
- *Pre-intervention and Post-intervention random sampling survey of IPC attitudes* (figure 1): Across the three professions, namely physicians, nurses and pharmacists, the effectiveness of the well-trained seed instructors in terms of team IPC promotion and IPC attitude modification was followed up during the 6^{th} month after beginning of the intervention program (T_{post}). The same questions, namely (1) Are you familiar with IPC skills? (2) Do you think that IPC helps you to understand the role of other healthcare team members? (3) Do you think that IPC improves patient care quality? (4) Do you think that IPC improves patient centered care? (5) Do you think that IPC improves team efficiency?. There are five Likert scale responses ranging from 1, strongly disagree to 5, strongly agree. In total 132 valid post-intervention questionnaires were collected for comparison with another 132 valid-pre-intervention questionnaires. These anonymous pre-intervention and post-intervention questionnaires were completed by random members sampled from the three professions, namely 51 physicians, 45 nurses and 36 pharmacists twice. In other words, the individuals who responded to the online IPC attitude survey might be but are not necessarily different between pre-intervention and post-intervention survey. However, it is important to note that the enrolled participants in our interventional study were excluded from the sampling pool for post-intervention sampling survey.

Statistical analysis

Since the IEPS and ATHCTS items are ordinal in nature, Wilcoxon's signed rank test was used to analyze each item. The means of the overall IEPS score and the four subscales were evaluated with the Student's two-tailed paired *t*-test for continuous measures, with the aim of detecting any differences between before and after training. Data from the IEPS and ATHCTS were matched by profession for analysis.

RESULTS

The baseline characteristics of the participants, including mean age, gender and clinical experiences, were similar across the physicians, nurses and pharmacist as can be seem in table 1. Notably, a greater number of nurses and pharmacists compared to the physicians had previously experienced IPE and had taken part in more workplace IPC meeting.

The baseline IPC attitude, pre-course (T_1) IEPS scores and pre-course (T_1) ATHCTS scores were also similar across the physicians, nurses and pharmacist (table 2). Compared to nurses, there were lower scores for the "competency and autonomy" and "understanding others values" basal IEPS subscales (T_1) among the physicians. Similarly, also compared to nurses, there were lower scores for the "competency and autonomy" and "perception of actual cooperation" basal IEPS subscales (T_1) among the pharmacists. Notably, the "competency and autonomy" subscale of IEPS score and the "team efficiency" subscale of the ATHCTS score (T_2-T_1) were increased by the 7-hour stepwise simulation-enhanced IPE course across all three categories, physicians, nurses and pharmacists and, especially, the magnitude of increase in IEPS and ATHCTS scores were significantly greater among the nurses and pharmacist than the physicians (table 2). Obviously, pharmacists had the highest increase in percent change of post-courses (T_2) ATHCTS score from pre-courses (T_1) score than those in nurses and physicians (table 2).

Based on the benchmarking-sharing presentations of group 1 participants, the instructors found that the transference and sustainability of the "coordination" and "leadership" skills regarding IPC were higher among physicians than nurses (table 3). Furthermore, the instructors assessed that the transference and sustainability of the "communication" and "teamwork" skills regarding IPC were higher among the pharmacists than the physicians (table 3). Finally, a greater trend indicating better transference and sustainability of the "communication" and "teamwork" skills regarding IPC was observed among the nurses than the physicians (table 3).

Previous studies had suggested that training videos consistently enhance the observational powers of trainees, as well as improving their ability to integrate different information and increasing their motivation to learn.[20,21] In response in open-ended questions at the end of our study, most participants reported that watching the IPE-specific video and discussing it, as well as viewing the uploaded videos on the e-learning platform, markedly encourage their motivation to improve their IPC attitude. Specifically, the participant's responses indicated that the availability of an IPE/IPC-specific e-learning platform was able to continuously improve the users' IPC attitude by providing useful resource and instruction.

Some interesting comments from the participants are listed as below:

"we are all geared to patient-centered care, all professions need to use their best assessment and judgment to evaluate patients in order to provide the best patient care that we can…… ";

"…there is a lot of team work going on our institution";

"…all professions should be encouraged within their training program to become independent in order to make IPC work better..";

"…there are differences in language and discipline across different professions, but the similarities are core elements of IPE, including coordination, communication, teamwork and leadership skills…";

"the future of health care is teamwork, so being able to work with one another, our scopes of practice mesh together.";

"There are situations that are different, but we do have to rely on the expertise of other professionals' in order to obtain the best outcome for the patient";

"we were able to collaborate very well with other professional health care members, especially with the nurses in their second simulation; they sort of referred to us regarding our drug management skills and sort of learned how important pharmacists can actually be in a hospital setting.";

And "sometime staying in your own profession is great and everything, but you really sort of need to reach outwards and see what other professions have to offer, because only if you do that can you truly use the entire knowledge base of other profession and provide the best patient care."

Compared to pre-courses (T_1) scores, the degree of increase in total IEPS and ATHCTS scores at post-courses (T_2) self assessments were not different between group 1 and 2 participants (data not shown). Among the group 1 and 2 participants, the sustainability of the effectiveness of 7-hour stepwise simulation-enhanced IPE was confirmed by the fact that there were similar or higher end-of-study (T_3) IEPS and ATHCTS scores than post-courses (T_2) scores (figure 3). From the post-course (T_2) to end-of-study (T_3) period, a significantly greater increase in the total IEPS and ATHCTS scores of the group 1 participants than the group 2 participants can be seen (figure 3). This indicates that the benchmarking-sharing helps to improve the group 1 participant's IPC attitude. Among the group 1 participants, the most improved items were the "competency and autonomy" and "perception of actual cooperation" subscales of the IEPS and the "quality of care delivery" and "team efficiency" subscales of the ATHCTS when the T_2 and T_3 self-assessments were compared.

Inappropriate attitudes to IPC were initially present among many of the randomly sampled team members; this finding was observed from all three professions, physicians, nurses and pharmacists via the pre-intervention survey (T_{pre}) (figure 3C). The aim of the interventional training program was to develop the team

member volunteers via this interventional program as seed instructors after they had taken part in the three months of the program. In this context, after the stepwise sequential simulation-based IPE courses had taken place, the post-intervention (T_{post}, 6^{th} month) survey revealed that there was significant improvement in randomly sampled team member's IPC attitude (figure 3B) across physicians, nurses and pharmacists. Overall, after seed instructors began promoting IPC in the institution, these responders (n=132) now strongly agreed with the following; that they were familiar with IPC skills, that IPC helped with understanding the role of other team members, that IPC improved patient care quality and that IPC improved team efficiency. Notwithstanding the above findings, the randomly sampled team members across the three professions agreed both pre-intervention and post-intervention that IPC improves patient-centered care.

DISCUSSION

Previous studies reported that simulation team training significantly improved participant′s teamwork skills.[6,8,9,17-19] Integrated simulators, also known as human patient simulators (HPS), help suspend disbelief during a simulation due to the integrated computer technology that is housed in the mannequin; these systems allow the mannequin to respond in real time to specific care interventions and treatments. The formal reflective stage in the simulation learning process is the "debriefing" Debriefing follows the actual simulation and serves to help learners clarify and integrate the simulation experience with their previous knowledge. When debriefing is skillfully facilitated using a positive and constructive method, the learning advances to clinical transference, the final step in the simulation learning pyramid.

The Diamond debriefing method encourages a standardized approach to high-quality debriefing across courses, which benefits both the participants and the involved faculty members.[12] The Diamond DAA debriefing method is related to various aspects of the advocacy-inquiry approach and of debriefing with good judgment. It is specifically designed to allow an exploration of the non-technical aspects of a simulated scenario. The Diamond is a two-sided prompt sheet: the first contains the scaffolding, with a series of specifically constructed questions for each phase of the debriefing; while the second lays out the theory behind the questions and the process. The Diamond encourages a standardized approach for high-quality debriefing on non-technical skills.[12] The Diamond provides an easy but pedagogically sound structure to follow and also makes available specific prompts to use in an appropriate moment. During our study, the facilitators-led post-video watching discussion phase of the preparation workshop and in the post-simulation debriefing phases of simulation workshop, the participants from three professions took turns to be responsible for the DAA-based group reflection. This well-organized design allows each participant from three professions to have equal IPE exposure, which helps their development as seed instructors in their healthcare team. Our study provided good evidence as to the effectiveness of using "diamond debriefing method" during the simulation-enhanced IPE course.

The strengths of our study are firstly the Kirkpatrick 1-4 levels–based design[22] used to evaluate the effectiveness of the stepwise simulation-based IPE intervention regarding improvements in participants as seed instructors. Kirkpatrick's first and second levels evaluate "participants satisfaction" and "participants increase confidence, knowledge and performance". For these two levels we used the post-courses (T_2) self assessed-IEPS and ATHCTS scores, which assess IPC attitude"; these results showed, significant improvements compared to the pre-courses scores (T_1) across all three professions, physicians, nurses and pharmacists. Kirkpatrick's

third level evaluates "the amount of knowledge and skills learned that participants actually use in everyday work". In our study, this level was evaluated by the instructors and assessed the transference and sustainability of the learnt IPC skills using the group 1 participants' presentation. In parallel, the post-benchmarking-sharing (T_3) self-assessed IPC attitude scores, using IEPS and ATHCTS, represents the group 1 and group 2 participants' Kirkpatrick's level 3 outcomes. Kirkpatrick's fourth level evaluates "Did the implementation of the interventional training program impact the healthcare system?". Promisingly, the post-intervention random sampling survey (T_{post}) in our study across three professions was focused on revealed that there had been a general improvement in their team members' IPC attitudes. In other words, our pilot interventional program has already reached, at least partly, the Kirkpatrick's fourth level goal.

There are some limitations to our study. Our IPE approach targets IPC attitude specifically using a number of defined types of patient scenario that are suitable for all three of the enrolled professions. Nonetheless, the specific IPC skills required for holistic care of COPD cases are obviously different from those need to care for acute renal failure cases. Undoubtedly, IPC skills are learned more readily when the simulation-enhanced IPE used is more specific to relevant type of clinical situation. In our study, this limitation was alleviated by the multi-professional post-simulation DAA debriefing during a 3.5-hour simulation workshop and the fact that the enrolled participants continued to carry out their regular clinical routines during the 3-month intervention period. In other words, our enrolled participants were likely to interacting with other professions in their clinical routine after the first and second stimuli presented during the preparation and simulation workshops. In fact, it has been suggested that the participants who have learnt IPC skills in a variety of simulation modules will be able to synthesize a higher level of IPC abilities that can then be applied across many clinical situations. In terms of continuity, the availability of an e-learning platform that has sufficient IPE resources will help the participants to continue with self-directed learning freely. Finally, the benchmarking-sharing provides the enrolled participants with the opportunity for IPC self-reflection, as well as enhancing their motivation as seed instructors in their teams.

As participation in this course was voluntary, participants were likely to be more highly motivated to engage in collaboration than other professionals in the general hospital population. This limits the generalizability of our results. Moreover, we did not include a control group, leaving the study vulnerable to confounding factors such as history and the Hawthorne effect.[23] Both IEPS and ATHCTS have been suggested as methods of determining the effect of practice-based IPE educational interventions among health care students and clinicians.[13,14,16] Tests

assessing the reliability and validity of these approaches have demonstrate that each subscale of IEPS and ATHCTS is a strong measure of its respective underlying IPC concept that are crucial to students and residents in these medical and health professions.[13,14,16] So, in this study, we used in our IPE interventional programs a series of well validated instruments with good psychometric properties to decrease potential interference due to the above mentioned confounding factors.

CONCLUSIONS

This multidimensional interventional simulation-based IPE program was able to successfully train voluntary participants as seed instructors that in turn allowed them to modify the IPC attitude of their team members. This is a pilot promising study that should be considered in the future for extension to professions other than the three enrolled professions here. Ultimately, good IPE/IPC training is important to improving IPC within the healthcare teams and to ensuring high-quality patient care.

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Contributors All authors actively participated in analysis of the research results. YYY, FYL, JFL were responsible for study design. YYY, FYL, LYY, CCH participated in the questionnaires. YYY, CCH, HMC, FYL participated in the creation and management of the database. YYY, FYL, SYK, CCH were responsible for the statistical analysis and writing of the manuscript.

Competing interests None.

FIGURES AND LEGENDS

Figure 1 Study flow chart.

Figure 2 Protocols for small group (n=22) simulation-enhanced IPE workshops in each sessions within two consecutive days**.**

Figure 3 The comparison of sequential changes of post-course ($\mathbf{T_2}$) and end-of-study ($\mathbf{T_3}$) subscales and scales of IEPS (**A**) and ATHCTS (**B**) between group 1 and group 2 participants. **(C).** Comparison of responses from 132 randomly sampled members from the three professions (51 physicians, 45 nurses. 36 pharmacists twice) about IPC's attitudes in pre-intervention (T_{pre}) and post-intervention (T_{post}) survey. IPC attitude was assessed by five Likert scale responses ranging from 1: strongly disagree to 5, strongly agree. $^{*}p<0.01$ *vs.* post-course (T_2) or pre-intervention (T_{pre}) scores; $^{\#}p<0.01$ *vs.* group 2 participants' scores.

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Table 1 Characteristics of study population (n=88)			
	Physicians (n=34)	**Nurses (n=30)**	**Pharmacists (n=24)**
Age (years)	31.3± 2.7	29.1 ±4.8	30.5 ±3.6
Female/male (No.)	30/4	27/3	10/14
Clinical work years			
1-2/2-3/ 3-4 years (%)	76/14/10%	84/10/6%	69/20/11%
Previous IPE training (yes/no)	15/85%#	35/65%	45/55%
Frequency of participation of IPC meeting during the last 1-yr of clinical workplace			
High exposure (>9 time)	14%#	36%	43%
Low exposure (<3 times)	86%#	64%	57%

#p<0.01 *vs.* corresponding nurse′s group**;** high exposure indicated participate more than 80% f monthly IPC meeting; low Exposure indicated joined less than 20% of monthly IPC meeting.

Table 2 Comparison between pre-courses and post-courses self-reported IPC attitude (IEPS and ATHCTS) among three professions

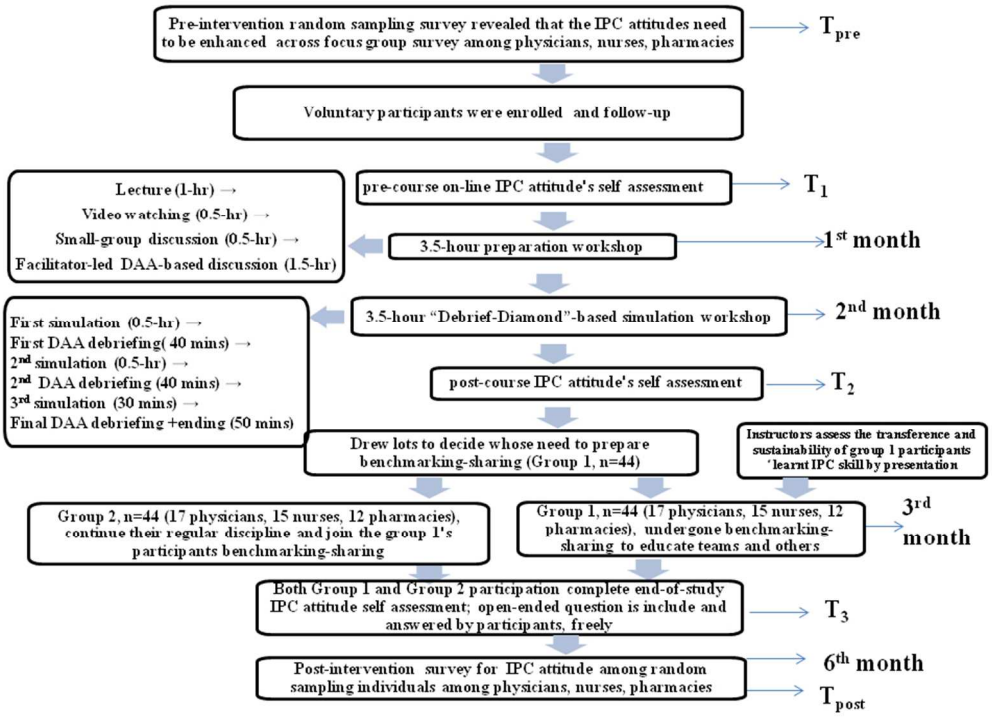
	Physicians (n=34)		Nurses (n=30)		Pharmacists (n=24)	
	pre-course (T_1)	post-course (T_2)	pre-course (T_1)	post-course (T_2)	pre-course(T_1)	post-course (T_2)
Total IEPS-18 scores [6-point scale]	56±1.8$^{\#}$	76±9.8$^{*,\#}$	65±1.6	91±1.2	64±8	91±4.7$^{*,\#}$
percent change of total IEPS post-course (T_2) score from pre-course (T_1) score		18%		40%†		42%†
IEPS subscales scores						
Competency and autonomy (8 items)	24±3.5$^{\#}$	28±4.1$^{*,\#}$	30±4.5	39±7.2*	22±5.4$^{\#}$	40±6.1$^{*,\#}$
Perceived need for cooperation (2 items)	7±2.2	9±1.6	8±2.9	10±1.8	9±3	11±1.8
Perception of actual cooperation (5 items)	17±2.7	24±3.7$^{*,\#}$	15±1.2	26±4.3*	20±4.8$^{\#}$	23±2.5$^{\#}$
Understanding others values (3 items)	8±2.4$^{\#}$	15±2.9*	12±3.8	16±1.4	13±2.1	17±5.1*
Total ATHCTS-14 [5-point scale]	39±2.3	48±5.4*	38±2.6	51±4.6	32±3.7$^{\#}$	54±7.5$^{\#}$
percent change of total ATHCTS post-course (T_2) score from pre-course (T_1) score		23%		34%†		69%†
ATHCTS subscales scores						
Quality of care delivery (5 items)	14±2.2	15±1.8$^{\#}$	13±1.6	18±4.1*	12±4.2	20±2.0*
Patient-centered care (4 items)	13±1.7	18±2.1*	15±7.4	19±3.3	11±2.8$^{\#}$	18±3.5*
Team efficiency (5 items)	12±1.1	15±3.7*	10±1.9	14±2.7*	9±2.6	16±4.1*

*p<0.01 *vs.* pre-course scores; #p<0.01 *vs.* corresponding nurse scores; †p<0.01 *vs.* physicians scores

Table 3 Instructors-assessed transference and sustainability of the learnt IPE skills of group 1 participants by their benchmarking-sharing presentation.

	Physicians (n=17)	Nurses (n=15)	Pharmacists (n=12)
Participant appropriately transfer the "coordination" skills of IPC	4.3±0.64	3.6±0.7#	3.9±0.8
Participant appropriately transfer the "communication" skills of IPC	3.9±0.52	4.1±0.94	4.4±0.7#
Participant appropriately transfer the "teamwork" skills of IPC	3.4±0.502	4.5±0.46#	4.1±0.9#
Participant appropriately transfer the "leadership" skills of IPC	4.4±0.803	3.4±0.61#	4.0±0.5
Participant has good sustainability in practicing the "coordination" skills of IPC	4.6±0.54	3.3±0.21#	4.1±0.7#
Participant has good sustainability in practicing the "communication" skills of IPC	3.3±0.71	4.01±0.76	4.8±0.1#
Participant has good sustainability in practicing the "teamwork" skills of IPC	3.8±0.2	4.7±0.1#	4.5±0.6#
Participant has good sustainability in practicing the "leadership" skills of IPC	4.7±0.4	3.0±0.3#	3.8±0.4

5-point Likerts scale-based assessment; #p<0.01 *vs.* physician's group



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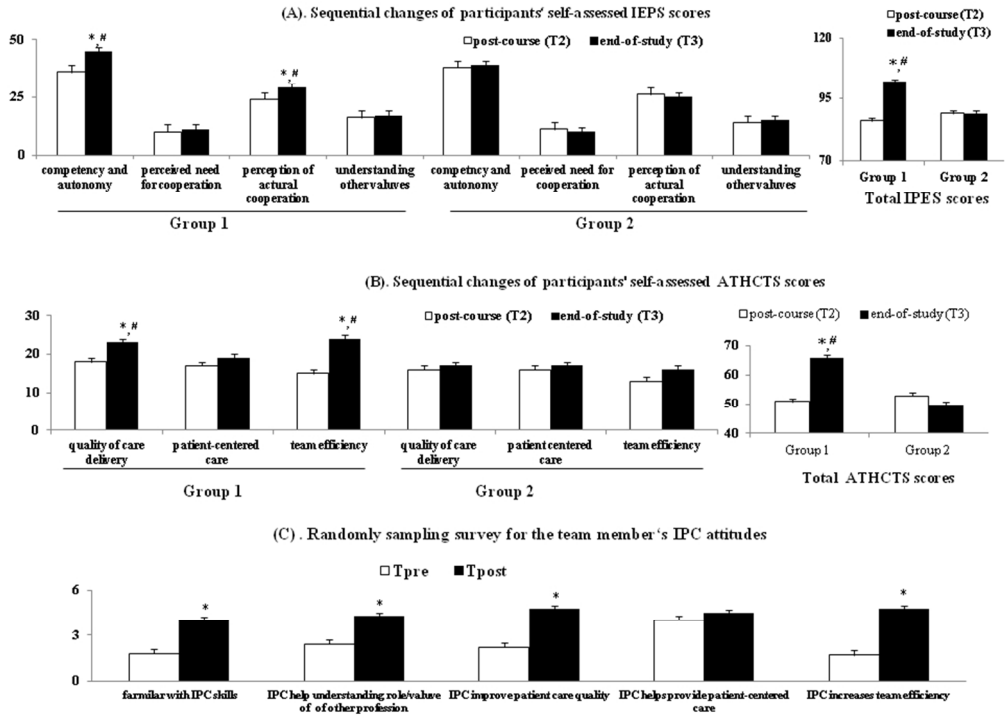
Protocols for small group (n=22) simulation-enhanced IPE workshops as four sessions in two consecutive days

	physicians	nurses	pharmacists	mission	context
Combination-1	n=3	n=2	n=2	1st simulation	Physicians-led assessment of patient
Combination-2	n=3	n=2	n=2	1st debriefing	D-A-A for 1st simulation by three professions, separately
Combination-3	n=3	n=3	n=2	2nd simulation	Pharmacies-led treatment of patient
Combination-1	n=3	n=2	n=2	2nd debriefing	D-A-A for 2nd simulation by three professions, separately
Combination-2	n=3	n=2	n=2	3rd simulation	Nurses-led general care of patient and family
Combination-3	n=3	n=3	n=2	3rd debriefing	D-A-A for 3rd simulation by three professions, separately

D-A-A indicates description, analysis and application of peer's 1st, 2nd or 3rd simulation for future IPC

254x190mm (96 x 96 DPI)



254x190mm (96 x 96 DPI)

Supplement table 1 Interdisciplinary education perception scale (IEPS)	
subsclases	statement
competency and autonomy (8 items)	1. Individuals in my profession are well-trained. 2. Individuals in my profession demonstrate a great deal of autonomy. 3. Individuals in my profession are very positive about their goals and objectives. 4. Individuals in my profession are very positive about their contributions and accomplishments. 5. Individuals in my profession trust each other's professional judgment. 6. Individuals in my profession are extremely competent. 7. Individuals in other professions respect the work done by my profession. 8. Individuals in other professions think highly of my profession.
perceived need for cooperation (2 items)	9. Individuals in my profession need to cooperate with other professions. 10. Individuals in my profession must depend upon the work of people in other professions.
perception of actual cooperation (5 items)	11. Individuals in my profession are able to work closely with individuals in other professions. 12. Individuals in my profession are willing to share information and resources with other professionals. 13. Individuals in my profession have good relations with people in other professions. 14. Individuals in my profession think highly of other related professions. 15. Individuals in my profession work well with each other.
understanding others value (3 items)	16. Individuals in my profession have a higher status than individuals in other professions. 17. Individuals in my profession make every effort to understand the capabilities and contributions of other professions. 18. Individuals in other professions often seek the advice of people in my profession.
Likert's Scale with 6 possible responses (1=Strongly Disagree, 2=Moderately Disagree, 3=Somewhat Disagree, 4=Somewhat Agree, 5=Moderately Agree, 6=Strongly Agree); ** Higher scores represent more positive attitudes toward teamwork.	

Supplement table 2 Attitudes Toward Interprofessional Health Care Teams Scale (ATIHCTS)	
Subscales	STATEMENT
quality of care delivery (5 items)	1. Developing an interprofessional patient care plan is excessively time consuming. 2. The give and take among team members helps them make better patient care decisions. 3. The interprofessional approach makes the delivery of care more efficient. 4. Developing a patient care plan with other team members avoids errors in delivering care. 5. The interprofessional approach improves the quality of care to patients
patient-centered care (4 items)	6. Patients receiving interprofessional care are more likely than others to be treated as whole persons. 7. Health professionals working as teams are more responsive than others to the emotional and financial needs of patients 8. The interprofessional approach permits health professionals to meet the needs of family caregivers as well as patients. 9. Hospital patients who receive interprofessional team care are better prepared for discharge than other patients.
team efficiency (5 items)	10. Working in an interprofessional manner unnecessarily complicates things most of the time. 11. Working in an interprofessional environment keeps most health professionals enthusiastic and interested in their jobs. 12. In most instances, the time required for interprofessional consultations could be better spent in other ways 13. Having to report observations to a team helps team members better understand the work of other health professionals. 14. Team meetings foster communication among team members from different professions or disciplines.
* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);* Higher scores represent more positive attitudes toward teamwork.	

Research check list

Our article title had included the following point.

1. A structured abstract (max. 300 words) of: objectives, design, results and conclusion, or that meets the standards of the relevant reporting guideline (see below).
2. An 'Article summary' section consisting of three headings: 'Article focus' (up to three bullet points on the research questions or hypotheses addressed); 'Key messages' (up to three bullet points showing the key messages or significance of the study); and a 'Strengths and limitations of this study' section. This should be placed after the abstract.
3. The original protocol for the study, where one exists.
4. A funding statement, preferably worded as follows. Either: 'This work was supported by [name of funder] grant number [xxx]' or 'This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors'.
5. A competing interests statement.
6. Articles should list each author's contribution individually at the end; this section may also include contributors who do not qualify as authors.
7. Any checklist and flow diagram for the appropriate reporting sttement, e.g. STROBE (see below).
8. Any article that contains personal medical information about an identifiable living individual requires the patient's explicit consent before we can publish it. We will need the patient to sign our consent form, which requires the patient to have read the article. This form is available in multiple languages.

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Simulation based inter-professional education to improve attitudes towards collaborative practice

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Simulation based inter-professional education to improve attitudes towards collaborative practice

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ABSTRACT

Objectives: Inter-professional education (IPE) builds inter-professional collaboration (IPC) attitude/skills of medical professionals. This interventional IPE program aims to evaluate whether benchmarking strategy is able to cultivate seed instructors responsible for improving their team members' IPC attitudes.

Design: Prospective, pre-post comparative cross-sectional pilot study.

Setting/participants: 34 physicians, 30 nurses and 24 pharmacists, whose volunteered to be trained as seed instructors, participate 3.5-hr preparation and 3.5-hr simulation workshops. Then, participants (n=88) drew lots to decide 44 presenters, half of each profession, whose need to prepare IPC benchmarking, formed group 1, while remaining participants formed group 2 (regular). Through group 1 participants' IPC benchmarking presentation, facilitators assessed whether they appropriately transfer and sustainably practice of the learnt IPC skills at workspace by preset checklist.

Results: For three professions, improvement in IPC attitude was identified by sequential increase in the post-course (2^{nd} month, T_2) and end-of-study (3^{rd} month, T_3) interdisciplinary education perception scale (IEPS) and Attitudes Towards Health Care Teams Scale (ATHCTS) scores compared to pre-courses (1^{st} month, T_1) scores. By IEPS and ATHCTS-based assessment, the degree of sequential improvements in IPC attitude was higher among nurses and pharmacists than those in physicians. Through real examples in benchmarking presentation, the facilitators agreement for the degree of participants appropriately transfer and sustainably practice leant "communication and teamwork" skills at workplace were significantly higher among pharmacists and nurses than that among physicians. The post-intervention randomly sampling survey (6^{th} month, T_{post}) found that the IPC attitude of three professions had improved after on-site IPC skills promotion by new program-trained seed instructors within teams.

Conclusions: Addition of benchmarking to diamond-based IPE simulation program enhances participants' IPC attitude, self-reflection, workspace' transfer and practice of the learnt skills. Furthermore, IPC promotion within teams by newly trained seed instructors led to improvements in IPC attitudes across all three professions.

Keywords: nurses, pharmacists, inter-professional collaboration, interdisciplinary education perception, attitudes towards health care teams

Strengths and limitations of this study

- This pilot study described the experiences of a prospective cross-sectional cohort of physicians, nurses and pharmacists who volunteered to receive serial benchmarking-enhanced diamond-based IPE simulation program for cultivating them as seed instructors to improve team members' IPC attitude.
- In our new IPE program, IPC benchmarking were implemented to enhance participants' continuous motivation to self-reflection and to promote IPC among team members.
- Using well-validated IEPS and ATHCTS, our study revealed the significant improvements in participant's motivation and IPC attitude across three professions after receiving training of our new IPE program.
- Through IPC benchmarking presentation, facilitators, in our study, revealed that participants' appropriately transfer and sustainably practice the learnt IPC skills at workplace.
- Nonetheless, the participant's satisfaction of new program and the degree of improvement in participant's competencies were not evaluated in our study.
- However, for this part, the usage of newly acquired knowledge or skills by medical professionals of our institution was not evaluated in our study.
- These results were limited to experience in one institution; the degree to which this can be extrapolated to IPE training in other institutions was not known.

INTRODUCTION

Inter-professional education (IPE) aims to improve the coordination, communication, teamwork and leadership skills of medical professionals by learning with, from and about each other.[1] Two key family of learning theory including behaviorism and constructivism had been applied to the curriculum design of IPE.[2,3] It had been reported that learning theories for IPE are not mutually exclusive. In fact, both theorists agree that inter-professional learning "by doing" and learner centerdness are key.[2,3] Health care simulations are recognized as an ideal vehicle for IPE.[4] Today's patients have complex chronic health issues that need inter-professional collaboration (IPC) in order to delivery well-coordinated, high-quality and patient-centered care.[5,6] Simulation-enhanced IPE helps the development of a medical professional's IPC skills and these are very important when managing critical clinical situations.[7]

Baker, *et al*. study reported that 2-hour cardiac resuscitation/intravenous access simulation-based IPE prepared medical students, nursing students and junior medical residents for their future as practitioners.[8] Immediate attitudinal scores and responses by interdisciplinary education perception scale (IEPS) survey were consistently positive among both medical and nursing students.[8] Undre, *et. al.* study reported that, using technical and human factors rating scales, trainers and multidisciplinary trainees assessed the crisis scenarios-based simulation training favorably especially in technical skills.[9] Paige, *et al*. study revealed that 3-hour simulation-based interdisciplinary operating room IPE significantly improve the trainees' self-efficacy teamwork performance in the role clarity, anticipatory response, cross monitoring, team cohesion and interaction.[10] In Vyas *et al.* study, using the team building and inter-professional communications survey, pharmacy student's reported that semi-urgent situations simulation-based IPE increased their understanding of professional roles and the importance of inter-professional communication.[11]

In Estis *et al.* study, using the attitudinal survey, speech language pathology, cardio-respiratory care and nursing students reported that simulated-based IPE enhanced their knowledge of medical professional roles/responsibilities and teamwork skills of caring tracheostomy patients with speaking valves.[12] Nonetheless, participants in Estis *et al.* study suggested that pre-simulation training and more structural interaction during the debriefing phase were likely to enhance effective of the IPE.[12] Specifially, Watters et al. study implemented Diamond debriefing, following description-analysis-application steps, during a 1-day simulation IPE course.[13] The standardized Diamond debriefing is designed to allow an high-quality exploration of the non-technical aspects of a simulated scenario. The Diamond is a two-sided prompt sheet: the first contains the scaffolding, with a series of constructed questions for each phase of the debriefing; while the second lays out the theory behind

the questions and the process.[13,14] In Watters *et al.* study, using the self-efficacy questionnaires, doctors and nurses reported that Diamond-based simulation increase their confidence in "communication and teamwork" skills.[13] Darlow *et al*. study reported that addition of preparation workshop in their 11-hour IPE program resulted in improved attitudes towards inter-professional teams and inter-professional learning, as well as self-reported ability to function within an inter-professional team.[15]

Taken together, previous simulation-based IPE studies[8-15] had lacked post-course continuous training; in addition, there is an absence of long-term follow-up that allows the transference and sustainability of IPC practice to be assessed. Furthermore, there is an absence in these studies of opportunities for the participants to reflect on their training after a period of IPC practice. In 2014, a random sampling survey of three professions at our institution revealed that IPC attitudes of physician, nurses and pharmacists need to be improved (Figure 1).

Notably, it is important to develop feasible continuous IPE/IPC strategies to solve problems of previous studies[8-15] and our survey. So, our education committee targeted these three professions and organized a new IPE program that characterized by pre-simulation training, post-course continuous training, and immediate plus delay IPC attitude assessments. Additionally, post-training e-learning platform and IPC benchmarking provide opportunity for additional/deepening learning of inter-professional problem solving skills. Benchmarking, a good indicator of organization seriousness about quality, is a continuous quality improvement approach. Healthcare benchmarking provides opportunity for inter-professional participants to learn from others and develop innovative collaborative clinical care.[16,17] Intentionally, this pilot intervention evaluates it effects on cultivating new medical professionals as seed instructor to promote IPC within their team.

METHODS

Participants and setting

Medical professionals having longer than 1-year but less than 4-years clinical work experience were invited to participate this study (Figure 1). The participants volunteered to be trained (n=94) were invited to join the 2015 pilot benchmarking-enhanced diamond-based IPE simulation courses to improve their IPC attitude. After excluding six participants due to incomplete questionnaires, a final total of n=88 individuals were included in this study. They consisted of physicians (n=34), nurses (n=30) and pharmacists (n=24). After a brief introduction, the participants were asked to complete the pre-course (T_1) on-line IPC attitude assessment that consisted of interdisciplinary education perception scale (IEPS) and the Attitudes Toward Health Care Teams Scale (ATHCTS) (supplement Table 1-2). Each on-line self-assessment was numbered so that participants remained anonymous but their numbers could be used to match their pre-course (T_1) self-assessment with post-course (T_2) and end-of-study (T_3) self-assessment (Figure 1). All participants continued with their usual professional clinical routine throughout the 3-month interventional study.

Taipei Veterans General Hospital (TVGH) is a 3000-bed medical center providing primary and tertiary care to active-duty and retired military personnel and their dependent; in addition TVGH is the teaching hospital for several medical universities in Northern Taiwan. Between January 2015 and May 2016, we conducted a prospective cross-sectional comparative study at the high-fidelity clinical simulation and interactive learning centre of TVGH; this centre trains around 2500 staff each year. Ethical approval (2015-06-017CC) was obtained from the Ethics committee of our institution and care was taken to apply the World Medical Association Declaration of Helsinki principles to the research.

Diamond-based benchmarking-enhanced IPE simulation program

Each participant attended a 3.5-hour preparation workshop (T_1) at the first month of this study. Subsequently, a 3.5-hour simulation workshop was arranged for the participants during the second month (T_2). At the end of simulation workshop, participants drew lots to decide whose (group 1) needed to prepare for post-course IPC benchmarking at the third months (T_3) of study. In order to keep the fix ratio (34:30:24) among the three professions (Figure 1), half (17:15:12) of the physicians, nurses and pharmacists were selected as benchmarking group and the others as group 2 (regular). All facilitators received serial sessions training to use the Diamond debriefing strategy and to consent about how to rate their agreement about the degree of participants appropriately transfer and sustainably practice of the trained

"coordination, communication, teamwork, and leadership" skills regarding IPC at workplace by real examples in their benchmarking presentation (supplement Table 3). Especially, the Diamond Description-Analysis-Application (DAA) debriefing were used to involve participants in preparation (T1) and simulation (T2) workshops. The "description" step involving 'description' of each profession IPC performance in simulation scenario, the more challenging "analysis" and "application" steps involving 'how did participants feel about each profession IPC performance in simulation scenario?' and "how participants may apply the learnt knowledge from IPC simulation scenarios in their own clinical practice".[13,14]

7-hour preparation and simulation workshop

-Preparation workshop (T_1). According to previous study design,[15] two small-group preparation workshops were held in two consecutive days as shown in Figure 2. The simulated examples of IPC-based care from previous study[11] were revised by educational committee to make into 3 video clips for IPE. They were firstly, a simulation of a distracted wife and a 61-year-old dyspnea male who suffered from recurrent asthmatic attacks due to inappropriate home medication, secondly, a simulation of a 35-year-old anxious family including a pregnant nausea/vomiting/abdominal pain female who need the selection of suitable anti-emetics and a pediatrics/gynaecalogy consultation in an ER setting and, finally, a simulation of a 57-year-old chest pain male with a distracted son who had the wrong allergy and ID labeling on his arm band, as well as unlocked bed in ICU setting. These 10-minutes clips provided a basis for post-video watching discussion that were led by inter-professional facilitators followed a Diamond DAA debriefing (1-hour) ; these target the role and value of the IPC healthcare team involved in the simulated clinical scenarios presented in the three video.[13,14]

-simulation workshop (T_2). In our simulation centers, four small-group workshops were held in four rooms within two consecutive days (Figure 2). Using the clinical scenario outlined below, workshops were led by well-trained IPE facilitators from dietetics, social workers and respiratory therapists. This scenario, which incorporates multi-disciplinary care, was modified by previous study[12] and had been dry ran before formally used. A patient scenario involving Mr. Jason was developed collaboratively by the faculty members of the above mentioned professions. Participants were given the following information. Mr. Jason has a history of chronic obstructive pulmonary disease (COPD), smokes 60 packs per year of cigarettes and has hypertension, diabetes, coronary artery disease and atrial fibrillation. He has been admitted for acute exacerbation of his COPD five times in the past one year. Home medication includes aspirin, a calcium channel blocker, mycolytic agents, inhalation

corticorsteroid/bronchodilator and subcutaneous administrated insulin. Mr. Jason was admitted 3 weeks ago for emergent coronary artery bypass grafting surgery. Although there has been aggressive management with regular chest percussion, he had difficulty to wean from ventilator due to poor sputum expectation and malnutrition. The primary care teams are now considering a tracheostomy and intensive chest/nutrition therapy. His family members are at the bedside. During the simulation, a pre-set intubated high-fidelity SimMan® 3G simulator acted as the patient and standardized patients (SPs) were used as his family. Then, the 3.5-hour workshops were ran (Figure 2).

Before the beginning of the simulation, the participants were presented with above mentioned case's name, age, gender, admission diagnosis and current medication/management. In the three simulation phases, the participants involved were expected to carry out assessment, treatments, and general care of the patients, collaboratively. Then, the participants began the post-simulation debriefing phase and reflected on the challenges, pitfalls, and successes that occurred within the simulation.

The IPC benchmarking (T_3) of the Group 1 participants. As mentioned above, 17 physicians, 15 nurses and 12 pharmacists formed group 1 and these participants underwent IPC benchmarking. Presenters were asked to give their four examples of appropriately transfer and sustainably practice learnt IPC skills at workplace. Randomly, four small groups (n=11) with ratio (4:4:3, 4:4:3, 4:4:3 and 5:3:3) of physician to nurse to pharmacists were presented in four rooms in two consecutive days. During benchmarking, two facilitator's rated their 5-point Likert's-scale-based agreement to the presenters' degree of appropriately transfer and sustainably practice of the learnt IPC skills at workspace by preset checklist (Supplement Table 3). In each room, 4 hours (240 minutes) were needed for 11 presenters to complete their 20-minutes presentation (15-min.)/discussion (5-min.). Each presentation was recorded as a video by teaching assistants (TAs) to help with continuous IPC promotion. With the agreement of presenters, the TAs uploaded edited versions of the video to the e-learning platform. The Group 2 participants were asked to join this end-of-study (T_3) IPC benchmarking.

-e-learning platform. Both the group 1 and the group 2 participants were invited to use a common IPE e-learning platform containing the above mentioned scenario, various power points presentations, the video used in preparation/simulation workshop and the video from the IPC benchmarking to encourage self-directed learning, freely.

Measurements of IPC attitudes

In our study, we measured participants' IPC attitudes with Interdisciplinary

education perception scale[18-20] (IEPS, supplement Table 1), Attitudes Toward Health Care Teams Scale[21] (ATHCTS, supplement Table 2) and single-open-ended items descriptive feedback. IEPS is a 18-items scale that further classified into four subscales including "Competency and Autonomy", "Perceived Need for Cooperation", "Perception of Actual Cooperation" and "Understanding Others' Values". ATHCTS is a 20-items scale that consists of quality of care/process (14 items) and physician centrality (6 items) subscales'. Additionally, participants were asked to provide qualitative feedback freely by answering single-open-ended question "*what is the one thing you are going to take away with you at the end of this course?*" in the online post-courses self assessment (T_3). This question was designed to prompt a participant to reflect on their own learning during the course and allowed program director to gather evidence on which elements within the courses seemed to be contributing the most to the learning experience.

Pre-intervention (T_{pre}) and Post-intervention (T_{post}, 6th month) random sampling survey of IPC attitudes (Figure 1)

Using IPC core elements-based questionnaires (supplement Table 4), across the three professions, the effectiveness of the well-trained seed instructors in terms of team IPC promotion and IPC attitude modification was evaluated by comparison the T_{pre} and T_{post}' IPC attitude scores[22-24]. In total 132 valid T_{post} questionnaires were collected for comparison with another 132 valid T_{pre} questionnaires. These anonymous T_{pre} and T_{post} questionnaires were completed by random members sampled from the three professions, namely 51 physicians, 45 nurses and 36 pharmacists twice. In other words, the individuals who responded to the online IPC attitude survey might be but are not necessarily different between T_{pre} and T_{post} survey. However, it is important to note that the enrolled participants in our interventional study were excluded from the sampling pool for T_{post} sampling survey.

Analysis

Outcomes of our new training program were analyzed according to the Kirkpatrick levels.[25] Since the IEPS and ATHCTS items are ordinal in nature, Wilcoxon's signed rank test was used to analyze each item. The means of the overall IEPS score and the four subscales were evaluated with the Student's two-tailed paired *t*-test for continuous measures, with the aim of detecting any differences between T_1 and T_2 as well as T_2 and T_3 time-points. Data from the IEPS and ATHCTS were matched by profession for analysis with one-way ANOVA or Mann-Whitney U test to detect the significant difference between among groups.

RESULTS

The baseline characteristics of the participants, including mean age, gender and clinical experiences, were similar across the physicians, nurses and pharmacist as can be seem in Table 1. Notably, a lower number of the physicians compared to nurses and pharmacists had experience of receiving previous IPE training. In comparison with nurses and pharmacists, lower percentage of physicians belong to the high-exposure (>80% exposure to monthly IPC meeting/1-year) group, which indicated physician's have less experiences of previous IPC meeting participation during their last 1-year of clinical works

We assessed internal consistency of the IEPS/ATHCTS and its subscales by computing Cronbach's alpha coefficients. Notably, the Cronbach's alpha of IEPS overall scales (0.721), competency and autonomy subscales (0.69), Perceived need for cooperation subscales (0.73), Perception of actual cooperation subscales (0.85) and Understanding others values subscales (0.662) were good. Meanwhile, the Cronbach's alpha of ATHCTS overall scales (0.719), Quality of care delivery subscales (0.683), Patient-centered care subscales (0.801) and Team efficiency subscales (0.724) were acceptable.

The baseline IPC attitude, pre-course (T_1) IEPS scores and pre-course (T_1) ATHCTS scores were also similar across the physicians, nurses and pharmacist (Table 2). Compared to nurses, there were lower scores for the “competency and autonomy” and “understanding others values” basal IEPS subscales (T_1) among the physicians. Similarly, also compared to nurses, there were lower scores for the “competency and autonomy” and “perception of actual cooperation” basal IEPS subscales (T_1) among the pharmacists. Notably, the “competency and autonomy” subscale of IEPS score and the “team efficiency” subscale of the ATHCTS score (T_2-T_1) were increased by the 7-hour stepwise simulation-enhanced IPE course across all three categories, physicians, nurses and pharmacists and, especially, the magnitude of increase in IEPS and ATHCTS scores were significantly greater among the nurses and pharmacist than the physicians (Table 2). Obviously, pharmacists had the highest increase in percent change of post-courses (T_2) ATHCTS score from pre-courses (T_1) score than those in nurses and physicians (Table 2).

Based on the IPC benchmarking presentations of group 1 participants, the facilitators found that physicians were more appropriately transfer and sustainably practice of the learnt IPC “coordination and leadership” skills at workspace than nurses and pharmacists (Table 3). Furthermore, the facilitators reported that nurses and pharmacists were more appropriately transfer and sustainably practice the learnt IPC “communication and teamwork” skills at workspace than physicians (Table 3). Notably, the inter-rater reliability (Kappa statistics) on the items used to assess

whether participants appropriately transfer and sustainably practice the learnt IPC skills by benchmarking facilitators were good (Table 4).

In open-ended questions at the end of our study, most participants reported that watching the IPE-specific video and discussing it, as well as viewing the uploaded videos on the e-learning platform, markedly encourage their motivation to improve their IPC attitude. Specifically, the participant's reported that the availability of an IPE/IPC-specific e-learning platform was able to continuously improve the users' IPC attitude by providing useful resource and instruction.

Selected completed feedback sentences by the participants freely response open-ended items of post-course self-assessment (T3) are listed as below:

1. Benefits of our new benchmarking-enhanced diamond-based IPE simulation courses.
   "*this IPE courses improve inter-professional relationships, communication skills, efficiency in holistic patient care and services delivery, team work, respect for one another and build confidence in their my profession*".
2. Identified IPE/IPC elements in collaborative training.
   "*we are all geared to patient-centered care, all professions need to use their best assessment and judgment to evaluate patients in order to provide the best patient care that we can*";
   "*we understand that there is a lot of team work going on our institution*";
   "*we understand that all professions should be encouraged within their training program to become independent in order to make IPC work better*";
3. Improved skills of quality of clinical care.
   "*There are situations that are different, but we do have to rely on the expertise of other professionals' in order to obtain the best outcome for the patient*";
   "*we were able to collaborate very well with other professional health care members, especially with the nurses in their second simulation; they sort of referred to us regarding our drug management skills and sort of learned how important pharmacists can actually be in a hospital setting*."
4. Skills that learnt from their skillful facilitators
   "sometime staying in your own profession is great and everything, but you really sort of need to reach outwards and see what other professions have to offer, because only if you do that can you truly use the entire knowledge base of other profession and provide the best patient care."

Compared to pre-courses (T_1) scores, the degree of increase in total IEPS and ATHCTS scores at post-courses (T_2) self assessments were not different between group 1 and 2 participants (data not shown). Among the group 1 and 2 participants, similar or higher end-of-study (T_3) IEPS and ATHCTS scores than post-courses (T_2) scores indicated the sustained effects of 7-hour simulation-based diamond-enhanced IPE courses (Figure 3). From the post-course (T_2) to end-of-study (T_3) period, a significantly greater increase in the total IEPS and ATHCTS scores of the group 1 (benchmarking) participants than the group 2 (regular) participants can be seen

(Figure 3). This indicates that the additional benefits of IPC benchmarking on the group 1 participant's IPC attitude. Among the benchmarking-group' participants, the most improved items were the "competency and autonomy" and "perception of actual cooperation" subscales of the IEPS and the "quality of care delivery" and "team efficiency" subscales of the ATHCTS, when the T_2 and T_3 self-assessments were compared.

Among the randomly sampled team members, pre-intervention survey (T_{pre}) revealed that IPC attitudes across physicians, nurses and pharmacists, are needed to be improved on the aspects of IPC' familiarity, understanding of other profession's roles, benefits of IPC on quality of patient-centered care (Figure 3C). Across three professions, after seed instructors began promoting IPC at workplace, post-intervention (T_{post}, 6^{th} month) randomly sampled team member's reported that they were familiar with IPC skills, agreed that IPC help to understand the role of other team members, agreed that IPC improved patient care quality and agreed that IPC improved team efficiency (Figure 3C). Interestingly, the agreements of random sampled team members', across three professions, to the statement of "IPC helps provide patient-centered care" are excellent both during the pre-intervention (Tpre) and post-intervention (Tpost) surveys (Figure 3C).

DISCUSSION

Debriefing can help learner to clarify and integrate the simulation experience with their previous knowledge.[8,10,11,22-24] The Diamond debriefing method encourages a standardized approach to high-quality debriefing across courses, which benefits both the participants and the involved faculty members.[13,14] The Diamond DAA method is related to various aspects of the advocacy-inquiry approach and of debriefing with good judgment. The Diamond provides an easy but pedagogically sound structure to follow and also makes available specific prompts to use in an appropriate moment. Nonetheless, the long-term effects of structured debriefing had not been throughfully evaluated in previous simulated-enhanced IPE studies.[8-15]

In addition to serial subjective and objective assessments, our new IPE model is characterized by Diamond debriefing strategy (Figure 2). When trying to improve each medical professional's IPC attitude with limited resource, including the time needed to carry out the training etc., the number of faculty members needed to run the training and the facilities needed for the training, each newly trained participant should acted as a seed instructor within their team. In other words, successful training of seed instructors can result in profession-wide IPC promotion and attitude remodeling. In our study, this well-organized design allows each participant from three professions to have equal IPE exposure, which helps their development as seed instructors in their healthcare team.

By training volunteers from physicians, nurses and pharmacists, our interventional training program aims to change participant's behaviors and to act as seed instructors for promoting IPC in team member. In our study, the post-intervention survey, which performing after the sequential simulation-based IPE courses, revealed that there was significant improvement in randomly sampled team member's IPC attitude across physicians, nurses and pharmacists.

The strengths of our pilot study are the extension of IPE by e-learning platform, benchmarking and continuous self-evaluations. Previous studies had suggested that training videos consistently enhance the observational powers of trainees, as well as improving their ability to integrate different information and increasing their motivation to learn.[26,27] In our study, most participants reported that the availability of an e-learning platform that has sufficient IPE resources help to continue their self-directed learning. Meanwhile, the benchmarking provides the enrolled participants with the opportunity for IPC self-reflection as well as enhancing their motivation as seed instructors in their teams.

Primarily, this new simulation-based IPE program was intended to solve challenges, which are lack of continuous training and follow-up, of previous studies[8-13,15] and our institution. Indeed, there were some limitations in our study that

need to be improved in future study before concluding the effectiveness of this pilot benchmarking-enhanced diamond-based IPE program on medical professionals' IPC practices and outcomes.

For a training program, Kirkpatrick level 1 and 2 were the evaluation of "participants satisfaction" and "participants increase confidence, knowledge and performance". Using IEPS and ATHCTS, our study revealed the significant improvements in participant's motivation and IPC attitude across three professions after receiving training of our new IPE program. Nonetheless, the participant's satisfaction of new program and the degree of improvement in participant's competencies were not evaluated in our study. Kirkpatrick level 3 and 4 in our study were the "multiplication" of knowledge by "seeding" and influence on the health care system. According to the real presented example in benchmarking of our study, facilitators' gave high ratings for their agreement to participants' degree of appropriately transfer and sustainably practice the learnt IPC skills to clinical works. The sequential improvements in participants' self-assessed IPC attitude scores were also noted in our study. Moreover, the comparison of pre-intervention and post-intervention random sampled team members, whose are non-participants, revealed the general improvement in their IPC attitude and motivation. However, for this part, the usage of newly acquired knowledge or skills by medical professionals of our institution was not evaluated in our study. Taken together, our pilot study only achieved parts of the goals of a training program according to the Kirkpatrick 1-4 levels.[25]

Our IPE approach targets IPC attitude specifically using a number of defined types of patient scenario that are suitable for all three of the enrolled professions. Nonetheless, the specific IPC skills required for holistic care of COPD cases are obviously different from those need to care for acute renal failure cases. Undoubtedly, IPC skills are learned more readily when the simulation-enhanced IPE used is more specific to relevant type of clinical situation. In our study, this limitation was alleviated by the multi-professional post-simulation diamond debriefing during a 3.5-hour simulation workshop and the fact that the enrolled participants continued to carry out their regular clinical routines during the 3-month intervention period. In other words, our enrolled participants were likely to interacting with other professions in their clinical routine after the first and second stimuli presented during the preparation and simulation workshops. In fact, it has been suggested that the participants who have learnt IPC skills in a variety of simulation modules will be able to synthesize a higher level of IPC abilities that can then be applied across many clinical situations.

As participation in this course was voluntary, participants were likely to be more highly motivated than others, which may limit the generalizability of our results. Actually, the positive effects of diamond debriefing and preparation workshop had been reported in previous simulated-based IPE studies.[13-15] In our study, the lack of control groups without diamond method and preparation workshop, to exclude more effects of them on inter-professional skills, may still limit us to conclude the definite effectiveness of benchmarking-enhanced IPE on training. Both IEPS and ATHCTS have been suggested as reliable tools to assess the effectiveness of practice-based IPE interventions.[19-21] It had been validated that each subscale of IEPS and ATHCTS is a strong measurement for underlying IPC concepts that are crucial to medical professions.[19-21]

In Table 3, through real examples in benchmarking presentation, the facilitators agreement for the degree of participant's appropriately transfer and sustainably practice leant “communication and teamwork” skills at workplace were significantly higher among pharmacists and nurses than that among physicians. This result can be explained by higher percentage of pharmacists (43,45%) and nurses (35,36%) had experience of receiving previous IPE training and higher frequency of exposure to IPC meeting during their last 1-yr of clinical works than that among physicians (14,15%) (Table 1). Notably, the core elements in the constructive assessment tools, IEPS and ATHCTS, used in our studies were more focused on “communication and teamwork” than “coordination and leadership” skills.” So, from Table 2, it seems that pharmacists and nurses perform better than physicians. Nonetheless, the facilitators' agreement for the degree of participant's appropriately transfer and sustainably practice learnt “coordination and leadership” skills at workplace were significantly higher among physicians than pharmacists and nurses in benchmarking presentation (Table 3). This might be caused by the culture that physicians take over the role of the leadership in healthcare system. These results remind educator to rethink about the strategy to balance the inter-professional trainings.

CONCLUSIONS

Our benchmarking-enhanced diamond-based IPE simulation program was able to cultivated participants as seed instructors to modify the IPC attitude of their team members. The results of this plot study are promising and suggest that a future large-scale study that extension to professions other than the three enrolled professions here should be considered. As enhancement of inter-professional skills can ensure high-quality patient care, seed instructor training can be suggested as personal development plan for every medical professional.

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Contributors All authors actively participated in analysis of the research results. YYY, FYL, JFL were responsible for study design. YYY, FYL, LYY, CCH participated in the questionnaires. YYY, CCH, HMC, FYL participated in the creation and management of the database. YYY, FYL, SYK, CCH were responsible for the statistical analysis and writing of the manuscript.

Competing interests None.

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FIGURES AND LEGENDS

Figure 1 Study flow chart. Diamond Description-Analysis-Application (DAA) debriefing were used to involve all participants. The "description" step involving 'description' of each profession IPC performance in simulation scenario, the more challenging "analysis" and "application" steps involving 'how did participants feel about each profession IPC performance in simulation scenario?' and "how participants may apply the learnt knowledge from IPC simulation scenarios in their own clinical practice". In order to provide opportunity for inter-professional participants to learn from others and develop innovative collaborative clinical care, presenter gave their success examples of beside IPE/IPC in benchmarking.

Figure 2 Protocols for small group preparation and simulation workshops which ran in separate rooms in two consecutive days

Figure 3 Benchmarking-enhanced IPE pilot program improved participants and their team members' IPC attitudes. The comparison of sequential changes of post-course (T_2) and end-of-study (T_3) subscales and scales of IEPS (**A**) and ATHCTS (**B**) between group 1 (benchmarking) and group 2 (regular) participants. **(C).** Comparison of responses from 132 randomly sampled members from the three professions (51 physicians, 45 nurses. 36 pharmacists twice) about IPC's attitudes in pre-intervention (T_{pre}) and post-intervention (T_{post}) survey. IPC attitude was assessed by five Likert scale responses ranging from 1: strongly disagree to 5: strongly agree. *p<0.01 *vs*. post-course (T_2) or pre-intervention (T_{pre}) scores; $^{\#}p$<0.01 *vs*. group 2 participants' scores.

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Table 1 Baseline characteristics of study population (n=88)			
	Physicians (n=34)	**Nurses (n=30)**	**Pharmacists (n=24)**
Age (years)	31.3± 2.7	29.1 ±4.8	30.5 ±3.6
Female/male (No.)	30/4	27/3	10/14
Percentage of distribution of clinical-work-year of participants among groups			
1-2/2-3/ 3-4 years (%)	76/14/10%	84/10/6%	69/20/11%
Percentage of distribution of participants with and without experience of receiving previous IPE training	15/85%#	35/65%	45/55%
Percentage of distribution of participants with high/low frequency of exposure to IPC meeting during their last 1-yr of clinical works among groups			
Percentage of ‡high-exposure participants	14%#	36%	43%
Percentage of ‡ low-exposure participants	86%#	64%	57%

#p<0.01 *vs.* corresponding nurse′s/pharmacist's group**;** ‡high-exposure participants indicated individual that participating more than 80% of monthly IPC meeting; ‡low-exposure participants indicated individual that participating less than 20% of monthly IPC meeting.

Table 2 Comparison between pre-courses and post-courses self-reported IPC attitude (IEPS and ATHCTS) among three professions

	Physicians (n=34)		Nurses (n=30)		Pharmacists (n=24)	
	pre-course (T_1)	post-course (T_2)	pre-course (T_1)	post-course (T_2)	pre-course(T_1)	post-course (T_2)
Total IEPS-18 scores [6-point scale]	56±1.8$^{\#}$	76±9.8*$^{,\#}$	65±1.6	91±1.2	64±8	91±4.7*
percent change of total IEPS post-course (T_2) score from pre-course (T_1) score		18%		40%†		42%†
IEPS subscales scores						
Competency and autonomy (8 items)	24±3.5$^{\#}$	28±4.1*$^{,\#}$	30±4.5	39±7.2*	22±5.4	40±6.1*
Perceived need for cooperation (2 items)	7±2.2	9±1.6	8±2.9	10±1.8	9±3	11±1.8
Perception of actual cooperation (5 items)	17±2.7	24±3.7*$^{,\#}$	15±1.2	26±4.3*	20±4.8	23±2.5
Understanding others values (3 items)	8±2.4$^{\#}$	15±2.9*	12±3.8	16±1.4	13±2.1	17±5.1*
Total ATHCTS-14 [5-point scale]	39±2.3	48±5.4*	38±2.6	51±4.6	32±3.7	54±7.5
percent change of total ATHCTS post-course (T_2) score from pre-course (T_1) score		23%		34%†		69%†
ATHCTS subscales scores						
Quality of care delivery (5 items)	14±2.2	15±1.8$^{\#}$	13±1.6	18±4.1*	12±4.2	20±2.0*
Patient-centered care (4 items)	13±1.7	18±2.1*	15±7.4	19±3.3	11±2.8	18±3.5*
Team efficiency (5 items)	12±1.1	15±3.7*	10±1.9	14±2.7*	9±2.6	16±4.1*

Data were expressed as mean±SD; *p<0.01 *vs.* pre-course scores; #p<0.01 *vs.* corresponding nurse's/pharmacists score's; †p<0.01 *vs.* physicians scores

Table 3 Comparison of facilitators' agreement to group 1 participant's degree of appropriately transfer and sustainably practice of the learnt IPC skills at workplaces according to 4 real examples in their benchmarking presentation

		Physicians (n=17)	Nurses (n=15)	Pharmacists (n=12)
Example 1	[1-1].Presenter transfers the "coordination" skills appropriately at workplaces	4.3±0.64	3.6±0.7#	3.9±0.8#
	[1-2].Presenter practices the "coordination" skills sustainably at workplaces	4.6±0.54	3.3±0.21#	4.1±0.7#
Example 2	[2-1].Presenter transfers the "communication" skills appropriately at workplaces	3.9±0.52*	4.1±0.94	4.4±0.7
	[2-2].Presenter practices the "communication" skills sustainably at workplaces	3.3±0.71*	4.01±0.76	4.8±0.1
Example 3	[3-1].Presenter transfers the "teamwork" skills appropriately at workplaces	3.4±0.502*	4.5±0.46	4.1±0.9
	[3-2].Presenter practices the "teamwork" skills sustainably at workplaces	3.8±0.2*	4.7±0.1	4.5±0.6
Example 4	[4-1].Presenter transfers the "leadership" skills appropriately at workplaces	4.4±0.803	3.4±0.61#	4.0±0.5#
	[4-2].Presenter practices the "leadership" skills sustainably at workplaces	4.7±0.4	3.0±0.3#	3.8±0.4#

Data were expressed as mean±SD; The IPC skills including coordination, communication, teamwork and leadership. Presenters were asked to present their four examples according to the sequences of items listed above. Sequentially, benchmarking' example 1 for item 1-1&1-2, example 2 for item 2-1&2-2, example 3 for item 3-1&3-2, example 4 for item 4-1&4-2 were presented. Facilitator's degree of agreement to presenters' performance were rated by 5-point Likerts scale-based (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree); By consensus meeting, facilitators rate their agreement to the items 1-1 and 1-2 according to the example 1 of presenter, items 2-2 and 2-2 from example 2, item 3-1 and 3-2 from example 3, items 4-1 and 4-2 from example 4 in separate rooms. The results were averaged data of ratings completed by two facilitators for presenter's performance of each item in above checklist; #$p<0.05$ *vs.* physician's group; *$p<0.05$ vs. nurse's/pharmacist's group.

Table 4 Inter-rater reliability of facilitators' benchmarking ratings derived from group 1 participants

	Physicians	Nurses	Pharmacists
	Kappa	Kappa	Kappa
[1-1].Presenter transfers the "coordination" skills appropriately at workplaces	0.73	0.71	0.85
[1-2].Presenter practices the "coordination" skills sustainably at workplaces	0.67	0.843	0.76
[2-1].Presenter transfers the "communication" skills appropriately at workplaces	0.69	0.82	0.89
[2-2].Presenter practices the "communication" skills sustainably at workplaces	0.71	0.79	0.77
[3-1].Presenter transfers the "teamwork" skills appropriately at workplaces	0.683	0.679	0.711
[3-2].Presenter practices the "teamwork" skills sustainably at workplaces	0.78	0.812	0.79
[4-1].Presenter transfers the "leadership" skills appropriately at workplaces	0.72	0.77	0.849
[4-2].Presenter practices the "leadership" skills sustainably at workplaces	0.83	0.74	0.816

Two facilitators for each small-group [n=11, either with 4:4:3, 4:4:3, 4:4:3, 5:3:3 ratio of physician: nurse: pharmacists] benchmarking presentation held in four rooms in two consecutive days.

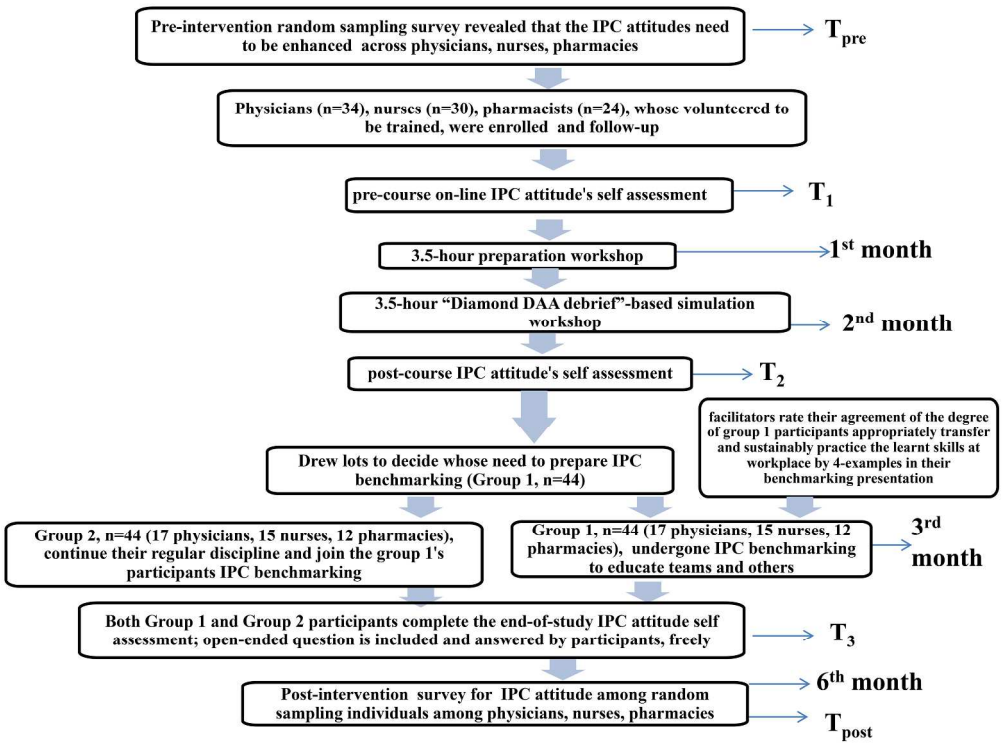

Fig. 1

245x181mm (300 x 300 DPI)

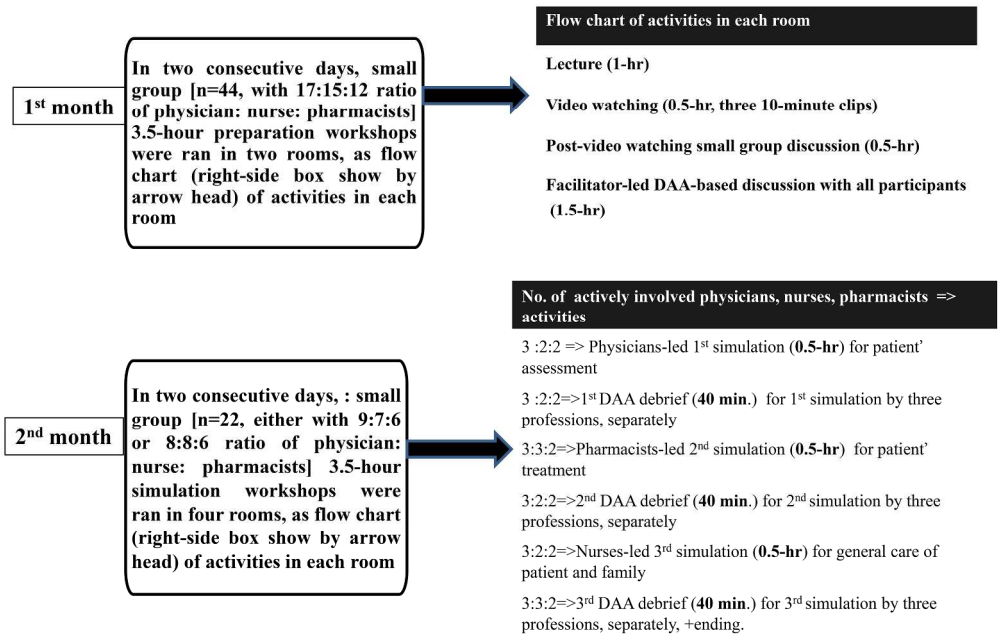

Fig. 2

248x157mm (300 x 300 DPI)

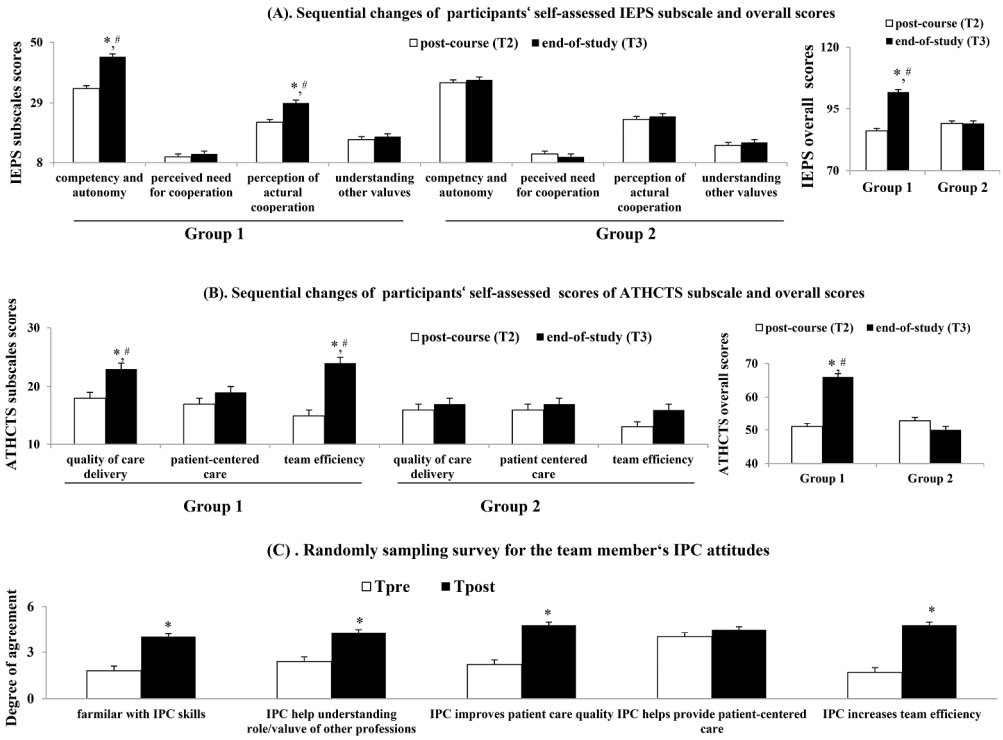

Fig. 3

250x184mm (300 x 300 DPI)

Supplement table 1 Interdisciplinary education perception scale (IEPS)	
subsclases	statement
competency and autonomy (8 items)	1. Individuals in my profession are well-trained. 2. Individuals in my profession demonstrate a great deal of autonomy. 3. Individuals in my profession are very positive about their goals and objectives. 4. Individuals in my profession are very positive about their contributions and accomplishments. 5. Individuals in my profession trust each other's professional judgment. 6. Individuals in my profession are extremely competent. 7. Individuals in other professions respect the work done by my profession. 8. Individuals in other professions think highly of my profession.
perceived need for cooperation (2 items)	9. Individuals in my profession need to cooperate with other professions. 10. Individuals in my profession must depend upon the work of people in other professions.
perception of actual cooperation (5 items)	11. Individuals in my profession are able to work closely with individuals in other professions. 12. Individuals in my profession are willing to share information and resources with other professionals. 13. Individuals in my profession have good relations with people in other professions. 14. Individuals in my profession think highly of other related professions. 15. Individuals in my profession work well with each other.
understanding others value (3 items)	16. Individuals in my profession have a higher status than individuals in other professions. 17. Individuals in my profession make every effort to understand the capabilities and contributions of other professions. 18. Individuals in other professions often seek the advice of people in my profession.
Likert's Scale with 6 possible responses (1=Strongly Disagree, 2=Moderately Disagree, 3=Somewhat Disagree, 4=Somewhat Agree, 5=Moderately Agree, 6=Strongly Agree); ** Higher scores represent more positive attitudes toward teamwork. "Competency and Autonomy" subscale measures how highly students respect their profession, in the sense that it is well taught and contributes significantly to improving the healthcare field, as well as to what extent they believe that other professions are respected in a similar fashion. "Perceived Need for Cooperation" reflects the responders' perceptions of the need for teamwork, which typically includes respecting and working well with other professions. "Perception of Actual Cooperation", aims to reveal the responders' perception of how their profession typically respects and works well with other professions. "Understanding Others' Values" aims to reflect the degree of respect the responder has for contributions from all healthcare professions.	

Supplement table 2 Attitudes Toward Interprofessional Health Care Teams Scale (ATIHCTS)	
Subscales	STATEMENT
quality of care delivery (5 items)	1. Developing an inter-professional patient care plan is excessively time consuming. 2. The give and take among team members helps them make better patient care decisions. 3. The inter-professional approach makes the delivery of care more efficient. 4. Developing a patient care plan with other team members avoids errors in delivering care. 5. The inter-professional approach improves the quality of care to patients
patient-centered care (4 items)	6. Patients receiving inter-professional care are more likely than others to be treated as whole persons. 7. Health professionals working as teams are more responsive than others to the emotional and financial needs of patients 8. The inter-professional approach permits health professionals to meet the needs of family caregivers as well as patients. 9. Hospital patients who receive inter-professional team care are better prepared for discharge than other patients.
team efficiency (5 items)	10. Working in an inter-professional manner unnecessarily complicates things most of the time. 11. Working in an inter-professional environment keeps most health professionals enthusiastic and interested in their jobs. 12. In most instances, the time required for inter-professional consultations could be better spent in other ways 13. Having to report observations to a team helps team members better understand the work of other health professionals. 14. Team meetings foster communication among team members from different professions or disciplines.
* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);*Higher scores represent more positive attitudes toward teamwork.	

Supplement Table 3 Items of the facilitators' agreement to group 1 participant's degree of appropriately transfer and sustainably practice of the learnt IPC skills, including coordination, communication, teamwork and leadership, at workplaces according to 4 real examples in their benchmarking presentation	
Example 1	[1-1].Presenter transfers the “coordination” skills appropriately at workplaces
	[1-2].Presenter practices the “coordination” skills sustainably at workplaces
Example 2	[2-1].Presenter transfers the “communication” skills appropriately at workplaces
	[2-2].Presenter practices the “communication” skills sustainably at workplaces
Example 3	[3-1].Presenter transfers the “teamwork” skills appropriately at workplaces
	[3-2].Presenter practices the “teamwork” skills sustainably at workplaces
Example 4	[4-1].Presenter transfers the “leadership” skills appropriately at workplaces
	[4-2].Presenter practices the “leadership” skills sustainably at workplaces
Presenters were asked to present their four examples according to the sequences of items listed above. Sequentially, benchmarking' example 1 for item 1-1&1-2, example 2 for item 2-1&2-2, example 3 for item 3-1&3-2, example 4 for item 4-1&4-2 were presented. Facilitator's degree of agreement to presenters' performance were rated by 5-point Likerts scale-based (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree); By consensus meeting, facilitators rate their agreement to the items 1-1 and 1-2 according to the example 1 of presenter, items 2-2 and 2-2 from example 2, item 3-1 and 3-2 from example 3, items 4-1 and 4-2 from example 4 in separate rooms.	

Supplement table 4 Items of questionnaires used for pre-intervention and post-intervention random sampling survey of IPC attitudes
1. Are you familiar with IPC skills?
2. Do you agree that IPC helps understanding the role of other healthcare team members?
3. Do you agree that IPC improves quality of patient care?
4. Do you agree that IPC improves patient-centered care?
5. Do you agree that IPC improves team efficiency?
* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);* Higher scores represent better IPC attitudes

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***
Title: **Simulation based inter-professional education to improve attitudes towards collaborative practice**

	Item No	Recommendation	Page No.
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			
Study design	4	Present key elements of study design early in the paper	Page 6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Page 6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	Page 6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 8-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 8-9
Bias	9	Describe any efforts to address potential sources of bias	Page 9
Study size	10	Explain how the study size was arrived at	Page 6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 9
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	Page 9
		(*d*) If applicable, explain how loss to follow-up was addressed	Page 9
		(*e*) Describe any sensitivity analyses	Page 9
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 11
		(b) Give reasons for non-participation at each stage	Page 11

		(c) Consider use of a flow diagram	Page 11
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 12
		(b) Indicate number of participants with missing data for each variable of interest	Page 12
		(c) Summarise follow-up time (eg, average and total amount)	Page 12
Outcome data	15*	Report numbers of outcome events or summary measures over time	Page 13
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 13
		(*b*) Report category boundaries when continuous variables were categorized	Page 13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Page 13
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 13
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 14-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 14-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 14-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Simulation based inter-professional education to improve attitudes towards collaborative practice: a prospective comparative pilot study in a Chinese medical center

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Keywords:	nurses, pharmacists, inter-professional collaboration, interdisciplinary education perception, attitudes towards health care teams

Simulation based inter-professional education to improve attitudes towards collaborative practice: a prospective comparative pilot study in a Chinese medical center

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ABSTRACT

Objectives: Inter-professional education (IPE) builds inter-professional collaboration (IPC) attitude/skills of health professionals. This interventional IPE program evaluates whether benchmarking sharing can successfully cultivate seed instructors responsible for improving their team members' IPC attitudes.

Design: Prospective, pre-post comparative cross-sectional pilot study.

Setting/participants: 34 physicians, 30 nurses and 24 pharmacists, who volunteered to be trained as seed instructors participated in 3.5-hr preparation and 3.5-hr simulation workshops. Then, participants (n=88) drew lots to decide 44 presenters, half of each profession, who needed to prepare IPC benchmarking and formed Group 1. The remaining participants formed Group 2 (regular). Facilitators rated the Group 1 participants' degree of appropriate transfer and sustainable practice of the learnt IPC skills in the workplace according to successful IPC examples in their benchmarking sharing.

Results: For the three professions, improvement in IPC attitude was identified by sequential increase in the post-course (2^{nd} month, T_2) and end-of-study (3^{rd} month, T_3) Interdisciplinary Education Perception Scale (IEPS) and Attitudes Towards Health Care Teams Scale (ATHCTS) scores, compared to pre-course (1^{st} month, T_1) scores. By IEPS and ATHCTS-based assessment, the degree of sequential improvements in IPC attitude was found to be higher among nurses and pharmacists than in physicians. In benchmarking sharing, the facilitators' agreement about the degree of participant's appropriate transfer and sustainable practice learnt “communication and teamwork” skills in the workplace were significantly higher among pharmacists and nurses than among physicians. The post-intervention random sampling survey (6^{th} month, T_{post}) found that the IPC attitude of three professions improved after on-site IPC skill promotion by new program-trained seed instructors within teams.

Conclusions: Addition of benchmark sharing to a diamond-based IPE simulation program enhances participants' IPC attitudes, self-reflection, workplace transfer and practice of the learnt skills. Furthermore, IPC promotion within teams by newly trained seed instructors improved the IPC attitudes across all three professions.

Keywords: nurses, pharmacists, inter-professional collaboration, interdisciplinary education perception, attitudes towards health care teams

Strengths and limitations of this study

- This pilot study describes the experiences of a prospective cross-sectional cohort of physicians, nurses and pharmacists who volunteered to receive serial benchmarking-enhanced diamond-based IPE simulation program for cultivating them as seed instructors to improve team members' IPC attitude.
- In our IPE program, IPC benchmarking sharing was implemented to enhance participants' continual motivation to self-reflect and to promote IPC among team members.
- Using IEPS and ATHCTS, our study reveals the significant improvements in participant's motivation and IPC attitude across three professions after receiving training with our new IPE program.
- Through IPC benchmarking presentation, participants' appropriate transfer and sustainable practice of the learnt IPC skills in the workplace was evaluated.
- Although participant's satisfaction with the new program and the degree of improvement in participant's competencies were not evaluated in our study.
- At this stage, the use of newly acquired knowledge or skills by medical professionals of our institution was not evaluated in our study.
- These results were limited to experience in one institution; the degree to which this can be extrapolated to IPE training in other institutions is not known.

INTRODUCTION

Inter-professional education (IPE) aims to improve the coordination, communication, teamwork and leadership skills of health professionals by learning with, from and about each other.[1] Two key families of learning theory behaviorism and constructivism were applied to the curriculum design of IPE.[2,3] It has been reported that learning theories for IPE are not mutually exclusive. In fact, theorists agree that inter-professional learning "by doing" combined with learner centeredness is the key.[2,3] Health care simulations are recognized as an ideal vehicle for IPE.[4] Today's patients have complex chronic health issues that need inter-professional collaboration (IPC) in order to delivery well-coordinated, high-quality and patient-centered care.[5,6] Simulation-enhanced IPE helps the development of a health professional's IPC skills and these are very important when managing critical clinical situations.[7]

Baker, *et al*. reported that 2-hour cardiac resuscitation/intravenous access simulation-based IPE prepared medical students, nursing students and junior medical residents for their future as practitioners.[8] In their study, immediate attitudinal scores and responses by Interdisciplinary Education Perception Scale (IEPS) survey were consistently positive among both medical and nursing students.[8] Undre *et. al.* reported that, using technical and human factors rating scales, trainers and multidisciplinary trainees assessed the crisis scenarios-based simulation training favorably, especially in technical skills.[9] Paige *et al*. revealed that 3-hour simulation-based interdisciplinary operating room IPE significantly improve the trainees' self-efficacy teamwork performance in role clarity, anticipatory response, cross monitoring, team cohesion and interaction.[10] In Vyas *et al.* study, using the team building and inter-professional communications survey, pharmacy student's reported that semi-urgent situations simulation-based IPE increased their understanding of professional roles and the importance of inter-professional communication.[11]

In Estis *et al.* study, using an attitudinal survey, speech language pathology, cardio-respiratory care and nursing students reported that simulation-based IPE enhanced their knowledge of medical professional roles/responsibilities and teamwork skills of caring for tracheostomy patients with speaking valves.[12] Nevertheless, participants in the Estis *et al.* study suggested that pre-simulation training and more structural interaction during the debriefing phase were likely to enhance effective of the IPE.[12] Specifically, Watters *et al*. implemented a debrief diamond, following description-analysis-application steps, during a 1-day simulation IPE course.[13] The standardized debrief diamond was designed to allow high-quality exploration of the non-technical aspects of a simulated scenario. The diamond is a two-sided prompt sheet: the first contains the scaffolding, with a series of constructed questions for each phase of the debriefing; while the second lays out the theory behind the questions and the process.[13,14] In Watters *et al.* study, using self-efficacy questionnaires, doctors and nurses reported that diamond-based simulation increased their confidence in "communication and teamwork" skills.[13] Darlow *et al*. reported that addition of a preparation workshop to their 11-hour IPE program resulted in improved attitudes towards inter-professional teams and inter-professional learning, as well as self-reported ability to function within an inter-professional team.[15]

Taken together, previous simulation-based IPE studies[8-15] were lacked post-course continuous training. In addition, there is an absence of long-term follow-up that allows the transference and sustainability of IPC practice to be assessed. Furthermore, there is an absence in these studies of opportunities for the participants

to reflect on their training after a period of IPC practice. In 2014, a random sampling survey of three professions at our institution revealed that IPC attitudes of physician, nurses and pharmacists need to be improved (Figure 1).

It is important to develop feasible continuous IPE/IPC strategies to solve the problems of previous studies[8-15] and of our survey. Therefore, our education committee targeted these three professions and organized a new IPE program characterized by pre-simulation training, post-course continuous training, and immediate plus delayed IPC attitude assessments. Additionally, post-training e-learning platform and IPC benchmarking sharing provide an opportunity for additional/deepening learning of inter-professional problem solving skills. Benchmarking sharing, a good indicator of organizational seriousness about quality, is a continuous quality improvement approach. Healthcare benchmarking sharing provides opportunities for inter-professional participants to learn from others and develop innovative collaborative clinical care.[16,17] This pilot intervention intentionally evaluates its impact on cultivating new health professionals as seed instructors to promote IPC within their teams.

METHODS

Participants and setting

Health professionals having more than 1 year but less than 4 years of clinical work experience were invited to participate in this study (Figure 1). The participants volunteering to be trained (n=94) were invited to join the 2015 pilot benchmarking-enhanced diamond-based IPE simulation courses to improve their IPC attitudes. After excluding six participants due to incomplete questionnaires, a total of n=88 individuals were included in this study. They consisted of physicians (n=34), nurses (n=30) and pharmacists (n=24). After a brief introduction, the participants were asked to complete the pre-course (T_1) on-line IPC attitude assessment, which consisted of Interdisciplinary Education Perception Scale (IEPS) and the Attitudes Toward Health Care Teams Scale (ATHCTS) (supplement Tables 1-2).

Supplement table 1 Interdisciplinary education perception scale (IEPS)

subsclases	statement
competency and autonomy (8 items)	1. Individuals in my profession are well-trained. 2. Individuals in my profession demonstrate a great deal of autonomy. 3. Individuals in my profession are very positive about their goals and objectives. 4. Individuals in my profession are very positive about their contributions and accomplishments. 5. Individuals in my profession trust each other's professional judgment. 6. Individuals in my profession are extremely competent. 7. Individuals in other professions respect the work done by my profession. 8. Individuals in other professions think highly of my profession.
perceived need for cooperation (2 items)	9. Individuals in my profession need to cooperate with other professions. 10. Individuals in my profession must depend upon the work of people in other professions.
perception of actual cooperation (5 items)	11. Individuals in my profession are able to work closely with individuals in other professions. 12. Individuals in my profession are willing to share information and resources with other professionals. 13. Individuals in my profession have good relations with people in other professions. 14. Individuals in my profession think highly of other related professions. 15. Individuals in my profession work well with each other.
understanding others value (3 items)	16. Individuals in my profession have a higher status than individuals in other professions. 17. Individuals in my profession make every effort to understand the capabilities and contributions of other professions. 18. Individuals in other professions often seek the advice of people in my profession.
Likert's Scale with 6 possible responses (1=Strongly Disagree, 2=Moderately Disagree, 3=Somewhat Disagree, 4=Somewhat Agree, 5=Moderately Agree, 6=Strongly Agree); ** Higher scores represent more positive attitudes toward teamwork. "Competency and Autonomy" subscale measures how highly students respect their profession, in the sense that it is well taught and contributes significantly to improving the healthcare field, as well as to what extent they believe that other professions are respected in a similar fashion. "Perceived Need for Cooperation" reflects the responders' perceptions of the need for teamwork, which typically includes respecting and working well with other professions. "Perception of Actual Cooperation", aims to reveal the responders' perception of how their profession typically respects and works well with other professions. "Understanding Others' Values" aims to reflect the degree of respect the responder has for contributions from all healthcare professions.	

Supplement table 2 Attitudes Toward Interprofessional Health Care Teams Scale (ATIHCTS)

Subscales	STATEMENT
quality of care delivery (5 items)	1. Developing an inter-professional patient care plan is excessively time consuming.
	2. The give and take among team members helps them make better patient care decisions.
	3. The inter-professional approach makes the delivery of care more efficient.
	4. Developing a patient care plan with other team members avoids errors in delivering care.
	5. The inter-professional approach improves the quality of care to patients
patient-centered care (4 items)	6. Patients receiving inter-professional care are more likely than others to be treated as whole persons.
	7. Health professionals working as teams are more responsive than others to the emotional and financial needs of patients
	8. The inter-professional approach permits health professionals to meet the needs of family caregivers as well as patients.
	9. Hospital patients who receive inter-professional team care are better prepared for discharge than other patients.
team efficiency (5 items)	10. Working in an inter-professional manner unnecessarily complicates things most of the time.
	11. Working in an inter-professional environment keeps most health professionals enthusiastic and interested in their jobs.
	12. In most instances, the time required for inter-professional consultations could be better spent in other ways
	13. Having to report observations to a team helps team members better understand the work of other health professionals.
	14. Team meetings foster communication among team members from different professions or disciplines.

* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);*Higher scores represent more positive attitudes toward teamwork.

Each on-line self-assessment was numbered so that participants remained anonymous but their numbers could be used to match their pre-course (T_1) self-assessment with post-course (T_2) and end-of-study (T_3) self-assessment (Figure 1). All participants continued with their usual professional clinical routine throughout the 3-month interventional study.

Taipei Veterans General Hospital (TVGH) is a 3000-bed medical center providing primary and tertiary care to active-duty and retired military personnel and their dependents, and the general public. In addition TVGH is the teaching hospital for several medical universities in Northern Taiwan. Between January 2015 and May 2016, we conducted a prospective cross-sectional comparative study at the high-fidelity clinical simulation and interactive learning center of TVGH; this center trains around 2500 staff each year. Ethical approval (2015-06-017CC) was obtained from the Ethics committee of our institution and care was taken to apply the World Medical Association Declaration of Helsinki principles to the research.

Diamond-based benchmarking-enhanced IPE simulation program

Each participant attended a 3.5-hour preparation workshop (T_1) in the first month of this study. Subsequently, a 3.5-hour simulation workshop was arranged for the participants during the second month (T_2). At the end of the simulation workshop, participants drew lots to decide who needed to prepare for post-course IPC benchmarking at the third month (T_3) of study (*i.e.*, who was in Group 1). In order to

maintain a fixed ratio (34:30:24) among the three professions (Figure 1), half (17:15:12) of the physicians, nurses and pharmacists were selected as the benchmarking group and the others as Group 2 (regular). All facilitators received serial sessions training in how to use the debrief diamond and to consent about how to rate their agreement about the degree of participants appropriate transfer and sustainable practice of the trained "coordination, communication, teamwork, and leadership" skills regarding IPC in the workplace using real examples in their benchmarking sharing. In particular, the Description-Analysis-Application (DAA) debrief diamond was used to involve participants in preparation (T1) and simulation (T2) workshops. The "description" step involved 'description' of each profession's IPC performance in the simulation scenario, along with more challenging "analysis" and "application" steps involving 'how did participants feel about each profession's IPC performance in simulation scenario?' and "how participants may apply the learnt knowledge from IPC simulation scenarios in their own clinical practice".[13,14]

7-hour preparation and simulation workshop

-Preparation workshop (T_1). In accordance with previous study design,[15] two small-group preparation workshops were held on two consecutive days as shown in Figure 2. The simulated examples of IPC-based care from a previous study[11] were revised by educational committee and made into three video clips for IPE. They were, first, a simulation of a distracted wife and a 61-year-old dyspnea male who suffered from recurrent asthmatic attacks due to inappropriate home medication; second, a simulation of a 35-year-old anxious family, including a pregnant nausea/vomiting/abdominal pain female who needed the selection of suitable anti-emetics and a pediatrics/gynecology consultation in an ER setting and, finally, a simulation of a 57-year-old chest pain male with a distracted son and with the wrong allergy and ID labeling on his arm band, as well as unlocked bed in ICU setting. These 10-minutes clips provided a basis for post-video viewing discussion that were led by inter-professional facilitators following a Diamond DAA debriefing (1-hour); these target the role and value of the IPC healthcare team involved in the simulated clinical scenarios presented in the three videos.[13,14]

-Simulation workshop (T_2). In our simulation centers, four small-group workshops were held in four rooms within two consecutive days (Figure 2). Using the clinical scenario outlined below, workshops were led by well-trained IPE facilitators from dietetics, social workers and respiratory therapists. This scenario, which incorporates multi-disciplinary care, was modified by a previous study[12] and had a dry run before formally being used. A patient scenario involving Mr. Jason was developed collaboratively by the faculty members of the aforementioned professions. Participants were given the following information. Mr. Jason has a history of chronic obstructive pulmonary disease (COPD), smokes 60 packs per year of cigarettes and has hypertension, diabetes, coronary artery disease and atrial fibrillation. He has been admitted for acute exacerbation of his COPD five times in the past one year. Home medication includes aspirin, a calcium channel blocker, mycolytic agents, inhalation corticosteroid/bronchodilator and subcutaneous administrated insulin. Mr. Jason was admitted 3 weeks ago for emergency coronary artery bypass grafting surgery. Although there has been aggressive management with regular chest percussion, he has had difficulty being weaned from the ventilator due to poor sputum expectation and malnutrition. The primary care teams now are considering a tracheostomy and intensive chest/nutrition therapy. His family members are at the bedside. During the simulation, a pre-set intubated high-fidelity SimMan® 3G simulator acted as the

patient and standardized patients (SPs) were used as his family. Then, the 3.5-hour workshops were ran (Figure 2).

Before the beginning of the simulation, the participants were presented with the case's name, age, gender, admission diagnosis and current medication/management. In the three simulation phases, the participants involved were expected to carry out assessment, treatments, and general care of the patients, collaboratively. Then, the participants began the post-simulation debriefing phase and reflected on the challenges, pitfalls, and successes that occurred within the simulation.

The IPC benchmarking (T_3) of the Group 1 participants. As mentioned above, 17 physicians, 15 nurses and 12 pharmacists formed Group 1 and these participants underwent IPC benchmarking sharing. Presenters were asked to give their four examples of appropriately transfer and sustainable practice learnt IPC skills in the workplace. Randomly, four small groups (n=11) with ratio (4:4:3, 4:4:3, 4:4:3 and 5:3:3) of physician to nurse to pharmacists were presented in four rooms over two consecutive days. During benchmarking sharing, two facilitators rated their 5-point Likert-scale-based agreement to the presenters' degree of appropriate transfer and sustainable practice of the learnt IPC skills in the workspace according to their four success examples. In each room, 4 hours (240 minutes) were needed for 11 presenters to complete their 20-minutes presentation (15-min.)/discussion (5-min.). Each presentation was video recorded by teaching assistants (TAs) to help with continuous IPC promotion. With the agreement of the presenters, the TAs uploaded edited versions of the video to the e-learning platform. The Group 2 participants were asked to join this end-of-study (T_3) IPC benchmarking sharing.

-*e-learning platform.* Both the Group 1 and Group 2 participants were invited to use a common IPE e-learning platform containing the aforementioned scenario, various Power-point presentations, the video used in the preparation/simulation workshop and the video from the IPC benchmarking to encourage self-directed learning.

Measurements of IPC attitudes

In our study, we measured participants' IPC attitudes with Interdisciplinary education perception scale[18-20] (IEPS, supplemental Table 1), Attitudes Toward Health Care Teams Scale[21] (ATHCTS, supplemental Table 2) and single-open-ended items descriptive feedback. IEPS is a 18-items scale that classified further into four subscales, including "Competency and Autonomy," "Perceived Need for Cooperation," "Perception of Actual Cooperation" and "Understanding Others' Values". ATHCTS is a 20-item scale consisting of quality of care/process (14 items) and physician centrality (6 items) subscales'. Additionally, participants were asked to provide qualitative feedback freely by answering the single-open-ended question, "*what is the one thing you are going to take away with you at the end of this course?*" in the online post-courses self-assessment (T_3). This question was designed to prompt a participant to reflect on their own learning during the course and allowed the program director to gather evidence on which elements within the courses seemed to be contributing the most to the learning experience.

Pre-intervention (T_{pre}) and Post-intervention (T_{post}, 6th month) random sampling survey of IPC attitudes (Figure 1)

Using IPC core elements-based questionnaires (supplement Table 3), across the three professions, the effectiveness of the well-trained seed instructors was evaluated

by comparing the differences between T_{pre} and T_{post}' IPC attitude scores[22-24].

Supplement table 3 IPC core elements-based questionnaires used for pre-intervention and post-intervention random sampling survey of IPC attitudes
1. Are you familiar with IPC skills?
2. Do you agree that IPC helps understanding the role of other healthcare team members?
3. Do you agree that IPC improves quality of patient care?
4. Do you agree that IPC improves patient-centered care?
5. Do you agree that IPC improves team efficiency?
* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);* Higher scores represent better IPC attitudes

In total, 132 valid T_{post} questionnaires were collected for comparison with another 132 valid T_{pre} questionnaires. These anonymous T_{pre} and T_{post} questionnaires were completed by random members sampled twice from the three professions, namely 51 physicians, 45 nurses and 36 pharmacists. In other words, the individuals who responded to the online IPC attitude survey might be but are not necessarily different between T_{pre} and T_{post} survey. Nonetheless, it is important to note that the enrolled participants in our interventional study were excluded from the sampling pool for T_{post} sampling survey.

Analysis

Outcomes of our new training program were analyzed according to Kirkpatrick levels.[25] Since the IEPS and ATHCTS items are ordinal in nature, Wilcoxon's signed rank test was used to analyze each item. The means of the overall IEPS score and the four subscales were evaluated with the Student's two-tailed paired *t*-test for continuous measures, with the aim of detecting any differences between T_1 and T_2 as well as T_2 and T_3 time-points. Data from the IEPS and ATHCTS were matched by profession for analysis with one-way ANOVA or Mann-Whitney U test to detect the significant difference between among groups.

RESULTS

The baseline characteristics of the participants, including mean age, gender and clinical experiences, were similar across the physicians, nurses and pharmacist as can be seen in Table 1. A higher percentage of pharmacists (45%/43%) and nurses (35%/36%) having experience receiving previous IPE training and higher frequency of exposure to IPC meeting during their previous year of clinical works than physicians (15%/14%) (Table 1). In other words, in comparison with nurses and pharmacists, a lower percentage of physicians belong to the high-exposure (>80% exposure to monthly IPC meeting/1-year) group, which indicates the physician's had less experience with IPC meeting participation during their last 1-year of clinical work

Table 1 Baseline characteristics of study population (n=88)

	Physicians (n=34)	Nurses (n=30)	Pharmacists (n=24)
Age (years)	31.3± 2.7	29.1 ±4.8	30.5 ±3.6
Female/male (No.)	30/4	27/3	10/14
Percentage of distribution of clinical-work-year of participants among groups			
1-2/2-3/ 3-4 years (%)	76/14/10%	84/10/6%	69/20/11%
Percentage of distribution of participants with and without experience of receiving previous IPE training	15/85%#	35/65%	45/55%
Percentage of distribution of participants with high/low frequency of exposure to IPC meeting during their last 1-yr of clinical work among groups			
Percentage of ‡high-exposure participants	14%#	36%	43%
Percentage of ‡ low-exposure participants	86%#	64%	57%

#p<0.01 *vs.* corresponding nurse′s/pharmacist's group**;** ‡high-exposure participants indicated individual that participating more than 80% of monthly IPC meeting; ‡low-exposure participants indicated individual that participating less than 20% of monthly IPC meeting.

Good internal consistency of the IEPS/ATHCTS and its subscales

In this study, the Cronbach's alpha coefficients of IEPS overall scales (0.721), competency and autonomy subscales (0.69), Perceived need for cooperation subscales (0.73), Perception of actual cooperation subscales (0.85) and Understanding others values subscales (0.662) were good. Meanwhile, Cronbach's alpha of ATHCTS overall scales (0.719), Quality of care delivery subscales (0.683), Patient-centered care subscales (0.801) and Team efficiency subscales (0.724) were acceptable.

Nurses and pharmacists had greater improvement of IEPS and ATHCTS scores than physicians

The baseline IPC attitude, pre-course (T_1) IEPS scores and pre-course (T_1) ATHCTS scores were also similar across the physicians, nurses and pharmacists (Table 2). Compared to nurses, there were lower scores for the "competency and autonomy" and "understanding others values" basal IEPS subscales (T_1) among the physicians. Similarly, also compared to nurses, there were lower scores for the "competency and autonomy" and "perception of actual cooperation" basal IEPS subscales (T_1) among the pharmacists. Notably, the "competency and autonomy" subscale of IEPS score and the "team efficiency" subscale of the ATHCTS score (T_2-T_1) were increased by the 7-hour stepwise simulation-enhanced IPE course across three professions. In particular, the magnitude of increase in IEPS and ATHCTS scores were significantly greater among the nurses and pharmacist than among the physicians (Table 2). Clearly, pharmacists had greater increase in percent change of post-courses (T_2) ATHCTS score from pre-courses (T_1) score than nurses or physicians (Table 2).

Table 2 Comparison between pre-courses and post-courses self-reported IPC attitude (IEPS and ATHCTS) among three professions

	Physicians (n=34)		Nurses (n=30)		Pharmacists (n=24)	
	pre-course (T_1)	post-course (T_2)	pre-course (T_1)	post-course (T_2)	pre-course(T_1)	post-course (T_2)
Total IEPS-18 scores [6-point scale]	56±1.8#	76±9.8*,#	65±1.6	91±1.2	64±8	91±4.7*
percent change of total IEPS post-course (T_2) score from pre-course (T_1) score		18%		40%†		42%†
IEPS subscales scores						
Competency and autonomy (8 items)	24±3.5#	28±4.1*,#	30±4.5	39±7.2*	22±5.4	40±6.1*
Perceived need for cooperation (2 items)	7±2.2	9±1.6	8±2.9	10±1.8	9±3	11±1.8
Perception of actual cooperation (5 items)	17±2.7	24±3.7*,#	15±1.2	26±4.3*	20±4.8	23±2.5
Understanding others values (3 items)	8±2.4#	15±2.9*	12±3.8	16±1.4	13±2.1	17±5.1*
Total ATHCTS-14 [5-point scale]	39±2.3	48±5.4*	38±2.6	51±4.6	32±3.7	54±7.5
Percent change of total ATHCTS post-course (T_2) score from pre-course (T_1) score		23%		34%†		69%†
ATHCTS subscales scores						
Quality of care delivery (5 items)	14±2.2	15±1.8#	13±1.6	18±4.1*	12±4.2	20±2.0*
Patient-centered care (4 items)	13±1.7	18±2.1*	15±7.4	19±3.3	11±2.8	18±3.5*
Team efficiency (5 items)	12±1.1	15±3.7*	10±1.9	14±2.7*	9±2.6	16±4.1*

Data were expressed as mean±SD; *p<0.01 *vs.* pre-course scores; #p<0.01 *vs.* corresponding nurse's/pharmacists score's; †p<0.01 *vs.* physicians scores

Participants appropriately transfer and sustainable practice of the learnt IPC skills in the workplace after training

Based on the real examples in IPC benchmarking presentations of Group 1 participants, the facilitators found that physicians were more appropriately able to transfer and sustainably practice of the learnt IPC "coordination and leadership" skills in the workspace than pharmacists and nurses (Table 3).

Table 3 Comparison of facilitators' agreement to group 1 participant's degree of appropriate transfer and sustainable practice of the learnt IPC skills in workplaces according to four success examples in their benchmarking sharing

		Physicians (n=17)	Nurses (n=15)	Pharmacists (n=12)
Example 1	[1-1].Presenter transfers the "coordination" skills appropriately in workplaces	4.3±0.64	3.6±0.7#	3.9±0.8#
	[1-2].Presenter practices the "coordination" skills sustainably in workplaces	4.6±0.54	3.3±0.21#	4.1±0.7#
Example 2	[2-1].Presenter transfers the "communication" skills appropriately in workplaces	3.9±0.52*	4.1±0.94	4.4±0.7
	[2-2].Presenter practices the "communication" skills sustainably in workplaces	3.3±0.71*	4.01±0.76	4.8±0.1
Example 3	[3-1].Presenter transfers the "teamwork" skills appropriately in workplaces	3.4±0.502*	4.5±0.46	4.1±0.9
	[3-2].Presenter practices the "teamwork" skills sustainably in workplaces	3.8±0.2*	4.7±0.1	4.5±0.6
Example 4	[4-1].Presenter transfers the "leadership" skills appropriately in workplaces	4.4±0.803	3.4±0.61#	4.0±0.5#
	[4-2].Presenter practices the "leadership" skills sustainably in workplaces	4.7±0.4	3.0±0.3#	3.8±0.4#

Data were expressed as mean±SD; The IPC skills include coordination, communication, teamwork and leadership. Presenters were asked to present their four examples according to the sequences of items listed above. Sequentially, benchmarking' Example 1 for Item 1-1&1-2, example 2 for item 2-1&2-2, Example 3 for Item 3-1&3-2, Example 4 for Item 4-1&4-2 were presented. Facilitator's degree of agreement to presenters' performance were rated by 5-point Likerts scale-based (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree); By consensus meeting, facilitators rate their agreement to the items 1-1 and 1-2 according to the Example 1 of presenter, Items 2-2 and 2-2 from Example 2, Item 3-1 and 3-2 from Example 3, Items 4-1 and 4-2 from Example 4 in separate rooms. The results are averaged data of ratings completed by two facilitators for the presenter's performance of each item in above checklist; #p<0.05 *vs.* physician's group; *p<0.05 vs. nurse's/pharmacist's group.

In benchmarking sharing, the inter-rater reliability (Kappa statistics) of facilitators for the items used to assess whether participants were able to transfer and sustainably practice the learnt IPC skills was good (Table 4).

Table 4 Inter-rater reliability of facilitators' ratings in benchmarking sharing of Group 1 participants

	Physicians	Nurses	Pharmacists
	Kappa	Kappa	Kappa
[1-1].Presenter transfers the "coordination" skills appropriately in workplaces	0.73	0.71	0.85
[1-2].Presenter practices the "coordination" skills sustainably in workplaces	0.67	0.843	0.76
[2-1].Presenter transfers the "communication" skills appropriately in workplaces	0.69	0.82	0.89
[2-2].Presenter practices the "communication" skills sustainably in workplaces	0.71	0.79	0.77
[3-1].Presenter transfers the "teamwork" skills appropriately in workplaces	0.683	0.679	0.711
[3-2].Presenter practices the "teamwork" skills sustainably in workplaces	0.78	0.812	0.79
[4-1].Presenter transfers the "leadership" skills appropriately in workplaces	0.72	0.77	0.849
[4-2].Presenter practices the "leadership" skills sustainably in workplaces	0.83	0.74	0.816

Two facilitators for each small-group [n=11, either with 4:4:3, 4:4:3, 4:4:3, 5:3:3 ratio of physician: nurse: pharmacists] benchmarking sharing held in four rooms over two consecutive days.

Participants gave positive descriptive feedbacks to the trainings

In open-ended questions at the end of our study, most participants reported that watching the IPE-specific video and discussing it, as well as viewing the uploaded videos on the e-learning platform, markedly encourage their motivation to improve their IPC attitude. Specifically, the participant's reported that the availability of an IPE/IPC-specific e-learning platform was able to improve the users' IPC attitude continuously by providing useful resources and instruction.

Selected completed feedback responses by the participants to the open-ended items of post-course self-assessment (T3) are listed below.

1. Benefits of our new benchmarking-enhanced debrief diamond-based IPE simulation courses.
   "*This IPE course improves inter-professional relationships, communication skills, efficiency in holistic patient care and service delivery, team work, respect for one another and builds confidence in my profession*."
2. Identified IPE/IPC elements in collaborative training.
   "*We are all geared to patient-centered care, all professions need to use their best assessment and judgment to evaluate patients in order to provide the best patient care that we can.*"
   "*We understand that there is a lot of team work going on our institution*."
   "*We understand that all professions should be encouraged within their training program to become independent in order to make IPC work better*."
3. Improved skills of quality of clinical care.

"*There are situations that are different, but we do have to rely on the expertise of other professionals' in order to obtain the best outcome for the patient*."

"*We were able to collaborate very well with other professional health care members, especially with the nurses in their second simulation; they sort of referred to us regarding our drug management skills and sort of learned how important pharmacists can actually be in a hospital setting*."

4. Skills learnt from their skillful facilitators.

"Sometimes, staying in your own profession is great and everything, but you really sort of need to reach outwards and see what other professions have to offer, because only if you do that can you truly use the entire knowledge base of other professions and provide the best patient care."

Addition of benchmarking sharing to enhance the continuous beneficial effects of training

Compared to pre-courses (T_1) scores, the degree of increase in total IEPS and ATHCTS scores at post-courses (T_2) self-assessments were not different between Group 1 and 2 participants (data not shown). Among the Group 1 and 2 participants, similar or higher end-of-study (T_3) IEPS and ATHCTS scores than post-courses (T_2) scores indicated the sustained effects of 7-hour simulation-based debrief diamond-enhanced IPE courses (Figure 3). From the post-course (T_2) to end-of-study (T_3) period, a significantly greater increase in the total IEPS and ATHCTS scores of the group 1 (benchmarking) participants than for the Group 2 (regular) participants can be seen (Figure 3). This indicates the additional benefits of IPC benchmarking on the Group 1 participants' IPC attitude. Among the benchmarking-group' participants, the most improved items were the "competency and autonomy" and "perception of actual cooperation" subscales of the IEPS and the "quality of care delivery" and "team efficiency" subscales of the ATHCTS, when the T_2 and T_3 self-assessments were compared.

Improvement of IPC attitudes among team members of three professions by the promotion of new intervention-trained seed instructors

Among the randomly sampled team members, the pre-intervention survey (T_{pre}) revealed that IPC attitudes across physicians, nurses and pharmacists must be improved in the aspects of IPC' familiarity, understanding of other professions' roles and benefits of IPC on quality of patient-centered care (Figure 3C). Across the three professions, after seed instructors began promoting IPC in the workplace, post-intervention (T_{post}, 6^{th} month) randomly sampled team member's reported that they were familiar with IPC skills, agreed that IPC helps one to understand the role of other team members, agreed that IPC improved patient care quality and agreed that IPC improved team efficiency (Figure 3C). Interestingly, the agreements of randomly sampled team members across three professions to the statement of "IPC helps provide patient-centered care" are excellent both in the pre-intervention (Tpre) and post-intervention (Tpost) surveys (Figure 3C).

DISCUSSION

Debriefing can help a learner clarify and integrate the simulation experience with their previous knowledge.[8,10,11,22-24] The debrief diamond encourages a standardized approach to high-quality debriefing across courses, which benefits both the participants and the involved faculty members.[13,14] The DAA debrief diamond is related to various aspects of the advocacy-inquiry approach and of debriefing with good judgment. The diamond provides an easy but pedagogically sound structure for facilitators to follow for specific post-simulation feedback and discussion. Nevertheless, the long-term effects of structured debriefing have not been through evaluated in previous simulated-enhanced IPE studies.[8-15]

In addition to serial subjective and objective assessments, our IPE model is characterized by a debrief diamond strategy (Figure 2). When trying to improve each medical professional's IPC attitude with limited resources, including the time needed to carry out the training, the number of faculty members needed to run the training and the facilities needed for the training, each newly-trained participant should act as a seed instructor within their team. In other words, successful training of seed instructors can result in profession-wide IPC promotion and attitude remodeling. In our study, this well-organized design allows each participant from three professions to have equal IPE exposure, which helps their development as seed instructors in their healthcare team.

By training volunteers from physicians, nurses and pharmacists, our interventional training program aims to change participants' behaviors and to act as seed instructors for promoting IPC in team member. In our study, the post-intervention survey, performed after the sequential simulation-based IPE courses, revealed that there was significant improvement in randomly sampled team members' IPC attitude across physicians, nurses and pharmacists.

The strengths of our pilot study are the extension of IPE via e-learning platform, benchmarking sharing and continuous self-evaluations. Previous studies have suggested that training videos consistently enhance the observational powers of trainees, as well as improving their ability to integrate different information and increasing their motivation to learn.[25,26] In our study, most participants reported that the availability of an e-learning platform that has sufficient IPE resources helps to continue their self-directed learning. Meanwhile, the benchmarking provides the enrolled participants with the opportunity for IPC self-reflection, as well as enhancing their motivation as seed instructors in their teams.

Primarily, this new simulation-based IPE program was intended to solve challenges, which are lack of continuous training and follow-up, of previous studies[8-13,15] and of our institution. Nevertheless, there were some limitations in our study that need to be improved in future study before concluding the effectiveness of this pilot benchmarking-enhanced debrief diamond-based IPE program on medical professionals' IPC practices and outcomes.

For a training program, Kirkpatrick level 1 and 2 were the evaluation of “participants satisfaction” and “participants increase confidence, knowledge and performance”. Using IEPS and ATHCTS, our study revealed significant improvements in participants' motivation and IPC attitudes across the three professions after receiving training with our new IPE program. The participant's satisfaction with the new program and the degree of improvement in participant's competency, however, was not evaluated in our study. Kirkpatrick levels 3 and 4 in our study were the "multiplication" of knowledge by "seeding" and influence on the health care system. According to the real presented example in benchmarking sharing of our study, facilitators' gave high ratings for their agreement to participants' degree of appropriate transfer and sustainable practice of the learnt IPC skills to clinical works. The sequential improvements in participants' self-assessed IPC attitude scores also was noted in our study. Moreover, the comparison of pre-intervention and post-intervention randomly sampled team members, who were non-participants, revealed the general improvement in their IPC attitudes

and motivation. Nevertheless, for this part, the use of newly acquired knowledge or skills by medical professionals of our institution was not evaluated in our study. Taken together, our pilot study only achieved some of the goals of a training program, according to the Kirkpatrick 1-4 levels.[27]

Our IPE approach targets IPC attitude specifically using a number of defined types of patient scenario that are suitable for all three of the enrolled professions. Nevertheless, the specific IPC skills required for holistic care of COPD cases clearly are different from those needed to care for acute renal failure cases. Undoubtedly, IPC skills are learned more readily when the simulation-enhanced IPE used is more relevant to the type of clinical situation. In our study, this limitation was alleviated by the multi-professional post-simulation debrief diamond-based debriefing during a 3.5-hour simulation workshop and the fact that the enrolled participants continued to carry out their regular clinical routines during the 3-month intervention period. In other words, our enrolled participants were likely interacting with other professions in their clinical routine after the first and second stimuli presented during the preparation and simulation workshops. In fact, it has been suggested that learning together with a variety of high-fidelity simulation modules in multi-professional groups would foster shared inter-professional collaborative (IPC) across many clinical situations.[28-31]

As participation in this course was voluntary, participants were likely to be more highly motivated than non-participants, which may limit the generalizability of our results. Actually, the positive effects of the debrief diamond and preparation workshop had been reported in previous simulated-based IPE studies.[13-15] In our study, the lack of control groups without the debrief diamond method and preparation workshop, to exclude more effects of them on inter-professional skills, may still limit us to conclude the definite effectiveness of benchmarking-enhanced IPE on training. Both IEPS and ATHCTS have been suggested as reliable tools to assess the effectiveness of practice-based IPE interventions.[19-21] It has been validated that each subscale of IEPS and ATHCTS is a strong measurement for underlying IPC concepts that are crucial to medical professions.[19-21]

Notably, the core elements in the constructive assessment tools, IEPS and ATHCTS, used in our studies were more focused on “communication and teamwork” than “coordination and leadership” skills.” Therefore, from Table 2, it seems that pharmacists and nurses perform better than physicians. Nonetheless, the facilitators' agreement for the degree of participant's appropriate transfer and sustainable practice of learnt “coordination and leadership” skills in the workplace were significantly higher among physicians than pharmacists and nurses in benchmarking sharing (Table 3). This might be caused by the culture where physicians take over the role of leadership in the healthcare system. These results remind educators to rethink strategies to balance inter-professional training.

CONCLUSIONS

Our benchmarking-enhanced debrief diamond-based IPE simulation program was able to cultivated participants as seed instructors to modify the IPC attitude of their team members. The results of this plot study are promising and suggest that a future large-scale study with extension to professions other than the three professions enrolled here should be considered. As enhancement of inter-professional skills can ensure high-quality patient care, seed instructor training can be suggested as a personal development plan for every health professional.

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Contributors All authors have read and approved the final manuscript. Y-YY conceived and designed the study, analysis and interpretation of data, wrote the draft, recruited the study subjects, planned and performed the statistical analysis. H-MC made critical revision of manuscript. L-YY conceived and designed the study. C-CH recruited the study subjects, analysis and interpretation of data. J-FL acquisition, analysis and interpretation of data. F-YL study supervision, critical revision of manuscript. S-YK study supervision. C-CH acquisition of data. RK critical revision of manuscript.

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Competing interests None.

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FIGURES AND LEGENDS

Figure 1 The flow chart of this diamond-based inter-professional education (IPE) simulation study. Detailed time points for trainings and assessment of this prospective pre-post comparative cross-sectional study.

Figure 2 Protocols for small group preparation and simulation workshops. The flow charts and detailed activities of first (preparation) and second (simulation) month' workshops, which were run in separate rooms over two consecutive days.

Figure 3 Benchmarking-enhanced IPE pilot program improved participants and their team members' IPC attitudes. The comparison of sequential changes of post-course ($\mathbf{T_2}$) and end-of-study ($\mathbf{T_3}$) subscales and scales of IEPS (**A**) and ATHCTS (**B**) between Group 1 (benchmarking) and Group 2 (regular) participants. **(C).** Comparison of responses from 132 randomly sampled members from the three professions (51 physicians, 45 nurses. 36 pharmacists twice) about IPC's attitudes in pre-intervention (T_{pre}) and post-intervention (T_{post}) survey. IPC attitude was assessed by five Likert scale responses ranging from 1: strongly disagree to 5: strongly agree. $^{*}p<0.01$ *vs*. post-course (T_2) or pre-intervention (T_{pre}) scores; $^{\#}p<0.01$ *vs.* Group 2 participants' scores.

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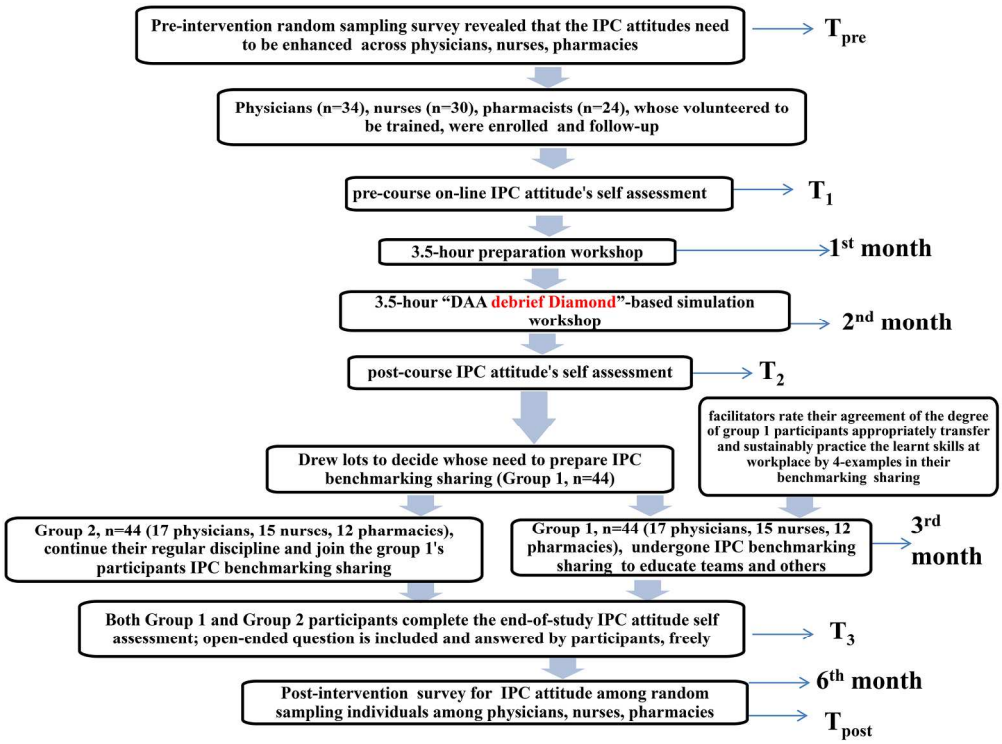

Fig. 1

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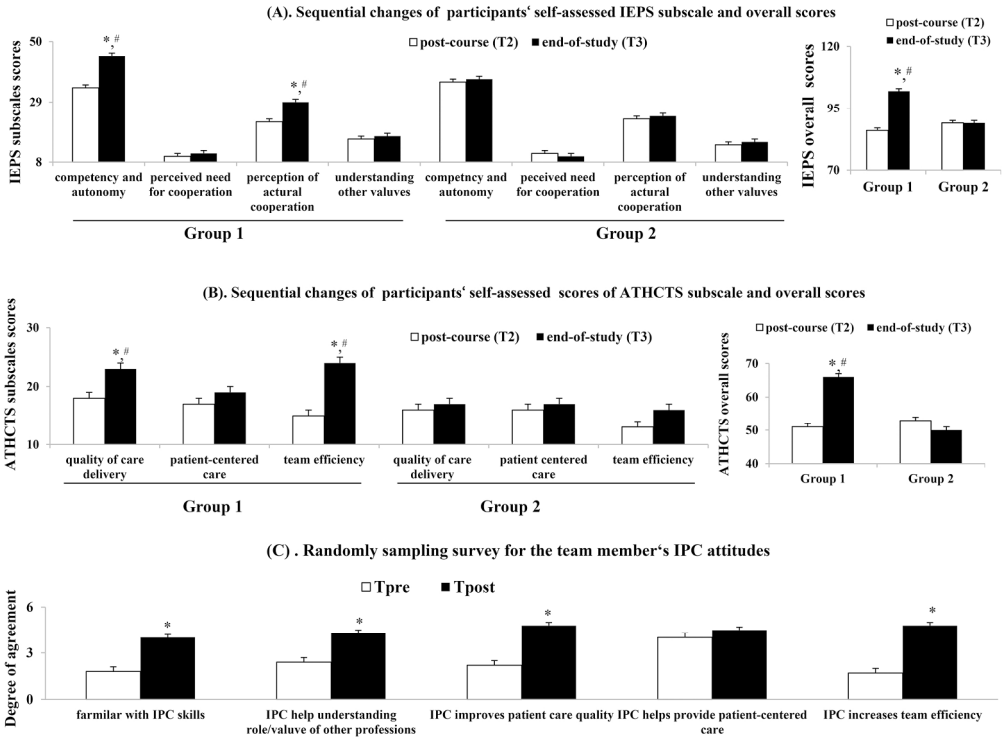

Fig. 2

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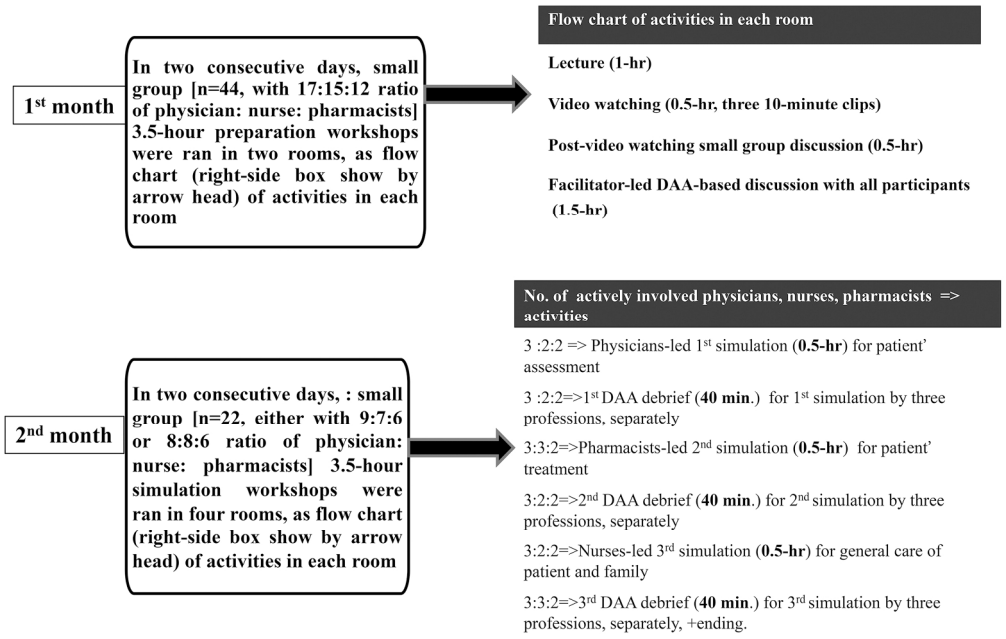

Fig. 3

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Supplement table 1 Interdisciplinary education perception scale (IEPS)	
subsclases	statement
competency and autonomy (8 items)	1. Individuals in my profession are well-trained. 2. Individuals in my profession demonstrate a great deal of autonomy. 3. Individuals in my profession are very positive about their goals and objectives. 4. Individuals in my profession are very positive about their contributions and accomplishments. 5. Individuals in my profession trust each other's professional judgment. 6. Individuals in my profession are extremely competent. 7. Individuals in other professions respect the work done by my profession. 8. Individuals in other professions think highly of my profession.
perceived need for cooperation (2 items)	9. Individuals in my profession need to cooperate with other professions. 10. Individuals in my profession must depend upon the work of people in other professions.
perception of actual cooperation (5 items)	11. Individuals in my profession are able to work closely with individuals in other professions. 12. Individuals in my profession are willing to share information and resources with other professionals. 13. Individuals in my profession have good relations with people in other professions. 14. Individuals in my profession think highly of other related professions. 15. Individuals in my profession work well with each other.
understanding others value (3 items)	16. Individuals in my profession have a higher status than individuals in other professions. 17. Individuals in my profession make every effort to understand the capabilities and contributions of other professions. 18. Individuals in other professions often seek the advice of people in my profession.
Likert's Scale with 6 possible responses (1=Strongly Disagree, 2=Moderately Disagree, 3=Somewhat Disagree, 4=Somewhat Agree, 5=Moderately Agree, 6=Strongly Agree); ** Higher scores represent more positive attitudes toward teamwork. "Competency and Autonomy" subscale measures how highly students respect their profession, in the sense that it is well taught and contributes significantly to improving the healthcare field, as well as to what extent they believe that other professions are respected in a similar fashion. "Perceived Need for Cooperation" reflects the responders' perceptions of the need for teamwork, which typically includes respecting and working well with other professions. "Perception of Actual Cooperation", aims to reveal the responders' perception of how their profession typically respects and works well with other professions. "Understanding Others' Values" aims to reflect the degree of respect the responder has for contributions from all healthcare professions.	

Supplement table 2 Attitudes Toward Interprofessional Health Care Teams Scale (ATIHCTS)	
Subscales	STATEMENT
quality of care delivery (5 items)	1. Developing an inter-professional patient care plan is excessively time consuming. 2. The give and take among team members helps them make better patient care decisions. 3. The inter-professional approach makes the delivery of care more efficient. 4. Developing a patient care plan with other team members avoids errors in delivering care. 5. The inter-professional approach improves the quality of care to patients
patient-centered care (4 items)	6. Patients receiving inter-professional care are more likely than others to be treated as whole persons. 7. Health professionals working as teams are more responsive than others to the emotional and financial needs of patients 8. The inter-professional approach permits health professionals to meet the needs of family caregivers as well as patients. 9. Hospital patients who receive inter-professional team care are better prepared for discharge than other patients.
team efficiency (5 items)	10. Working in an inter-professional manner unnecessarily complicates things most of the time. 11. Working in an inter-professional environment keeps most health professionals enthusiastic and interested in their jobs. 12. In most instances, the time required for inter-professional consultations could be better spent in other ways 13. Having to report observations to a team helps team members better understand the work of other health professionals. 14. Team meetings foster communication among team members from different professions or disciplines.
* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);*Higher scores represent more positive attitudes toward teamwork.	

Supplement table 3 Items of questionnaires used for pre-intervention and post-intervention random sampling survey of IPC attitudes
1. Are you familiar with IPC skills?
2. Do you agree that IPC helps understanding the role of other healthcare team members?
3. Do you agree that IPC improves quality of patient care?
4. Do you agree that IPC improves patient-centered care?
5. Do you agree that IPC improves team efficiency?
* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);* Higher scores represent better IPC attitudes

Research check list

Our article title had included the following point.

1. A structured abstract (max. 300 words) of: objectives, design, results and conclusion, or that meets the standards of the relevant reporting guideline (see below).
2. An 'Article summary' section consisting of three headings: 'Article focus' (up to three bullet points on the research questions or hypotheses addressed); 'Key messages' (up to three bullet points showing the key messages or significance of the study); and a 'Strengths and limitations of this study' section. This should be placed after the abstract.
3. The original protocol for the study, where one exists.
4. A funding statement, preferably worded as follows. Either: 'This work was supported by [name of funder] grant number [xxx]' or 'This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors'.
5. A competing interests statement.
6. Articles should list each author's contribution individually at the end; this section may also include contributors who do not qualify as authors.
7. Any checklist and flow diagram for the appropriate reporting sttement, e.g. STROBE (see below).
8. Any article that contains personal medical information about an identifiable living individual requires the patient's explicit consent before we can publish it. We will need the patient to sign our consent form, which requires the patient to have read the article. This form is available in multiple languages.

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Simulation based inter-professional education to improve attitudes towards collaborative practice: a prospective comparative pilot study in a Chinese medical center

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Simulation based inter-professional education to improve attitudes towards collaborative practice: a prospective comparative pilot study in a Chinese medical center

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ABSTRACT

Objectives: Inter-professional education (IPE) builds inter-professional collaboration (IPC) attitude/skills of health professionals. This interventional IPE program evaluates whether benchmarking sharing can successfully cultivate seed instructors responsible for improving their team members' IPC attitudes.

Design: Prospective, pre-post comparative cross-sectional pilot study.

Setting/participants: 34 physicians, 30 nurses and 24 pharmacists, who volunteered to be trained as seed instructors participated in 3.5-hr preparation and 3.5-hr simulation workshops. Then, participants (n=88) drew lots to decide 44 presenters, half of each profession, who needed to prepare IPC benchmarking and formed Group 1. The remaining participants formed Group 2 (regular). Facilitators rated the Group 1 participants' degree of appropriate transfer and sustainable practice of the learnt IPC skills in the workplace according to successful IPC examples in their benchmarking sharing.

Results: For the three professions, improvement in IPC attitude was identified by sequential increase in the post-course (2^{nd} month, T_2) and end-of-study (3^{rd} month, T_3) Interdisciplinary Education Perception Scale (IEPS) and Attitudes Towards Health Care Teams Scale (ATHCTS) scores, compared to pre-course (1^{st} month, T_1) scores. By IEPS and ATHCTS-based assessment, the degree of sequential improvements in IPC attitude was found to be higher among nurses and pharmacists than in physicians. In benchmarking sharing, the facilitators' agreement about the degree of participant's appropriate transfer and sustainable practice learnt “communication and teamwork” skills in the workplace were significantly higher among pharmacists and nurses than among physicians. The post-intervention random sampling survey (6^{th} month, T_{post}) found that the IPC attitude of three professions improved after on-site IPC skill promotion by new program-trained seed instructors within teams.

Conclusions: Addition of benchmark sharing to a diamond-based IPE simulation program enhances participants' IPC attitudes, self-reflection, workplace transfer and practice of the learnt skills. Furthermore, IPC promotion within teams by newly trained seed instructors improved the IPC attitudes across all three professions.

Keywords: nurses, pharmacists, inter-professional collaboration, interdisciplinary education perception, attitudes towards health care teams

Strengths and limitations of this study

- This pilot study describes the experiences of a prospective cross-sectional cohort of physicians, nurses and pharmacists who volunteered to receive serial benchmarking-enhanced diamond-based IPE simulation program for cultivating them as seed instructors to improve team members' IPC attitude.
- In our IPE program, IPC benchmarking sharing was implemented to enhance participants' continual motivation to self-reflect and to promote IPC among team members.
- Using IEPS and ATHCTS, our study reveals the significant improvements in participant's motivation and IPC attitude across three professions after receiving training with our new IPE program.
- Through IPC benchmarking presentation, participants' appropriate transfer and sustainable practice of the learnt IPC skills in the workplace was evaluated.
- Although participant's satisfaction with the new program and the degree of improvement in participant's competencies were not evaluated in our study.
- At this stage, the use of newly acquired knowledge or skills by medical professionals of our institution was not evaluated in our study.
- These results were limited to experience in one institution; the degree to which this can be extrapolated to IPE training in other institutions is not known.

INTRODUCTION

Inter-professional education (IPE) aims to improve the coordination, communication, teamwork and leadership skills of health professionals by learning with, from and about each other.[1] Two key families of learning theory behaviorism and constructivism were applied to the curriculum design of IPE.[2,3] It has been reported that learning theories for IPE are not mutually exclusive. In fact, theorists agree that inter-professional learning "by doing" combined with learner centeredness is the key.[2,3] Health care simulations are recognized as an ideal vehicle for IPE.[4] Today's patients have complex chronic health issues that need inter-professional collaboration (IPC) in order to delivery well-coordinated, high-quality and patient-centered care.[5,6] Simulation-enhanced IPE helps the development of a health professional's IPC skills and these are very important when managing critical clinical situations.[7]

Baker, *et al*. reported that 2-hour cardiac resuscitation/intravenous access simulation-based IPE prepared medical students, nursing students and junior medical residents for their future as practitioners.[8] In their study, immediate attitudinal scores and responses by Interdisciplinary Education Perception Scale (IEPS) survey were consistently positive among both medical and nursing students.[8] Undre *et. al.* reported that, using technical and human factors rating scales, trainers and multidisciplinary trainees assessed the crisis scenarios-based simulation training favorably, especially in technical skills.[9] Paige *et al*. revealed that 3-hour simulation-based interdisciplinary operating room IPE significantly improve the trainees' self-efficacy teamwork performance in role clarity, anticipatory response, cross monitoring, team cohesion and interaction.[10] In Vyas *et al.* study, using the team building and inter-professional communications survey, pharmacy student's reported that semi-urgent situations simulation-based IPE increased their understanding of professional roles and the importance of inter-professional communication.[11]

In Estis *et al.* study, using an attitudinal survey, speech language pathology, cardio-respiratory care and nursing students reported that simulation-based IPE enhanced their knowledge of medical professional roles/responsibilities and teamwork skills of caring for tracheostomy patients with speaking valves.[12] Nevertheless, participants in the Estis *et al.* study suggested that pre-simulation training and more structural interaction during the debriefing phase were likely to enhance effective of the IPE.[12] Specifically, Watters *et al*. implemented a debrief diamond, following description-analysis-application steps, during a 1-day simulation IPE course.[13] The standardized debrief diamond was designed to allow high-quality exploration of the non-technical aspects of a simulated scenario. The diamond is a two-sided prompt sheet: the first contains the scaffolding, with a series of constructed questions for each phase of the debriefing; while the second lays out the theory behind the questions and the process.[13,14] In Watters *et al.* study, using self-efficacy questionnaires, doctors and nurses reported that diamond-based simulation increased their confidence in "communication and teamwork" skills.[13] Darlow *et al*. reported that addition of a preparation workshop to their 11-hour IPE program resulted in improved attitudes towards inter-professional teams and inter-professional learning, as well as self-reported ability to function within an inter-professional team.[15]

Taken together, previous simulation-based IPE studies[8-15] were lacked post-course continuous training. In addition, there is an absence of long-term follow-up that allows the transference and sustainability of IPC practice to be assessed. Furthermore, there is an absence in these studies of opportunities for the participants

to reflect on their training after a period of IPC practice. In 2014, a random sampling survey of three professions at our institution revealed that IPC attitudes of physician, nurses and pharmacists need to be improved (Figure 1).

It is important to develop feasible continuous IPE/IPC strategies to solve the problems of previous studies[8-15] and of our survey. Therefore, our education committee targeted these three professions and organized a new IPE program characterized by pre-simulation training, post-course continuous training, and immediate plus delayed IPC attitude assessments. Additionally, post-training e-learning platform and IPC benchmarking sharing provide an opportunity for additional/deepening learning of inter-professional problem solving skills. Benchmarking sharing, a good indicator of organizational seriousness about quality, is a continuous quality improvement approach. Healthcare benchmarking sharing provides opportunities for inter-professional participants to learn from others and develop innovative collaborative clinical care.[16,17] This pilot intervention intentionally evaluates its impact on cultivating new health professionals as seed instructors to promote IPC within their teams.

METHODS

Participants and setting

Between January 2015 and May 2016, we conducted a prospective cross-sectional comparative study at the high-fidelity clinical simulation and interactive learning center of TVGH; this center trains around 2500 staff each year. Taipei Veterans General Hospital (TVGH) is a 3000-bed medical center providing primary and tertiary care to active-duty and retired military personnel and their dependents, and the general public. Meanwhile, TVGH is the teaching hospital for several medical universities in Northern Taiwan.

Health professionals having more than 1 year but less than 4 years of clinical work experience were invited to participate in this study. The participants volunteering to be trained (n=94) were invited to join the 2015 pilot benchmarking-enhanced diamond-based IPE simulation courses to improve their IPC attitudes. After excluding six participants due to incomplete questionnaires, a total of n=88 individuals were included in this study. They consisted of physicians (n=34), nurses (n=30) and pharmacists (n=24).

Ethical approval (2015-06-017CC) was obtained from the Ethics committee of our institution and care was taken to apply the World Medical Association Declaration of Helsinki principles to the research.

Time points of serial assessments

After a brief introduction, the participants were asked to complete the pre-course (T_1) on-line IPC attitude's self-assessment. Each on-line self-assessment was numbered so that participants remained anonymous but their numbers could be used to match their pre-course (T_1) self-assessment with post-course (T_2) and end-of-study (T_3) self-assessment (Figure 1). All participants continued with their usual professional clinical routine throughout the 3-month interventional study.

IPC attitude's self-assessments

In our study, we measured participants' IPC attitudes with Interdisciplinary education perception scale[18-20] (IEPS, supplemental Table 1), Attitudes Toward Health Care Teams Scale[21] (ATHCTS, supplemental Table 2).

Additionally, participants were asked to provide qualitative feedback freely by answering the single-open-ended question, "*what is the one thing you are going to take away with you at the end of this course?*" in the online post-courses self-assessment (T_3). This question was designed to prompt a participant to reflect on their own learning during the course and allowed the program director to gather evidence on which elements within the courses seemed to be contributing the most to the learning experience.

Benchmarking-enhanced diamond-based IPE simulation courses

Each participant attended a 3.5-hour preparation workshop (T_1) in the first month of this study (Figure 1). Subsequently, a 3.5-hour simulation workshop was arranged for the participants during the second month (T_2). At the end of the simulation workshop, participants drew lots to decide who needed to prepare for post-course IPC benchmarking at the third month (T_3) of study (*i.e.*, who was in Group 1). In order to maintain a fixed ratio (34:30:24) among the three professions (Figure 1), half (17:15:12) of the physicians, nurses and pharmacists were selected as Group 1 (benchmarking) and the others as Group 2 (regular).

(1).Facilitators training and DAA debrief diamond

All facilitators received serial sessions training in how to use the debrief diamond and to consent about how to rate their agreement about the degree of participants appropriate transfer and sustainable practice of the trained "coordination, communication, teamwork, and leadership" skills regarding IPC in the workplace using real examples in their benchmarking sharing. In particular, the Description-Analysis-Application (DAA) debrief diamond was used to involve participants in preparation (T1) and simulation (T2) workshops. The "description" step involved 'description' of each profession's IPC performance in the simulation scenario, along with more challenging "analysis" and "application" steps involving 'how did participants feel about each profession's IPC performance in simulation scenario?' and "how participants may apply the learnt knowledge from IPC simulation scenarios in their own clinical practice".[13,14]

(2).7-hour preparation and simulation workshop

-Preparation workshop (T_1). In accordance with previous study design,[15] two small-group preparation workshops were held on two consecutive days as shown in Figure 2. The simulated examples of IPC-based care from a previous study[11] were revised by educational committee and made into three video clips for IPE. They were, first, a simulation of a distracted wife and a 61-year-old dyspnea male who suffered from recurrent asthmatic attacks due to inappropriate home medication; second, a simulation of a 35-year-old anxious family, including a pregnant nausea/vomiting/abdominal pain female who needed the selection of suitable anti-emetics and a pediatrics/gynecology consultation in an ER setting and, finally, a simulation of a 57-year-old chest pain male with a distracted son and with the wrong allergy and ID labeling on his arm band, as well as unlocked bed in ICU setting. These 10-minutes clips provided a basis for post-video viewing discussion that were led by inter-professional facilitators following a Diamond DAA debriefing (1-hour); these target the role and value of the IPC healthcare team involved in the simulated clinical scenarios presented in the three videos.[13,14]

-Simulation workshop (T_2). In our simulation centers, four small-group workshops were held in four rooms within two consecutive days (Figure 2). Using the clinical scenario outlined below, workshops were led by well-trained IPE facilitators from dietetics, social workers and respiratory therapists. This scenario, which incorporates multi-disciplinary care, was modified by a previous study[12] and had a dry run before formally being used. A patient scenario involving Mr. Jason was developed collaboratively by the faculty members of the aforementioned professions. Participants were given the following information. Mr. Jason has a history of chronic obstructive pulmonary disease (COPD), smokes 60 packs per year of cigarettes and has hypertension, diabetes, coronary artery disease and atrial fibrillation. He has been admitted for acute exacerbation of his COPD five times in the past one year. Home medication includes aspirin, a calcium channel blocker, mycolytic agents, inhalation corticosteroid/bronchodilator and subcutaneous administrated insulin. Mr. Jason was admitted 3 weeks ago for emergency coronary artery bypass grafting surgery. Although there has been aggressive management with regular chest percussion, he has had difficulty being weaned from the ventilator due to poor sputum expectation and malnutrition. The primary care teams now are considering a tracheostomy and intensive chest/nutrition therapy. His family members are at the bedside. During the simulation, a pre-set intubated high-fidelity SimMan® 3G simulator acted as the patient and standardized patients (SPs) were used as his family. Then, the 3.5-hour workshops were ran (Figure 2).

Before the beginning of the simulation, the participants were presented with the case's name, age, gender, admission diagnosis and current medication/management. In the three simulation phases, the participants involved were expected to carry out assessment, treatments, and general care of the patients, collaboratively. Then, the participants began the post-simulation debriefing phase and reflected on the challenges, pitfalls, and successes that occurred within the simulation.

(3).The IPC benchmarking (T_3) of the Group 1 participants.

As mentioned above, 17 physicians, 15 nurses and 12 pharmacists formed Group 1 and these participants underwent IPC benchmarking sharing. Presenters were asked to give their four examples of appropriately transfer and sustainable practice learnt IPC skills in the workplace. Randomly, four small groups (n=11) with ratio (4:4:3, 4:4:3, 4:4:3 and 5:3:3) of physician to nurse to pharmacists were presented in four rooms over two consecutive days. During benchmarking sharing, two facilitators rated their 5-point Likert-scale-based agreement to the presenters' degree of appropriate transfer and sustainable practice of the learnt IPC skills in the workspace according to their four success examples. In each room, 4 hours (240 minutes) were needed for 11 presenters to complete their 20-minutes presentation (15-min.)/discussion (5-min.). Each presentation was video recorded by teaching assistants (TAs) to help with continuous IPC promotion. With the agreement of the presenters, the TAs uploaded edited versions of the video to the e-learning platform. The Group 2 participants were asked to join this end-of-study (T_3) IPC benchmarking sharing.

e-learning platform

Both the Group 1 and Group 2 participants were invited to use a common IPE e-learning platform containing the aforementioned scenario, various Power-point presentations, the video used in the preparation/simulation workshop and the video from the IPC benchmarking to encourage self-directed learning.

Pre-intervention (T_{pre}) and Post-intervention (T_{post}, 6th month) random sampling survey of IPC attitudes (Figure 1)

Using IPC core elements-based questionnaires (supplement Table 3), across the three professions, the effectiveness of the well-trained seed instructors was evaluated by comparing the differences between T_{pre} and T_{post}' IPC attitude scores[22-24].

Analysis

Outcomes of our new training program were analyzed according to Kirkpatrick levels.[25] Since the IEPS and ATHCTS items are ordinal in nature, Wilcoxon's signed rank test was used to analyze each item. The means of the overall IEPS score and the four subscales were evaluated with the Student's two-tailed paired *t*-test for continuous measures, with the aim of detecting any differences between T_1 and T_2 as well as T_2 and T_3 time-points. Data from the IEPS and ATHCTS were matched by profession for analysis with one-way ANOVA or Mann-Whitney U test to detect the significant difference between among groups.

RESULTS

The baseline characteristics of the participants, including mean age, gender and clinical experiences, were similar across the physicians, nurses and pharmacist as can be seen in Table 1. A higher percentage of pharmacists (45%/43%) and nurses (35%/36%) having experience receiving previous IPE training and higher frequency of exposure to IPC meeting during their previous year of clinical works than physicians (15%/14%) (Table 1). In other words, in comparison with nurses and pharmacists, a lower percentage of physicians belong to the high-exposure (>80% exposure to monthly IPC meeting/1-year) group, which indicates the physician's had less experience with IPC meeting participation during their last 1-year of clinical work

Table 1 Baseline characteristics of study population (n=88)

	Physicians (n=34)	Nurses (n=30)	Pharmacists (n=24)
Age (years)	31.3± 2.7	29.1 ±4.8	30.5 ±3.6
Female/male (No.)	30/4	27/3	10/14
Percentage of distribution of clinical-work-year of participants among groups			
1-2/2-3/ 3-4 years (%)	76/14/10%	84/10/6%	69/20/11%
Percentage of distribution of participants with and without experience of receiving previous IPE training	15/85%#	35/65%	45/55%
Percentage of distribution of participants with high/low frequency of exposure to IPC meeting during their last 1-yr of clinical work among groups			
Percentage of ‡high-exposure participants	14%#	36%	43%
Percentage of ‡ low-exposure participants	86%#	64%	57%

#p<0.01 *vs.* corresponding nurse′s/pharmacist's group**;** ‡high-exposure participants indicated individual that participating more than 80% of monthly IPC meeting; ‡low-exposure participants indicated individual that participating less than 20% of monthly IPC meeting.

Good internal consistency of the IEPS/ATHCTS and its subscales

In this study, the Cronbach's alpha coefficients of IEPS overall scales (0.721), competency and autonomy subscales (0.69), Perceived need for cooperation subscales (0.73), Perception of actual cooperation subscales (0.85) and Understanding others values subscales (0.662) were good. Meanwhile, Cronbach's alpha of ATHCTS overall scales (0.719), Quality of care delivery subscales (0.683), Patient-centered care subscales (0.801) and Team efficiency subscales (0.724) were acceptable.

Nurses and pharmacists had greater improvement of IEPS and ATHCTS scores than physicians

The baseline IPC attitude, pre-course (T_1) IEPS scores and pre-course (T_1) ATHCTS scores were also similar across the physicians, nurses and pharmacists (Table 2). Compared to nurses, there were lower scores for the “competency and autonomy” and “understanding others values” basal IEPS subscales (T_1) among the physicians. Similarly, also compared to nurses, there were lower scores for the “competency and autonomy” and “perception of actual cooperation” basal IEPS subscales (T_1) among the pharmacists. Notably, the “competency and autonomy” subscale of IEPS score and the “team efficiency” subscale of the ATHCTS score (T_2-T_1) were increased by the 7-hour stepwise simulation-enhanced IPE course across three professions. In particular, the magnitude of increase in IEPS and ATHCTS

scores were significantly greater among the nurses and pharmacist than among the physicians (Table 2). Clearly, pharmacists had greater increase in percent change of post-courses (T_2) ATHCTS score from pre-courses (T_1) score than nurses or physicians (Table 2).

Table 2 Comparison between pre-courses and post-courses self-reported IPC attitude (IEPS and ATHCTS) among three professions

	Physicians (n=34)		Nurses (n=30)		Pharmacists (n=24)	
	pre-course (T_1)	post-course (T_2)	pre-course (T_1)	post-course (T_2)	pre-course(T_1)	post-course (T_2)
Total IEPS-18 scores [6-point scale]	56±1.8$^{\#}$	76±9.8$^{*,\#}$	65±1.6	91±1.2	64±8	91±4.7*
percent change of total IEPS post-course (T_2) score from pre-course (T_1) score		18%		40%†		42%†
IEPS subscales scores						
Competency and autonomy (8 items)	24±3.5$^{\#}$	28±4.1$^{*,\#}$	30±4.5	39±7.2*	22±5.4	40±6.1*
Perceived need for cooperation (2 items)	7±2.2	9±1.6	8±2.9	10±1.8	9±3	11±1.8
Perception of actual cooperation (5 items)	17±2.7	24±3.7$^{*,\#}$	15±1.2	26±4.3*	20±4.8	23±2.5
Understanding others values (3 items)	8±2.4$^{\#}$	15±2.9*	12±3.8	16±1.4	13±2.1	17±5.1*
Total ATHCTS-14 [5-point scale]	39±2.3	48±5.4*	38±2.6	51±4.6	32±3.7	54±7.5
Percent change of total ATHCTS post-course (T_2) score from pre-course (T_1) score		23%		34%†		69%†
ATHCTS subscales scores						
Quality of care delivery (5 items)	14±2.2	15±1.8$^{\#}$	13±1.6	18±4.1*	12±4.2	20±2.0*
Patient-centered care (4 items)	13±1.7	18±2.1*	15±7.4	19±3.3	11±2.8	18±3.5*
Team efficiency (5 items)	12±1.1	15±3.7*	10±1.9	14±2.7*	9±2.6	16±4.1*

Data were expressed as mean±SD; *p<0.01 *vs.* pre-course scores; #p<0.01 *vs.* corresponding nurse's/pharmacists score's; †p<0.01 *vs.* physicians scores

Participants appropriately transfer and sustainable practice of the learnt IPC skills in the workplace after training

Based on the real examples in IPC benchmarking presentations of Group 1 participants, the facilitators found that physicians were more appropriately able to transfer and sustainably practice of the learnt IPC "coordination and leadership" skills in the workspace than pharmacists and nurses (Table 3).

Table 3 Comparison of facilitators' agreement to group 1 participant's degree of appropriate transfer and sustainable practice of the learnt IPC skills in workplaces according to four success examples in their benchmarking sharing

		Physicians (n=17)	Nurses (n=15)	Pharmacists (n=12)
Example 1	[1-1].Presenter transfers the "coordination" skills appropriately in workplaces	4.3±0.64	3.6±0.7#	3.9±0.8#
	[1-2].Presenter practices the "coordination" skills sustainably in workplaces	4.6±0.54	3.3±0.21#	4.1±0.7#
Example 2	[2-1].Presenter transfers the "communication" skills appropriately in workplaces	3.9±0.52*	4.1±0.94	4.4±0.7
	[2-2].Presenter practices the "communication" skills sustainably in workplaces	3.3±0.71*	4.01±0.76	4.8±0.1
Example 3	[3-1].Presenter transfers the "teamwork" skills appropriately in workplaces	3.4±0.502*	4.5±0.46	4.1±0.9
	[3-2].Presenter practices the "teamwork" skills sustainably in workplaces	3.8±0.2*	4.7±0.1	4.5±0.6
Example 4	[4-1].Presenter transfers the "leadership" skills appropriately in workplaces	4.4±0.803	3.4±0.61#	4.0±0.5#
	[4-2].Presenter practices the "leadership" skills sustainably in workplaces	4.7±0.4	3.0±0.3#	3.8±0.4#

Data were expressed as mean±SD; Presenters were asked to present their four examples according to the sequences of items listed above. Sequentially, benchmarking' Example 1 for Item 1-1&1-2, example 2 for item 2-1&2-2, Example 3 for Item 3-1&3-2, Example 4 for Item 4-1&4-2 were presented. By consensus meeting, facilitators rate their agreement to the items 1-1 and 1-2 according to the Example 1 of presenter, Items 2-2 and 2-2 from Example 2, Item 3-1 and 3-2 from Example 3, Items 4-1 and 4-2 from Example 4 in separate rooms. The results are averaged data of ratings completed by two facilitators for the presenter's performance of each item in above checklist; #p<0.05 *vs.* physician's group; *p<0.05 vs. nurse's/pharmacist's group.

In benchmarking sharing, the inter-rater reliability (Kappa statistics) of facilitators for the items used to assess whether participants were able to transfer and sustainably practice the learnt IPC skills was good (Table 4).

Table 4 Inter-rater reliability of facilitators' ratings in benchmarking sharing of Group 1 participants

	Physicians	Nurses	Pharmacists
	Kappa	Kappa	Kappa
[1-1].Presenter transfers the "coordination" skills appropriately in workplaces	0.73	0.71	0.85

[1-2].Presenter practices the "coordination" skills sustainably in workplaces	0.67	0.843	0.76
[2-1].Presenter transfers the "communication" skills appropriately in workplaces	0.69	0.82	0.89
[2-2].Presenter practices the "communication" skills sustainably in workplaces	0.71	0.79	0.77
[3-1].Presenter transfers the "teamwork" skills appropriately in workplaces	0.683	0.679	0.711
[3-2].Presenter practices the "teamwork" skills sustainably in workplaces	0.78	0.812	0.79
[4-1].Presenter transfers the "leadership" skills appropriately in workplaces	0.72	0.77	0.849
[4-2].Presenter practices the "leadership" skills sustainably in workplaces	0.83	0.74	0.816
Two facilitators for each small-group [n=11, either with 4:4:3, 4:4:3, 4:4:3, 5:3:3 ratio of physician: nurse: pharmacists] benchmarking sharing held in four rooms over two consecutive days.			

Participants gave positive descriptive feedbacks to the trainings

In open-ended questions at the end of our study, most participants reported that watching the IPE-specific video and discussing it, as well as viewing the uploaded videos on the e-learning platform, markedly encourage their motivation to improve their IPC attitude. Specifically, the participant's reported that the availability of an IPE/IPC-specific e-learning platform was able to improve the users' IPC attitude continuously by providing useful resources and instruction.

Selected completed feedback responses by the participants to the open-ended items of post-course self-assessment (T3) are listed below.

1. Benefits of our new benchmarking-enhanced debrief diamond-based IPE simulation courses.
   "*This IPE course improves inter-professional relationships, communication skills, efficiency in holistic patient care and service delivery, team work, respect for one another and builds confidence in my profession*."
2. Identified IPE/IPC elements in collaborative training.
   "*We are all geared to patient-centered care, all professions need to use their best assessment and judgment to evaluate patients in order to provide the best patient care that we can.*"
   "*We understand that there is a lot of team work going on our institution*."
   "*We understand that all professions should be encouraged within their training program to become independent in order to make IPC work better*."
3. Improved skills of quality of clinical care.
   "*There are situations that are different, but we do have to rely on the expertise of other professionals' in order to obtain the best outcome for the patient*."
   "*We were able to collaborate very well with other professional health care members, especially with the nurses in their second simulation; they sort of referred to us regarding our drug management skills and sort of learned how important pharmacists can actually be in a hospital setting*."
4. Skills learnt from their skillful facilitators.
   "Sometimes, staying in your own profession is great and everything, but you really sort of need to reach outwards and see what other professions have to offer, because only if you do that can you truly use the entire knowledge base of other professions and provide the

best patient care."

Addition of benchmarking sharing to enhance the continuous beneficial effects of training

Compared to pre-courses (T_1) scores, the degree of increase in total IEPS and ATHCTS scores at post-courses (T_2) self-assessments were not different between Group 1 and 2 participants (data not shown). Among the Group 1 and 2 participants, similar or higher end-of-study (T_3) IEPS and ATHCTS scores than post-courses (T_2) scores indicated the sustained effects of 7-hour simulation-based debrief diamond-enhanced IPE courses (Figure 3). From the post-course (T_2) to end-of-study (T_3) period, a significantly greater increase in the total IEPS and ATHCTS scores of the group 1 (benchmarking) participants than for the Group 2 (regular) participants can be seen (Figure 3). This indicates the additional benefits of IPC benchmarking on the Group 1 participants' IPC attitude. Among the benchmarking-group' participants, the most improved items were the "competency and autonomy" and "perception of actual cooperation" subscales of the IEPS and the "quality of care delivery" and "team efficiency" subscales of the ATHCTS, when the T_2 and T_3 self-assessments were compared.

Improvement of IPC attitudes among team members of three professions by the promotion of new intervention-trained seed instructors

In total, 132 valid T_{post} questionnaires were collected for comparison with another 132 valid T_{pre} questionnaires. These anonymous T_{pre} and T_{post} questionnaires were completed by random members sampled twice from the three professions, namely 51 physicians, 45 nurses and 36 pharmacists. In other words, the individuals who responded to the online IPC attitude survey might be but are not necessarily different between T_{pre} and T_{post} survey. Nonetheless, it is important to note that the enrolled participants in our interventional study were excluded from the sampling pool for T_{post} sampling survey.

Among the randomly sampled team members, the pre-intervention survey (T_{pre}) revealed that IPC attitudes across physicians, nurses and pharmacists must be improved in the aspects of IPC' familiarity, understanding of other professions' roles and benefits of IPC on quality of patient-centered care (Figure 3C). Across the three professions, after seed instructors began promoting IPC in the workplace, post-intervention (T_{post}, 6th month) randomly sampled team member's reported that they were familiar with IPC skills, agreed that IPC helps one to understand the role of other team members, agreed that IPC improved patient care quality and agreed that IPC improved team efficiency (Figure 3C). Interestingly, the agreements of randomly sampled team members across three professions to the statement of "IPC helps provide patient-centered care" are excellent both in the pre-intervention (Tpre) and post-intervention (Tpost) surveys (Figure 3C).

DISCUSSION

In addition to serial subjective and objective assessments, our IPE model is characterized by a debrief diamond strategy (Figure 2). Debriefing can help a learner clarify and integrate the simulation experience with their previous knowledge.[8,10,11,22-24] The debrief diamond encourages a standardized approach to high-quality debriefing across courses, which benefits both the participants and the involved faculty members.[13,14] The DAA debrief diamond is related to various aspects of the advocacy-inquiry approach and of debriefing with good judgment. The diamond provides an easy but pedagogically sound structure for facilitators to follow for specific post-simulation feedback and discussion. Nevertheless, the long-term effects of structured debriefing have not been through evaluated in previous simulated-enhanced IPE studies.[8-15]

When trying to improve each medical professional's IPC attitude with limited resources, including the time needed to carry out the training, the number of faculty members needed to run the training and the facilities needed for the training, each newly-trained participant should act as a seed instructor within their team. In other words, successful training of seed instructors can result in profession-wide IPC promotion and attitude remodeling. In our study, this well-organized design allows each participant from three professions to have equal IPE exposure, which helps their development as seed instructors in their healthcare team.

By training volunteers from physicians, nurses and pharmacists, our interventional training program aims to change participants' behaviors and to act as seed instructors for promoting IPC in team member. In our study, the post-intervention survey, performed after the sequential simulation-based IPE courses, revealed that there was significant improvement in randomly sampled team members' IPC attitude across physicians, nurses and pharmacists.

The strengths of our pilot study are the extension of IPE via e-learning platform, benchmarking sharing and continuous self-evaluations. Previous studies have suggested that training videos consistently enhance the observational powers of trainees, as well as improving their ability to integrate different information and increasing their motivation to learn.[25,26] In our study, most participants reported that the availability of an e-learning platform that has sufficient IPE resources helps to continue their self-directed learning. Meanwhile, the benchmarking provides the enrolled participants with the opportunity for IPC self-reflection, as well as enhancing their motivation as seed instructors in their teams.

Primarily, this new simulation-based IPE program was intended to solve challenges, which are lack of continuous training and follow-up, of previous studies[8-13,15] and of our institution. Nevertheless, there were some limitations in our study that need to be improved in future study before concluding the effectiveness of this pilot benchmarking-enhanced debrief diamond-based IPE program on medical professionals' IPC practices and outcomes.

For a training program, Kirkpatrick level 1 and 2 were the evaluation of “participants satisfaction” and “participants increase confidence, knowledge and performance”. Using IEPS and ATHCTS, our study revealed significant improvements in participants' motivation and IPC attitudes across the three professions after receiving training with our new IPE program. The participant's satisfaction with the new program and the degree of improvement in participant's competency, however, was not evaluated in our study. Kirkpatrick levels 3 and 4 in our study were the "multiplication" of knowledge by "seeding" and influence on the health care system. According to the real presented example in benchmarking sharing of our study, facilitators' gave high ratings for their agreement to participants' degree of appropriate transfer and sustainable practice of the learnt IPC skills to clinical works. The sequential improvements in participants' self-assessed IPC attitude scores also was noted in our study. Moreover, the comparison of pre-intervention and post-intervention randomly sampled team members, who were non-participants, revealed the general improvement in their IPC attitudes

and motivation. Nevertheless, for this part, the use of newly acquired knowledge or skills by medical professionals of our institution was not evaluated in our study. Taken together, our pilot study only achieved some of the goals of a training program, according to the Kirkpatrick 1-4 levels.[27]

Our IPE approach targets IPC attitude specifically using a number of defined types of patient scenario that are suitable for all three of the enrolled professions. Nevertheless, the specific IPC skills required for holistic care of COPD cases clearly are different from those needed to care for acute renal failure cases. Undoubtedly, IPC skills are learned more readily when the simulation-enhanced IPE used is more relevant to the type of clinical situation. In our study, this limitation was alleviated by the multi-professional post-simulation debrief diamond-based debriefing during a 3.5-hour simulation workshop and the fact that the enrolled participants continued to carry out their regular clinical routines during the 3-month intervention period. In other words, our enrolled participants were likely interacting with other professions in their clinical routine after the first and second stimuli presented during the preparation and simulation workshops. In fact, it has been suggested that learning together with a variety of high-fidelity simulation modules in multi-professional groups would foster shared inter-professional collaborative (IPC) across many clinical situations.[28-31]

As participation in this course was voluntary, participants were likely to be more highly motivated than non-participants, which may limit the generalizability of our results. Actually, the positive effects of the debrief diamond and preparation workshop had been reported in previous simulated-based IPE studies.[13-15] In our study, the lack of control groups without the debrief diamond method and preparation workshop, to exclude more effects of them on inter-professional skills, may still limit us to conclude the definite effectiveness of benchmarking-enhanced IPE on training. Both IEPS and ATHCTS have been suggested as reliable tools to assess the effectiveness of practice-based IPE interventions.[19-21] It has been validated that each subscale of IEPS and ATHCTS is a strong measurement for underlying IPC concepts that are crucial to medical professions.[19-21]

Notably, the core elements in the constructive assessment tools, IEPS and ATHCTS, used in our studies were more focused on “communication and teamwork” than “coordination and leadership” skills.” Therefore, from Table 2, it seems that pharmacists and nurses perform better than physicians. Nonetheless, the facilitators' agreement for the degree of participant's appropriate transfer and sustainable practice of learnt “coordination and leadership” skills in the workplace were significantly higher among physicians than pharmacists and nurses in benchmarking sharing (Table 3). This might be caused by the culture where physicians take over the role of leadership in the healthcare system. These results remind educators to rethink strategies to balance inter-professional training.

CONCLUSIONS

Our benchmarking-enhanced debrief diamond-based IPE simulation program was able to cultivated participants as seed instructors to modify the IPC attitude of their team members. The results of this plot study are promising and suggest that a future large-scale study with extension to professions other than the three professions enrolled here should be considered. As enhancement of inter-professional skills can ensure high-quality patient care, seed instructor training can be suggested as a personal development plan for every health professional.

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Contributors All authors have read and approved the final manuscript. Y-YY conceived and designed the study, analysis and interpretation of data, wrote the draft, recruited the study subjects, planned and performed the statistical analysis. H-MC made critical revision of manuscript. L-YY conceived and designed the study. C-CH recruited the study subjects, analysis and interpretation of data. J-FL acquisition, analysis and interpretation of data. F-YL study supervision, critical revision of manuscript. S-YK study supervision. C-CH acquisition of data. RK critical revision of manuscript.

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Competing interests None.

Data sharing statement No additional data available.

FIGURES AND LEGENDS

Figure 1 The flow chart of this diamond-based inter-professional education (IPE) simulation study. Detailed time points for trainings and assessment of this prospective pre-post comparative cross-sectional study.

Figure 2 Protocols for small group preparation and simulation workshops. The flow charts and detailed activities of first (preparation) and second (simulation) month' workshops, which were run in separate rooms over two consecutive days.

Figure 3 Benchmarking-enhanced IPE pilot program improved participants and their team members' IPC attitudes. The comparison of sequential changes of post-course ($\mathbf{T_2}$) and end-of-study ($\mathbf{T_3}$) subscales and scales of IEPS (**A**) and ATHCTS (**B**) between Group 1 (benchmarking) and Group 2 (regular) participants. **(C).** Comparison of responses from 132 randomly sampled members from the three professions (51 physicians, 45 nurses. 36 pharmacists twice) about IPC's attitudes in pre-intervention (T_{pre}) and post-intervention (T_{post}) survey. IPC attitude was assessed by five Likert scale responses ranging from 1: strongly disagree to 5: strongly agree. $^{*}p<0.01$ *vs*. post-course (T_2) or pre-intervention (T_{pre}) scores; $^{\#}p<0.01$ *vs.* Group 2 participants' scores.

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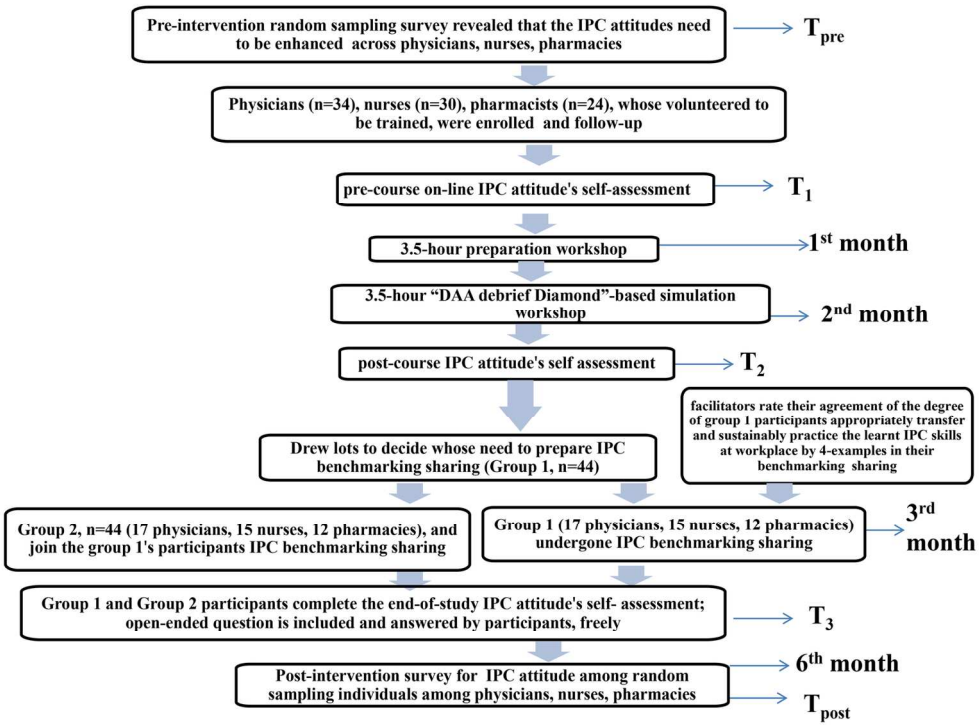

Fig. 1

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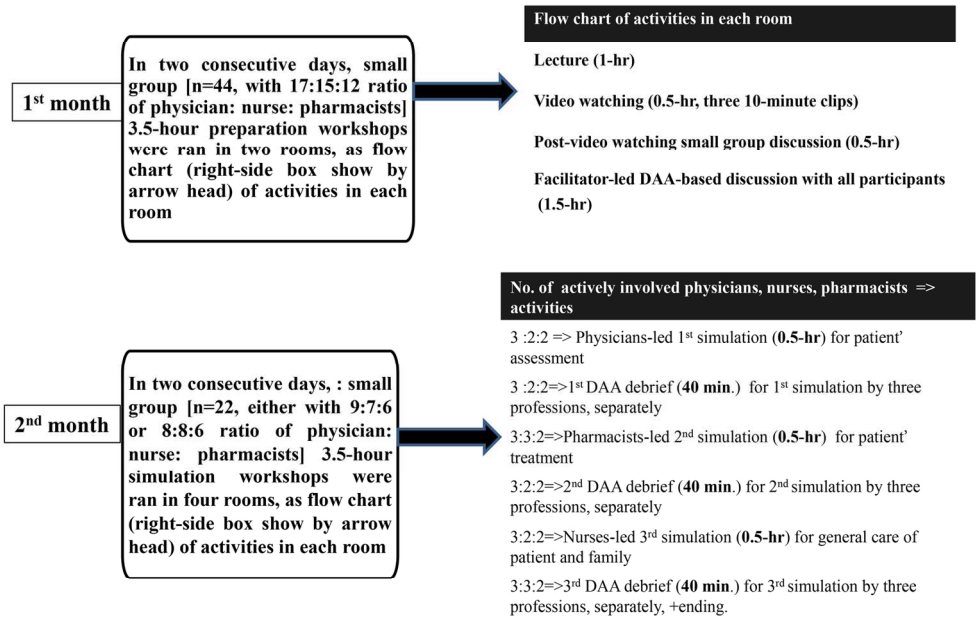

Fig. 2

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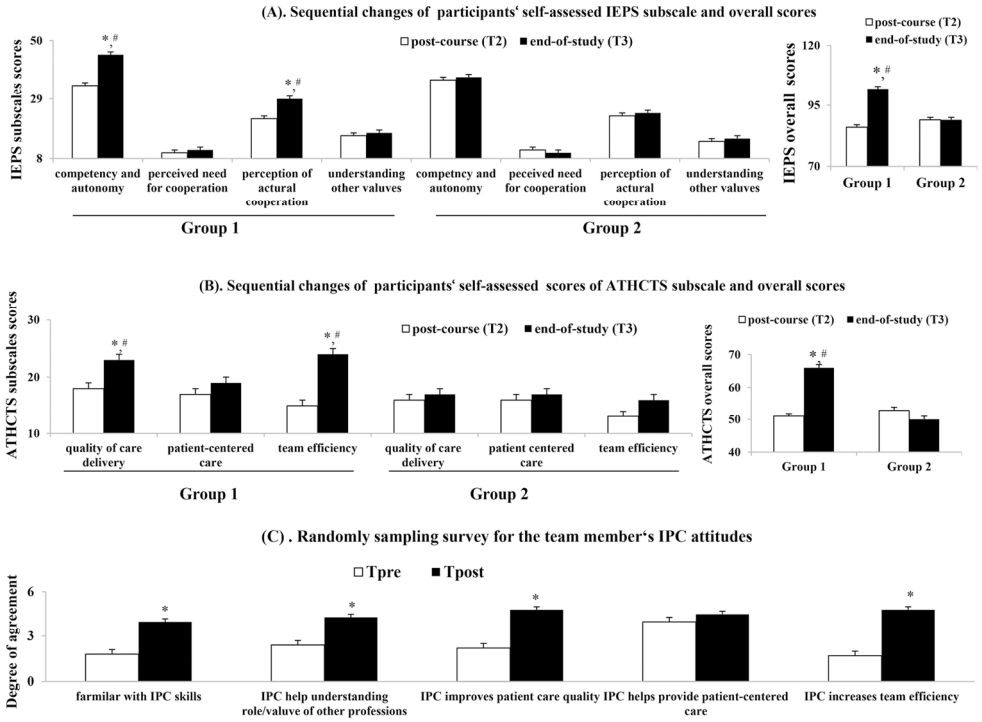

Fig. 3

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Supplement table 1 Interdisciplinary education perception scale (IEPS)

subsclases	statement
competency and autonomy (8 items)	1. Individuals in my profession are well-trained. 2. Individuals in my profession demonstrate a great deal of autonomy. 3. Individuals in my profession are very positive about their goals and objectives. 4. Individuals in my profession are very positive about their contributions and accomplishments. 5. Individuals in my profession trust each other's professional judgment. 6. Individuals in my profession are extremely competent. 7. Individuals in other professions respect the work done by my profession. 8. Individuals in other professions think highly of my profession.
perceived need for cooperation (2 items)	9. Individuals in my profession need to cooperate with other professions. 10. Individuals in my profession must depend upon the work of people in other professions.
perception of actual cooperation (5 items)	11. Individuals in my profession are able to work closely with individuals in other professions. 12. Individuals in my profession are willing to share information and resources with other professionals. 13. Individuals in my profession have good relations with people in other professions. 14. Individuals in my profession think highly of other related professions. 15. Individuals in my profession work well with each other.
understanding others value (3 items)	16. Individuals in my profession have a higher status than individuals in other professions. 17. Individuals in my profession make every effort to understand the capabilities and contributions of other professions. 18. Individuals in other professions often seek the advice of people in my profession.
Likert's Scale with 6 possible responses (1=Strongly Disagree, 2=Moderately Disagree, 3=Somewhat Disagree, 4=Somewhat Agree, 5=Moderately Agree, 6=Strongly Agree); ** Higher scores represent more positive attitudes toward teamwork.	

Supplement table 2 Attitudes Toward Interprofessional Health Care Teams Scale (ATIHCTS)

Subscales	STATEMENT
quality of care delivery (5 items)	1. Developing an inter-professional patient care plan is excessively time consuming. 2. The give and take among team members helps them make better patient care decisions. 3. The inter-professional approach makes the delivery of care more efficient. 4. Developing a patient care plan with other team members avoids errors in delivering care. 5. The inter-professional approach improves the quality of care to patients
patient-centered care (4 items)	6. Patients receiving inter-professional care are more likely than others to be treated as whole persons. 7. Health professionals working as teams are more responsive than others to the emotional and financial needs of patients 8. The inter-professional approach permits health professionals to meet the needs of family caregivers as well as patients. 9. Hospital patients who receive inter-professional team care are better prepared for discharge than other patients.
team efficiency (5 items)	10. Working in an inter-professional manner unnecessarily complicates things most of the time. 11. Working in an inter-professional environment keeps most health professionals enthusiastic and interested in their jobs. 12. In most instances, the time required for inter-professional consultations could be better spent in other ways 13. Having to report observations to a team helps team members better understand the work of other health professionals. 14. Team meetings foster communication among team members from different professions or disciplines.

* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);*Higher scores represent more positive attitudes toward teamwork.

Supplement table 3 IPC core elements-based questionnaires used for pre-intervention and post-intervention random sampling survey of IPC attitudes
1. Are you familiar with IPC skills?
2. Do you agree that IPC helps understanding the role of other healthcare team members?
3. Do you agree that IPC improves quality of patient care?
4. Do you agree that IPC improves patient-centered care?
5. Do you agree that IPC improves team efficiency?
* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);* Higher scores represent better IPC attitudes

Research check list

Our article title had included the following point.

1. A structured abstract (max. 300 words) of: objectives, design, results and conclusion, or that meets the standards of the relevant reporting guideline (see below).
2. An 'Article summary' section consisting of three headings: 'Article focus' (up to three bullet points on the research questions or hypotheses addressed); 'Key messages' (up to three bullet points showing the key messages or significance of the study); and a 'Strengths and limitations of this study' section. This should be placed after the abstract.
3. The original protocol for the study, where one exists.
4. A funding statement, preferably worded as follows. Either: 'This work was supported by [name of funder] grant number [xxx]' or 'This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors'.
5. A competing interests statement.
6. Articles should list each author's contribution individually at the end; this section may also include contributors who do not qualify as authors.
7. Any checklist and flow diagram for the appropriate reporting sttement, e.g. STROBE (see below).
8. Any article that contains personal medical information about an identifiable living individual requires the patient's explicit consent before we can publish it. We will need the patient to sign our consent form, which requires the patient to have read the article. This form is available in multiple languages.

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Simulation based inter-professional education to improve attitudes towards collaborative practice: a prospective comparative pilot study in a Chinese medical center

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Simulation based inter-professional education to improve attitudes towards collaborative practice: a prospective comparative pilot study in a Chinese medical center

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ABSTRACT

Objectives: Inter-professional education (IPE) builds inter-professional collaboration (IPC) attitude/skills of health professionals. This interventional IPE program evaluates whether benchmarking sharing can successfully cultivate seed instructors responsible for improving their team members' IPC attitudes.

Design: Prospective, pre-post comparative cross-sectional pilot study.

Setting/participants: 34 physicians, 30 nurses and 24 pharmacists, who volunteered to be trained as seed instructors participated in 3.5-hr preparation and 3.5-hr simulation courses. Then, participants (n=88) drew lots to decide 44 presenters, half of each profession, who needed to prepare IPC benchmarking and formed Group 1. The remaining participants formed Group 2 (regular). Facilitators rated the Group 1 participants' degree of appropriate transfer and sustainable practice of the learnt IPC skills in the workplace according to successful IPC examples in their benchmarking sharing.

Results: For the three professions, improvement in IPC attitude was identified by sequential increase in the post-course (2^{nd} month, T_2) and end-of-study (3^{rd} month, T_3) Interdisciplinary Education Perception Scale (IEPS) and Attitudes Towards Health Care Teams Scale (ATHCTS) scores, compared to pre-course (1^{st} month, T_1) scores. By IEPS and ATHCTS-based assessment, the degree of sequential improvements in IPC attitude was found to be higher among nurses and pharmacists than in physicians. In benchmarking sharing, the facilitators' agreement about the degree of participant's appropriate transfer and sustainable practice learnt “communication and teamwork” skills in the workplace were significantly higher among pharmacists and nurses than among physicians. The post-intervention random sampling survey (6^{th} month, T_{post}) found that the IPC attitude of three professions improved after on-site IPC skill promotion by new program-trained seed instructors within teams.

Conclusions: Addition of benchmark sharing to a diamond-based IPE simulation program enhances participants' IPC attitudes, self-reflection, workplace transfer and practice of the learnt skills. Furthermore, IPC promotion within teams by newly trained seed instructors improved the IPC attitudes across all three professions.

Keywords: nurses, pharmacists, inter-professional collaboration, interdisciplinary education perception, attitudes towards health care teams

Strengths and limitations of this study

- This pilot study describes the experiences of a prospective cross-sectional cohort of physicians, nurses and pharmacists who volunteered to receive serial benchmarking-enhanced diamond-based IPE simulation program for cultivating them as seed instructors to improve team members' IPC attitude.
- In our IPE program, IPC benchmarking sharing was implemented to enhance participants' continual motivation to self-reflect and to promote IPC among team members.
- Using IEPS and ATHCTS, our study reveals the significant improvements in participant's motivation and IPC attitude across three professions after receiving training with our new IPE program.
- Through IPC benchmarking presentation, participants' appropriate transfer and sustainable practice of the learnt IPC skills in the workplace was evaluated.
- Although participant's satisfaction with the new program and the degree of improvement in participant's competencies were not evaluated in our study.
- At this stage, the use of newly acquired knowledge or skills by medical professionals of our institution was not evaluated in our study.
- These results were limited to experience in one institution; the degree to which this can be extrapolated to IPE training in other institutions is not known.

INTRODUCTION

Inter-professional education (IPE) aims to improve the coordination, communication, teamwork and leadership skills of health professionals by learning with, from and about each other.[1] Two key families of learning theory behaviorism and constructivism were applied to the curriculum design of IPE.[2,3] It has been reported that learning theories for IPE are not mutually exclusive. In fact, theorists agree that inter-professional learning "by doing" combined with learner centeredness is the key.[2,3] Health care simulations are recognized as an ideal vehicle for IPE.[4] Today's patients have complex chronic health issues that need inter-professional collaboration (IPC) in order to deliver well-coordinated, high-quality and patient-centered care.[5,6] Simulation-enhanced IPE helps the development of a health professional's IPC skills and these are very important when managing critical clinical situations.[7]

Baker, *et al*. reported that 2-hour cardiac resuscitation/intravenous access simulation-based IPE prepared medical students, nursing students and junior medical residents for their future as practitioners.[8] In their study, immediate attitudinal scores and responses by means of an Interdisciplinary Education Perception Scale (IEPS) survey were consistently positive among both medical and nursing students.[8] Undre *et. al.* reported that, using technical and human factors rating scales, trainers and multidisciplinary trainees assessed the crisis scenarios-based simulation training favorably, especially in technical skills.[9] Paige *et al*. revealed that in a 3-hour simulation-based interdisciplinary operating room, IPE significantly improve the trainees' self-efficacy teamwork performance in role clarity, anticipatory response, cross monitoring, team cohesion and interaction.[10] In Vyas *et al.* study, using the team building and inter-professional communications survey, pharmacy students reported that semi-urgent situations simulation-based IPE increased their understanding of professional roles and the importance of inter-professional communication.[11]

In Estis *et al.* study, using an attitudinal survey, speech language pathology, cardio-respiratory care and nursing students reported that simulation-based IPE enhanced their knowledge of medical professional roles/responsibilities and teamwork skills of caring for tracheostomy patients with speaking valves.[12] Nevertheless, participants in the Estis *et al.* study suggested that pre-simulation training and more structural interaction during the debriefing phase were likely to enhance effective of the IPE.[12] Specifically, Watters *et al*. implemented a debrief diamond, following description-analysis-application steps, during a 1-day simulation IPE course.[13] The standardized debrief diamond was designed to allow high-quality exploration of the non-technical aspects of a simulated scenario. The diamond is a two-sided prompt sheet: the first contains the scaffolding, with a series of constructed questions for each phase of the debriefing; while the second lays out the theory behind the questions and the process.[13,14] In Watters *et al.* study, using self-efficacy questionnaires, doctors and nurses reported that diamond-based simulation increased their confidence in "communication and teamwork" skills.[13] Darlow *et al*. reported that addition of a preparation workshop to their 11-hour IPE program resulted in improved attitudes towards inter-professional teams and inter-professional learning, as well as self-reported ability to function within an inter-professional team.[15]

Taken together, previous simulation-based IPE studies[8-15] were lacking in post-course continuous training. In addition, there is an absence of long-term follow-up that allows the transference and sustainability of IPC practice to be assessed. Furthermore, there is an absence in these studies of opportunities for the participants

to reflect on their training after a period of IPC practice. In 2014, a random sampling survey of three professions at our institution revealed that IPC attitudes of physician, nurses and pharmacists need to be improved (Figure 1).

It is important to develop feasible continuous IPE/IPC strategies to solve the problems of previous studies[8-15] and of our survey. Therefore, our education committee targeted these three professions and organized a new IPE program characterized by pre-simulation training, post-course continuous training, and immediate plus delayed IPC attitude assessments. Additionally, post-training e-learning platform and IPC benchmarking sharing provide an opportunity for additional/deepening learning of inter-professional problem solving skills. Benchmarking sharing, a good indicator of organizational seriousness about quality, is a continuous quality improvement approach. Healthcare benchmarking sharing provides opportunities for inter-professional participants to learn from others and develop innovative collaborative clinical care.[16,17] This pilot intervention intentionally evaluates its impact on cultivating new health professionals as seed instructors to promote IPC within their teams.

METHODS

Participants and setting

Between January 2015 and May 2016, we conducted a prospective cross-sectional comparative study at the high-fidelity clinical simulation and interactive learning center of TVGH; this center trains around 2500 staff each year. Taipei Veterans General Hospital (TVGH) is a 3000-bed medical center providing primary and tertiary care to active-duty and retired military personnel and their dependents, and the general public. Meanwhile, TVGH is the teaching hospital for several medical universities in Northern Taiwan.

Health professionals having more than 1 year but less than 4 years of clinical work experience were invited to participate in this study. The participants volunteering to be trained (n=94) were invited to join the 2015 pilot benchmarking-enhanced diamond-based IPE simulation courses to improve their IPC attitudes. After excluding six participants due to incomplete questionnaires, a total of n=88 individuals were included in this study. They consisted of physicians (n=34), nurses (n=30) and pharmacists (n=24).

Ethical approval (2015-06-017CC) was obtained from the Ethics committee of our institution and care was taken to apply the World Medical Association Declaration of Helsinki principles to the research.

Time points of serial assessments

After a brief introduction, the participants were asked to complete the on-line pre-course self-assessment on attitudes to IPC in the pre-course survey (T_1). Each on-line self-assessment was numbered so that participants remained anonymous but their numbers could be used to match their pre-course (T_1) self-assessment with post-course (T_2) and end-of-study (T_3) self-assessment (Figure 1). All participants continued with their usual professional clinical routine throughout the 3-month interventional study.

IPC attitude's self-assessments

In our study, we measured participants' IPC attitudes with Interdisciplinary education perception scale[18-20] (IEPS, supplemental Table 1), and the Attitudes Toward Health Care Teams Scale[21] (ATHCTS, supplemental Table 2).

Additionally, participants were asked to provide qualitative feedback freely by answering the single-open-ended question, "*what is the one thing you are going to take away with you at the end of this course?*" in the online post-courses self-assessment (T_3). This question was designed to prompt a participant to reflect on their own learning during the course and allowed the program director to gather evidence on which elements within the courses seemed to be contributing the most to the learning experience.

Benchmarking-enhanced diamond-based IPE simulation courses

Each participant attended a 3.5-hour preparation courses (T_1) in the first month of this study (Figure 1). Subsequently, a 3.5-hour simulation courses was arranged for the participants during the second month (T_2). At the end of the simulation courses, participants drew lots to decide who needed to prepare for post-course IPC benchmarking at the third month (T_3) of study (*i.e.*, who was in Group 1). In order to maintain a fixed ratio (34:30:24) among the three professions (Figure 1), half (17:15:12) of the physicians, nurses and pharmacists were selected as Group 1 (benchmarking) and the others as Group 2 (regular).

(1).Facilitators training and DAA debrief diamond

All facilitators received serial sessions training in how to use the debrief diamond and to gain a consensus on how to rate their agreement about the degree of participants appropriate transfer and sustainable practice of the trained "coordination, communication, teamwork, and leadership" skills regarding IPC in the workplace using real examples in their benchmarking sharing. In particular, the Description-Analysis-Application (DAA) debrief diamond was used to involve participants in preparation (T1) and simulation (T2) courses. The "description" step involved 'description' of each profession's IPC performance in the simulation scenario, along with more challenging "analysis" and "application" steps involving 'how did participants feel about each profession's IPC performance in simulation scenario?' and "how participants may apply the learnt knowledge from IPC simulation scenarios in their own clinical practice".[13,14]

(2).7-hour preparation and simulation workshop

-Preparation courses (T_1). In accordance with previous study design,[15] two small-group preparation workshops were held on two consecutive days as shown in Figure 2. The simulated examples of IPC-based care from a previous study[11] were revised by an education committee and made into three video clips for IPE. They were, first, a simulation of a distracted wife and a 61-year-old male with dyspnea, who suffered from recurrent asthmatic attacks due to inappropriate home medication; second, a simulation of a 35-year-old family group who were anxious, about the pregnant woman who had nausea/vomiting/abdominal pain, who needed anti-emetics suitable for her condition and a pediatrics/gynecology consultation in an ER setting and, finally, a simulation of a 57-year-old male with chest pain, with a distraught son and with the wrong allergy and ID labeling on his arm band; and the fourth simulation was an unlocked bed in an ICU setting. These 10-minutes clips provided a basis for post-video viewing discussions that were led by inter-professional facilitators following a Diamond DAA debriefing of 1-hour; these clips targetted the roles and value of each member of the IPC healthcare team involved in the simulated clinical scenarios presented in the three videos.[13,14]

-Simulation courses (T_2). In our simulation centers, four small-group workshops were held in four rooms within two consecutive days (Figure 2). Using the clinical scenario outlined below, workshops were led by well-trained IPE facilitators from dietetics, social workers and respiratory therapists. This scenario, which incorporated multi-disciplinary care, was modified in a previous study[12] and had a practice run before formally being used. A patient scenario involving Mr. Jason was developed collaboratively by the faculty members of the aforementioned professions. Participants were given the following information:

Mr. Jason has a history of chronic obstructive pulmonary disease (COPD), smokes 60 packs per year of cigarettes and has hypertension, diabetes, coronary artery disease and atrial fibrillation. He has been admitted with an acute exacerbation of his COPD five times over the past year. Home medication includes aspirin, a calcium channel blocker, mycolytic agents, inhalation corticosteroid/bronchodilator (combined) and insulin for subcutaneous administration. Mr. Jason was admitted 3 weeks ago for emergency coronary artery bypass grafting surgery. Although there has been aggressive management with regular chest theraphy, he has had difficulty being weaned from the ventilator due to poor ability to expectorate sputum and his malnutrition. The primary care teams now are considering a tracheostomy and intensive physical therapy and nutrition therapy. His family members are at the bedside. During the simulation, a pre-set intubated high-fidelity SimMan® 3G

simulator acted as the patient and standardized patients (SPs) were used as his family. Then, the 3.5-hour courses were ran (Figure 2).

Before the beginning of the simulation, the participants were presented with the case's name, age, gender, admission diagnosis and current medication/management. In the three simulation phases, the participants involved were expected to carry out assessment, treatments, and general care of the patients, collaboratively. Then, the participants began the post-simulation debriefing phase and reflected on the challenges, pitfalls, and successes that occurred within the simulation.

(3).The IPC benchmarking (T_3) of the Group 1 participants.

As mentioned above, 17 physicians, 15 nurses and 12 pharmacists formed Group 1 and these participants underwent IPC benchmarking sharing. Presenters were asked to give their four examples of appropriately transfer and sustainable practice learnt IPC skills in the workplace. Randomly, four small groups (n=11) with ratio (4:4:3, 4:4:3, 4:4:3 and 5:3:3) of physician to nurse to pharmacists were presented in four rooms over two consecutive days. During benchmarking sharing, two facilitators rated their 5-point Likert-scale-based agreement to the presenters' degree of appropriate transfer and sustainable practice of the learnt IPC skills in the workspace according to their four success examples. In each room, 4 hours (240 minutes) were needed for 11 presenters to complete their 20-minutes presentation (15-min.)/discussion (5-min.). Each presentation was video recorded by teaching assistants (TAs) to help with continuous IPC promotion. With the agreement of the presenters, the TAs uploaded edited versions of the video to the e-learning platform. The Group 2 participants were asked to join this end-of-study (T_3) IPC benchmarking sharing.

e-learning platform

Both the Group 1 and Group 2 participants were invited to use a common IPE e-learning platform containing the aforementioned scenario, various Power-point presentations, the video used in the preparation/simulation workshop and the video from the IPC benchmarking to encourage self-directed learning.

Pre-intervention (T_{pre}) and Post-intervention (T_{post}, 6th month) random sampling survey of IPC attitudes (Figure 1)

Using IPC core elements-based questionnaires (supplement Table 3), across the three professions, the effectiveness of the well-trained seed instructors was evaluated by comparing the differences between T_{pre} and T_{post}' IPC attitude scores[22-24].

Analysis

Outcomes of our new training program were analyzed according to Kirkpatrick levels.[25] Since the IEPS and ATHCTS items are ordinal in nature, Wilcoxon's signed rank test was used to analyze each item. The means of the overall IEPS score and the four subscales were evaluated with the Student's two-tailed paired *t*-test for continuous measures, with the aim of detecting any differences between T_1 and T_2 as well as T_2 and T_3 time-points. Data from the IEPS and ATHCTS were matched by profession for analysis with one-way ANOVA or Mann-Whitney U test to detect the significant difference between and/or among groups.

RESULTS

The baseline characteristics of the participants, including mean age, gender and clinical experiences, were similar across the physicians, nurses and pharmacists as can be seen in Table 1. A higher percentage of pharmacists (45%/43%) and nurses (35%/36%) had experienced receiving previous IPE training and higher frequency of exposure to IPC meeting during their previous year of clinical works than physicians (15%/14%) (Table 1). In other words, in comparison with nurses and pharmacists, a lower percentage of physicians belong to the high-exposure (>80% exposure to monthly IPC meeting/1-year) group, which indicates the physician's had less experience with IPC meeting participation during their last 1-year of clinical work

Table 1 Baseline characteristics of study population (n=88)

	Physicians (n=34)	Nurses (n=30)	Pharmacists (n=24)
Age (years)	31.3± 2.7	29.1 ±4.8	30.5 ±3.6
Female/male (No.)	30/4	27/3	10/14
Percentage of distribution of clinical-work-year of participants among groups			
1-2/2-3/ 3-4 years (%)	76/14/10%	84/10/6%	69/20/11%
Percentage of distribution of participants with and without experience of receiving previous IPE training	15/85%#	35/65%	45/55%
Percentage of distribution of participants with high/low frequency of exposure to IPC meeting during their last 1-yr of clinical work among groups			
Percentage of ‡high-exposure participants	14%#	36%	43%
Percentage of ‡ low-exposure participants	86%#	64%	57%

#p<0.01 *vs.* corresponding nurse′s/pharmacist's group**;** ‡high-exposure participants indicated individual that participating more than 80% of monthly IPC meeting; ‡low-exposure participants indicated individual that participating less than 20% of monthly IPC meeting.

Good internal consistency of the IEPS/ATHCTS and its subscales

In this study, the Cronbach's alpha coefficients of IEPS overall scales (0.721), competency and autonomy subscales (0.69), Perceived need for cooperation subscales (0.73), Perception of actual cooperation subscales (0.85) and Understanding others values subscales (0.662) were good. Meanwhile, Cronbach's alpha of ATHCTS overall scales (0.719), Quality of care delivery subscales (0.683), Patient-centered care subscales (0.801) and Team efficiency subscales (0.724) were acceptable.

Nurses and pharmacists had greater improvement of IEPS and ATHCTS scores than physicians

The baseline IPC attitude, pre-course (T_1) IEPS scores and pre-course (T_1) ATHCTS scores were also similar across the physicians, nurses and pharmacists (Table 2). Compared to nurses, there were lower scores for the “competency and autonomy” and “understanding others values” basal IEPS subscales (T_1) among the physicians. Similarly, also compared to nurses, there were lower scores for the “competency and autonomy” and “perception of actual cooperation” basal IEPS subscales (T_1) among the pharmacists. Notably, the “competency and autonomy” subscale of IEPS score and the “team efficiency” subscale of the ATHCTS score (T_2-T_1) were increased by the 7-hour stepwise simulation-enhanced IPE course across the three professions. In particular, the magnitude of increase in IEPS and ATHCTS scores were significantly greater among the nurses and pharmacist than among the

physicians (Table 2). Clearly, pharmacists had greater increase in percent change of post-courses (T_2) ATHCTS score from pre-courses (T_1) score than nurses or physicians (Table 2).

Table 2 Comparison between pre-courses and post-courses self-reported IPC attitude (IEPS and ATHCTS) among three professions

	Physicians (n=34)		Nurses (n=30)		Pharmacists (n=24)	
	pre-course (T_1)	post-course (T_2)	pre-course (T_1)	post-course (T_2)	pre-course(T_1)	post-course (T_2)
Total IEPS-18 scores [6-point scale]	56±1.8$^{\#}$	76±9.8$^{*,\#}$	65±1.6	91±1.2	64±8	91±4.7*
percent change of total IEPS post-course (T_2) score from pre-course (T_1) score		18%		40%†		42%†
IEPS subscales scores						
Competency and autonomy (8 items)	24±3.5$^{\#}$	28±4.1$^{*,\#}$	30±4.5	39±7.2*	22±5.4	40±6.1*
Perceived need for cooperation (2 items)	7±2.2	9±1.6	8±2.9	10±1.8	9±3	11±1.8
Perception of actual cooperation (5 items)	17±2.7	24±3.7$^{*,\#}$	15±1.2	26±4.3*	20±4.8	23±2.5
Understanding others values (3 items)	8±2.4$^{\#}$	15±2.9*	12±3.8	16±1.4	13±2.1	17±5.1*
Total ATHCTS-14 [5-point scale]	39±2.3	48±5.4*	38±2.6	51±4.6	32±3.7	54±7.5
Percent change of total ATHCTS post-course (T_2) score from pre-course (T_1) score		23%		34%†		69%†
ATHCTS subscales scores						
Quality of care delivery (5 items)	14±2.2	15±1.8$^{\#}$	13±1.6	18±4.1*	12±4.2	20±2.0*
Patient-centered care (4 items)	13±1.7	18±2.1*	15±7.4	19±3.3	11±2.8	18±3.5*
Team efficiency (5 items)	12±1.1	15±3.7*	10±1.9	14±2.7*	9±2.6	16±4.1*

Data were expressed as mean±SD; *p<0.01 *vs.* pre-course scores; #p<0.01 *vs.* corresponding nurse's/pharmacists score's; †p<0.01 *vs.* physicians scores

Participants demonstrated appropriate transfer of the learnt IPC skills in the workplace and sustainable practice of the skills after training

Based on the real examples in IPC benchmarking presentations of Group 1 participants, the facilitators found that physicians were more appropriately able to transfer and sustainably practice of the learnt IPC "coordination and leadership" skills in the workspace than pharmacists and nurses (Table 3).

Table 3 Comparison of facilitators' agreement to group 1 participant's degree of appropriate transfer and sustainable practice of the learnt IPC skills in workplaces according to four success examples in their benchmarking sharing

		Physicians (n=17)	Nurses (n=15)	Pharmacists (n=12)
Example 1	[1-1].Presenter transfers the "coordination" skills appropriately in workplaces	4.3±0.64	3.6±0.7#	3.9±0.8#
	[1-2].Presenter practices the "coordination" skills sustainably in workplaces	4.6±0.54	3.3±0.21#	4.1±0.7#
Example 2	[2-1].Presenter transfers the "communication" skills appropriately in workplaces	3.9±0.52*	4.1±0.94	4.4±0.7
	[2-2].Presenter practices the "communication" skills sustainably in workplaces	3.3±0.71*	4.01±0.76	4.8±0.1
Example 3	[3-1].Presenter transfers the "teamwork" skills appropriately in workplaces	3.4±0.502*	4.5±0.46	4.1±0.9
	[3-2].Presenter practices the "teamwork" skills sustainably in workplaces	3.8±0.2*	4.7±0.1	4.5±0.6
Example 4	[4-1].Presenter transfers the "leadership" skills appropriately in workplaces	4.4±0.803	3.4±0.61#	4.0±0.5#
	[4-2].Presenter practices the "leadership" skills sustainably in workplaces	4.7±0.4	3.0±0.3#	3.8±0.4#

Data were expressed as mean±SD; Presenters were asked to present their four examples according to the sequences of items listed above. Sequentially, benchmarking' Example 1 for Item 1-1&1-2, example 2 for item 2-1&2-2, Example 3 for Item 3-1&3-2, Example 4 for Item 4-1&4-2 were presented. By consensus meeting, facilitators rate their agreement to the items 1-1 and 1-2 according to the Example 1 of presenter, Items 2-2 and 2-2 from Example 2, Item 3-1 and 3-2 from Example 3, Items 4-1 and 4-2 from Example 4 in separate rooms. The results are averaged data of ratings completed by two facilitators for the presenter's performance of each item in above checklist; #p<0.05 *vs.* physician's group; *p<0.05 vs. nurse's/pharmacist's group.

In benchmarking sharing, the inter-rater reliability (Kappa statistics) of facilitators for the items used to assess whether participants were able to transfer and sustainably practice the learnt IPC skills was good (Table 4).

Table 4 Inter-rater reliability of facilitators' ratings in benchmarking sharing of Group 1 participants

	Physicians	Nurses	Pharmacists
	Kappa	Kappa	Kappa
[1-1].Presenter transfers the "coordination" skills appropriately in workplaces	0.73	0.71	0.85

[1-2].Presenter practices the "coordination" skills sustainably in workplaces	0.67	0.843	0.76
[2-1].Presenter transfers the "communication" skills appropriately in workplaces	0.69	0.82	0.89
[2-2].Presenter practices the "communication" skills sustainably in workplaces	0.71	0.79	0.77
[3-1].Presenter transfers the "teamwork" skills appropriately in workplaces	0.683	0.679	0.711
[3-2].Presenter practices the "teamwork" skills sustainably in workplaces	0.78	0.812	0.79
[4-1].Presenter transfers the "leadership" skills appropriately in workplaces	0.72	0.77	0.849
[4-2].Presenter practices the "leadership" skills sustainably in workplaces	0.83	0.74	0.816
Two facilitators for each small-group [n=11, either with 4:4:3, 4:4:3, 4:4:3, 5:3:3 ratio of physician: nurse: pharmacists] benchmarking sharing held in four rooms over two consecutive days.			

Participants gave positive descriptive feedbacks to the trainings

In open-ended questions at the end of our study, most participants reported that watching the IPE-specific video and discussing it, as well as viewing the uploaded videos on the e-learning platform, markedly encouraged their motivation to improve their IPC attitude. Specifically, the participant's reported that having access to an IPE/IPC-specific e-learning platform was able to improve the users' IPC attitude continuously by providing useful resources and instruction.

Selected completed feedback responses by the participants to the open-ended items of post-course self-assessment (T3) are listed below.

1. Benefits of our new benchmarking-enhanced debrief diamond-based IPE simulation courses.
   "*This IPE course improves inter-professional relationships, communication skills, efficiency in holistic patient care and service delivery, team work, respect for one another and builds confidence in my profession*."
2. Identified IPE/IPC elements in collaborative training.
   "*We are all geared to patient-centered care, all professions need to use their best assessment and judgment to evaluate patients in order to provide the best patient care that we can.*"
   "*We understand that there is a lot of team work going on our institution*."
   "*We understand that all professions should be encouraged within their training program to become independent in order to make IPC work better*."
3. Improved skills of quality of clinical care.
   "*There are situations that are different, but we do have to rely on the expertise of other professionals' in order to obtain the best outcome for the patient*."
   "*We were able to collaborate very well with other professional health care members, especially with the nurses in their second simulation; they sort of referred to us regarding our drug management skills and sort of learned how important pharmacists can actually be in a hospital setting*."
4. Skills learnt from their skillful facilitators.
   "Sometimes, staying in your own profession is great and everything, but you really sort of need to reach outwards and see what other professions have to offer, because only if you do that can you truly use the entire knowledge base of other professions and provide the

best patient care."

Addition of benchmarking sharing to enhance the continuous beneficial effects of training

Compared to pre-courses (T_1) scores, the degree of increase in total IEPS and ATHCTS scores at post-courses (T_2) self-assessments were not different between Group 1 and 2 participants (data not shown). Among the Group 1 and 2 participants, similar or higher end-of-study (T_3) IEPS and ATHCTS scores than post-courses (T_2) scores indicated the sustained effects of 7-hour simulation-based debrief diamond-enhanced IPE courses (Figure 3). From the post-course (T_2) to end-of-study (T_3) period, a significantly greater increase in the total IEPS and ATHCTS scores of the group 1 (benchmarking) participants than for the Group 2 (regular) participants can be seen (Figure 3). This indicates the additional benefits of IPC benchmarking on the Group 1 participants' IPC attitude. Among the benchmarking-group' participants, the most improved items were the "competency and autonomy" and "perception of actual cooperation" subscales of the IEPS and the "quality of care delivery" and "team efficiency" subscales of the ATHCTS, when the T_2 and T_3 self-assessments were compared.

Improvement of IPC attitudes among team members of three professions by the promotion of new intervention-trained seed instructors

In total, 132 valid T_{post} questionnaires were collected for comparison with another 132 valid T_{pre} questionnaires. These anonymous T_{pre} and T_{post} questionnaires were completed by random members sampled twice from the three professions, namely 51 physicians, 45 nurses and 36 pharmacists. In other words, the individuals who responded to the online IPC attitude survey might be but are not necessarily different between T_{pre} and T_{post} survey. Nonetheless, it is important to note that the enrolled participants in our interventional study were excluded from the sampling pool for T_{post} sampling survey.

Among the randomly sampled team members, the pre-intervention survey (T_{pre}) revealed that IPC attitudes across physicians, nurses and pharmacists must be improved in the aspects of IPC' familiarity, understanding of other professions' roles and benefits of IPC on quality of patient-centered care (Figure 3C). Across the three professions, after seed instructors began promoting IPC in the workplace, post-intervention (T_{post}, 6th month) randomly sampled team members reported that they were familiar with IPC skills, agreed that IPC helped them to understand the role of other team members, agreed that IPC improved patient care quality and agreed that IPC improved team efficiency (Figure 3C). Interestingly, across the three professions of randomly sampled team members, the level of agreement to the statement of "IPC helps provide patient-centered care" were excellent both in the pre-intervention (Tpre) and post-intervention (Tpost) surveys (Figure 3C).

DISCUSSION

In addition to serial subjective and objective assessments, our IPE model is characterized by a debrief diamond strategy (Figure 2). Debriefing can help a learner clarify and integrate the simulation experience with their previous knowledge.[8,10,11,22-24] The debrief diamond encourages a standardized approach to high-quality debriefing across courses, which benefits both the participants and the involved faculty members.[13,14] The DAA debrief diamond is related to various aspects of the advocacy-inquiry approach and of debriefing with good judgment. The diamond provides an easy but pedagogically sound structure for facilitators to follow for specific post-simulation feedback and discussion. Nevertheless, the long-term effects of structured debriefing have not been thoroughly evaluated in previous simulated-enhanced IPE studies.[8-15]

When trying to improve each health professional's IPC attitude with limited resources, including the time needed to carry out the training, the number of faculty members needed to run the training and the facilities needed for the training, each newly-trained participant should act as a seed instructor within their team. In other words, successful training of seed instructors can result in profession-wide IPC promotion and attitude remodeling. In our study, this well-organized design allows each participant from three professions to have equal IPE exposure, which helps their development as seed instructors in their healthcare team.

By training volunteers from physicians, nurses and pharmacists, our interventional training program aims to change participants' behaviors and to act as seed instructors for promoting IPC in team member. In our study, the post-intervention survey, performed after the sequential simulation-based IPE courses, revealed that there was significant improvement in randomly sampled team members' IPC attitude across physicians, nurses and pharmacists.

The strengths of our pilot study are the extension of IPE via e-learning platform, benchmarking sharing and continuous self-evaluations. Previous studies have suggested that training videos consistently enhance the observational powers of trainees, as well as improving their ability to integrate different information and increasing their motivation to learn.[25,26] In our study, most participants reported that the availability of an e-learning platform that has sufficient IPE resources helps to continue their self-directed learning. Meanwhile, the benchmarking provides the enrolled participants with the opportunity for IPC self-reflection, as well as enhancing their motivation as seed instructors in their teams.

Primarily, this new simulation-based IPE program was intended to solve challenges, which included are lack of continuous training and follow-up, of previous studies[8-13,15] and those within our institution. Nevertheless, there were some limitations in our study that need to be altered and the method improved for any future study before determining the level of effectiveness of this pilot benchmarking-enhanced debrief diamond-based IPE program on health professionals IPC practices and outcomes.

For a training program, Kirkpatrick level 1 and 2 were the evaluation of “participants satisfaction” and “participants increase confidence, knowledge and performance”. Using IEPS and ATHCTS, our study revealed significant improvements in participants' motivation and IPC attitudes across the three professions after receiving training with our new IPE program. The participant's satisfaction with the new program and the degree of improvement in participant' competency, however, was not evaluated in our study. Kirkpatrick levels 3 and 4 in our study were the "multiplication" of knowledge by "seeding" and its influence on the health care system. According to the actual case scenario used as the example in benchmarking sharing of our study, facilitators gave high ratings for their level of agreement with the participants' degree of appropriate transfer and sustainable practice of the learnt IPC skills to clinical works. The sequential improvements in participants' self-assessed IPC attitude scores also was noted in our study. Moreover, the comparison of pre-intervention and

post-intervention randomly sampled team members, who were non-participants, revealed the general improvement in their IPC attitudes and motivation. Nevertheless, for this part, the use of newly acquired knowledge or skills by medical professionals of our institution was not evaluated in our study. Taken together, our pilot study only achieved some of the goals of a training program, according to the Kirkpatrick 1-4 levels.[27]

Our IPE approach targets IPC attitude specifically using a number of defined types of patient scenario that are suitable for all three of the enrolled professions. Nevertheless, the specific IPC skills required for holistic care of COPD cases clearly are different from those needed to care for acute renal failure cases. Undoubtedly, IPC skills are learned more readily when the simulation-enhanced IPE used is more relevant to the type of clinical situation. In our study, this limitation was alleviated by the multi-professional post-simulation debrief diamond-based debriefing during a 3.5-hour simulation workshop and the fact that the enrolled participants continued to carry out their regular clinical routines during the 3-month intervention period. In other words, our enrolled participants were likely interacting with other professions in their clinical routine after the first and second stimuli presented during the preparation and simulation workshops. In fact, it has been suggested that learning together with a variety of high-fidelity simulation modules in multi-professional groups would foster shared inter-professional collaborative (IPC) across many clinical situations.[28-31]

As participation in this course was voluntary, participants were likely to be more highly motivated than non-participants, which may limit the generalizability of our results. Actually, the positive effects of the debrief diamond and preparation workshop had been reported in previous simulated-based IPE studies.[13-15] In our study, the lack of control groups without the debrief diamond method and preparation workshop, to exclude more effects of them on inter-professional skills, may still limit us to conclude the definite effectiveness of benchmarking-enhanced IPE on training. Both IEPS and ATHCTS have been suggested as reliable tools to assess the effectiveness of practice-based IPE interventions.[19-21] It has been validated that each subscale of IEPS and ATHCTS is a strong measurement for underlying IPC concepts that are crucial to medical professions.[19-21]

Notably, the core elements in the constructive assessment tools, IEPS and ATHCTS, used in our studies were more focused on “communication and teamwork” than “coordination and leadership” skills.” Therefore, from Table 2, it seems that pharmacists and nurses perform better than physicians. Nonetheless, the facilitators' agreement for the degree of participant's appropriate transfer and sustainable practice of learnt “coordination and leadership” skills in the workplace were significantly higher among physicians than pharmacists and nurses in benchmarking sharing (Table 3). This might be caused by the culture where physicians take over the role of leadership in the healthcare system. These results remind educators to rethink strategies to balance inter-professional training.

CONCLUSIONS

Our benchmarking-enhanced debrief diamond-based IPE simulation program was able to cultivated participants as seed instructors to modify the IPC attitude of their team members. The results of this plot study are promising and suggest that a future large-scale study with extension to professions other than the three professions enrolled here should be considered. As enhancement of inter-professional skills can ensure high-quality patient care, seed instructor training can be suggested as a personal development plan for every health professional.

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Contributors All authors have read and approved the final manuscript. Y-YY conceived and designed the study, analysis and interpretation of data, wrote the draft, recruited the study subjects, planned and performed the statistical analysis. H-MC made critical revision of manuscript. L-YY conceived and designed the study. C-CH recruited the study subjects, analysis and interpretation of data. J-FL acquisition, analysis and interpretation of data. F-YL study supervision, critical revision of manuscript. S-YK study supervision. C-CH acquisition of data. RK critical revision of manuscript.

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Competing interests None.

Data sharing statement No additional data available.

FIGURES AND LEGENDS

Figure 1 The flow chart of this diamond-based inter-professional education (IPE) simulation study. Detailed time points for trainings and assessment of this prospective pre-post comparative cross-sectional study.

Figure 2 Protocols for small group preparation and simulation workshops. The flow charts and detailed activities of first (preparation) and second (simulation) month' workshops, which were run in separate rooms over two consecutive days.

Figure 3 Benchmarking-enhanced IPE pilot program improved participants and their team members' IPC attitudes. The comparison of sequential changes of post-course ($\mathbf{T_2}$) and end-of-study ($\mathbf{T_3}$) subscales and scales of IEPS (**A**) and ATHCTS (**B**) between Group 1 (benchmarking) and Group 2 (regular) participants. **(C).** Comparison of responses from 132 randomly sampled members from the three professions (51 physicians, 45 nurses. 36 pharmacists) about attitudes to IPC in the pre-intervention (T_{pre}) and post-intervention (T_{post}) survey. IPC attitude was assessed by five Likert scale responses ranging from 1: strongly disagree to 5: strongly agree. $^{*}p<0.01$ *vs*. post-course (T_2) or pre-intervention (T_{pre}) scores; $^{\#}p<0.01$ *vs.* Group 2 participants' scores.

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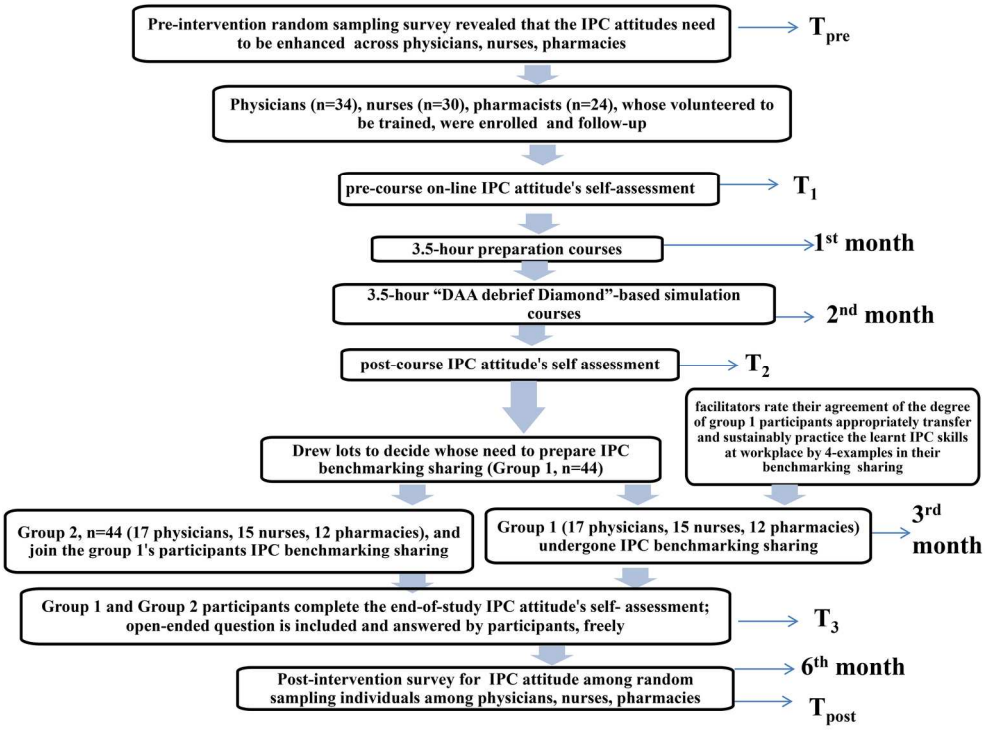

Fig. 1

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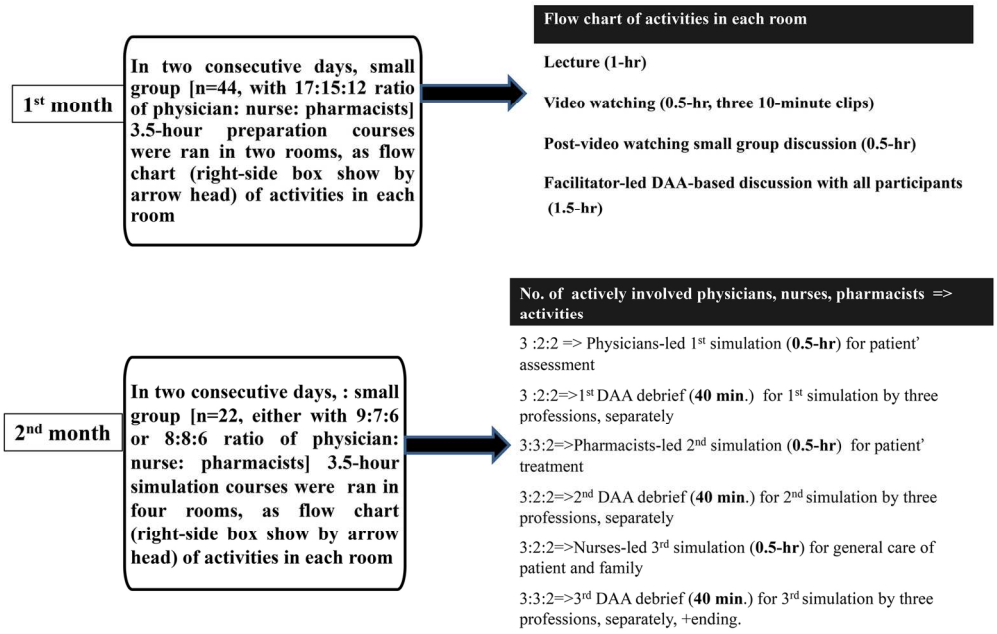

Fig. 2

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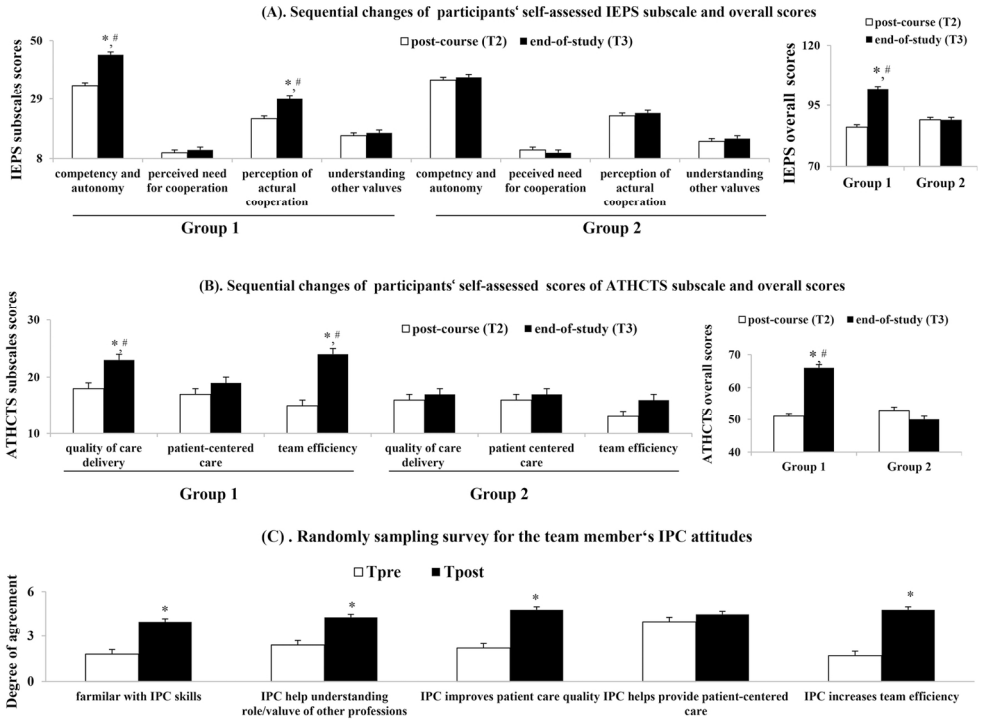

Fig. 3

152x114mm (300 x 300 DPI)

Supplement table 1 Interdisciplinary education perception scale (IEPS)

subsclases	statement
competency and autonomy (8 items)	1. Individuals in my profession are well-trained. 2. Individuals in my profession demonstrate a great deal of autonomy. 3. Individuals in my profession are very positive about their goals and objectives. 4. Individuals in my profession are very positive about their contributions and accomplishments. 5. Individuals in my profession trust each other's professional judgment. 6. Individuals in my profession are extremely competent. 7. Individuals in other professions respect the work done by my profession. 8. Individuals in other professions think highly of my profession.
perceived need for cooperation (2 items)	9. Individuals in my profession need to cooperate with other professions. 10. Individuals in my profession must depend upon the work of people in other professions.
perception of actual cooperation (5 items)	11. Individuals in my profession are able to work closely with individuals in other professions. 12. Individuals in my profession are willing to share information and resources with other professionals. 13. Individuals in my profession have good relations with people in other professions. 14. Individuals in my profession think highly of other related professions. 15. Individuals in my profession work well with each other.
understanding others value (3 items)	16. Individuals in my profession have a higher status than individuals in other professions. 17. Individuals in my profession make every effort to understand the capabilities and contributions of other professions. 18. Individuals in other professions often seek the advice of people in my profession.
Likert's Scale with 6 possible responses (1=Strongly Disagree, 2=Moderately Disagree, 3=Somewhat Disagree, 4=Somewhat Agree, 5=Moderately Agree, 6=Strongly Agree); ** Higher scores represent more positive attitudes toward teamwork.	

Supplement table 2 Attitudes Toward Interprofessional Health Care Teams Scale (ATIHCTS)

Subscales	STATEMENT
quality of care delivery (5 items)	1. Developing an inter-professional patient care plan is excessively time consuming. 2. The give and take among team members helps them make better patient care decisions. 3. The inter-professional approach makes the delivery of care more efficient. 4. Developing a patient care plan with other team members avoids errors in delivering care. 5. The inter-professional approach improves the quality of care to patients
patient-centered care (4 items)	6. Patients receiving inter-professional care are more likely than others to be treated as whole persons. 7. Health professionals working as teams are more responsive than others to the emotional and financial needs of patients 8. The inter-professional approach permits health professionals to meet the needs of family caregivers as well as patients. 9. Hospital patients who receive inter-professional team care are better prepared for discharge than other patients.
team efficiency (5 items)	10. Working in an inter-professional manner unnecessarily complicates things most of the time. 11. Working in an inter-professional environment keeps most health professionals enthusiastic and interested in their jobs. 12. In most instances, the time required for inter-professional consultations could be better spent in other ways 13. Having to report observations to a team helps team members better understand the work of other health professionals. 14. Team meetings foster communication among team members from different professions or disciplines.

* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);*Higher scores represent more positive attitudes toward teamwork.

Supplement table 3 IPC core elements-based questionnaires used for pre-intervention and post-intervention random sampling survey of IPC attitudes
1. Are you familiar with IPC skills?
2. Do you agree that IPC helps understanding the role of other healthcare team members?
3. Do you agree that IPC improves quality of patient care?
4. Do you agree that IPC improves patient-centered care?
5. Do you agree that IPC improves team efficiency?
* Likert's Scale with 5 possible responses (1=Strongly Disagree through 5=Strongly Agree);* Higher scores represent better IPC attitudes

Research check list

Our article title had included the following point.

1. A structured abstract (max. 300 words) of: objectives, design, results and conclusion, or that meets the standards of the relevant reporting guideline (see below).
2. An 'Article summary' section consisting of three headings: 'Article focus' (up to three bullet points on the research questions or hypotheses addressed); 'Key messages' (up to three bullet points showing the key messages or significance of the study); and a 'Strengths and limitations of this study' section. This should be placed after the abstract.
3. The original protocol for the study, where one exists.
4. A funding statement, preferably worded as follows. Either: 'This work was supported by [name of funder] grant number [xxx]' or 'This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors'.
5. A competing interests statement.
6. Articles should list each author's contribution individually at the end; this section may also include contributors who do not qualify as authors.
7. Any checklist and flow diagram for the appropriate reporting sttement, e.g. STROBE (see below).
8. Any article that contains personal medical information about an identifiable living individual requires the patient's explicit consent before we can publish it. We will need the patient to sign our consent form, which requires the patient to have read the article. This form is available in multiple languages.