▲ Interprofessional Teamwork Skills as Predictors of Clinical Outcomes in a Simulated Healthcare Setting

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PURPOSE: Teaching interprofessional teamwork skills is a goal of interprofessional education. The purpose of this study was to examine the relationship between IP teamwork skills, attitudes and clinical outcomes in a simulated clinical setting. METHODS: One hundred-twenty health professions students (medicine, pharmacy, physician assistant) worked in interprofessional teams to manage a "patient" in a health care simulation setting. Students completed the Interdisciplinary Education Perception Scale (IEPS) attitudinal survey instrument. Students' responses were averaged by team to create an IEPS attitudes score. Teamwork skills for each team were rated by trained observers using a checklist to calculate a teamwork score (TWS). Clinical outcome scores (COS) were determined by summation of completed clinical tasks performed by the team based on an expert developed checklist. Regression analyses were conducted to determine the relationship of IEPS and TWS with COS. RESULTS: IEPS score was not a significant predictor of COS (p=0.054), but TWS was a significant predictor (p< 0.001) of COS. Results suggest that in a simulated clinical setting, students' interprofessional teamwork skills are significant predictors of positive clinical outcomes. CONCLUSION: Interprofessional curricular models that produce effective teamwork skills can improve student performance in clinical environments and likely improve teamwork practice to positively affect patient care outcomes. J Allied Health 2013; 42(1):e1–e6.

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TEAMWORK SKILLS are essential components of effective interprofessional collaboration. Communication failures and break-downs in team functions have been associated with medical errors.[1–3] The Institute of Medicine endorses effective communication and teamwork as essential components for the delivery of high quality and safe patient care.[4] Interprofessional competency frameworks developed in Canada and the United States both include teamwork skills as fundamental competencies for successful interprofessional collaboration.[5] Six national associations of schools of the health professions formed a collaborative promoting interprofessional education, the Interprofessional Education Collaborative (IPEC).[6]

Health professions students need opportunities to acquire and apply teamwork skills suitable for interprofessional collaborative practice, particularly within patient care contexts. High-fidelity simulators offer a unique learning experience for health professions students. A human patient simulator is a mannequin interfaced with a computer program that can produce physiologic responses to student actions including changes in the mannequin's simulated heart rhythm, blood pressure, respiratory rate, pulse and heart sounds. Human patient simulators provide a context for students to assume the responsibility for patient care without compromising the safety of the patient, and to practice the role of a specific health profession in a patient care team.[7] Furthermore, the simulators present a rich learning environment for the application of teamwork skills in an interprofessional context. Few interprofessional simulations that include health professions students are reported in the literature and the majority of results are limited to pilot data. Reports suggest that health professions students learning in interprofessional simulated environments has positive outcomes in that students enjoy the experience, their attitudes toward interprofessional collaboration improve, and team communication skills improve.[8–12]

Team training, including the use of simulations, for licensed healthcare professionals has been associated with improvements in patient outcomes and a decrease in adverse events.[13–16] Compared to the data for practicing healthcare teams, student outcomes related to evaluation of teamwork and clinical outcomes using simulations is limited. A study of medical students used a simulated healthcare environment and determined an association between

positive teamwork skills and positive clinical performance.[17] Within an interprofessional education context, what might be the clinical performance of students from different professions working together as a team in a simulated environment? The purpose of this study was to determine if interprofessional teamwork skills, including attitudes, predict clinical outcomes for the simulated patient being cared for by the student interprofessional healthcare team. The specific hypotheses were:

1) Interprofessional teamwork by students will positively influence clinical outcomes as measured by team scores on observational checklists.
2) Positive attitudes toward working with students from different professions will positively influence interprofessional teamwork by students as measured by surveys and checklists.

Methods

The study took place on an academic health science campus that is implementing a major interprofessional education initiative across its six colleges.[18] Students in this particular interprofessional activity had participated in the university's Interprofessional Day (IP Day) as first and where applicable, second year students (medical and pharmacy students).[19] During first year and second-year student IP Day, students learn more about each other's profession and the importance of interprofessional collaboration in healthcare; students do not engage in specific teamwork activities as part of the event. None had experienced interprofessional teamwork in a purposeful manner during clinical rotations, as this requirement similarly was not in place during their education.

One hundred and twenty health professions students including fourth-year medical students (*n*=25), third-year pharmacy students (*n*=76), and first-year physician assistant (PA) students (*n*=19) participated in a high-fidelity simulation, caring for a patient like they were attending hospital rounds. All of the pharmacy students were required to participate as part of a required clinical assessment course; the fourth-year medical students and first-year physician assistant students were required to participate depending on what experiential rotation they were completing. All students involved were provided with formative evaluations of their performance; no students were formally graded on the simulation. The students were divided randomly into twenty-four teams consisting of five members (one medicine, one PA, three pharmacy students). Each team was newly formed and members did not have experience working together prior to the simulation. The study was approved by the institutional review board.

The interprofessional teams participated in a 15-minute orientation in which a course instructor explained the objectives of the experience and the function of the simulator mannequins. The students also conducted team introductions and discussed potential interprofessional team roles (e.g., establish a team leader, recorder for medical orders,

what each profession may contribute to patient care). After the orientation, the interprofessional teams were directed to the patient room where each was provided with the patient's medical record and given 10 minutes to review and begin team discussions. After 10 minutes, the simulation commenced and the team cared for the simulated patient just as they would for an actual patient during hospital rounds. They conducted a patient interview and physical examination, ordered laboratory and diagnostic tests, observed vital signs on the patient monitor, and ordered medications. Teams were instructed to use a whiteboard serving as the official patient order sheet to record team treatment decisions. Each team encounter was video-recorded. The interprofessional team was allotted 20 minutes to stabilize and treat the patient; then course instructors debriefed the team. Instructors were guided to debrief the team on both interprofessional/team communication and clinical skills. The simulated interprofessional rounding experience was developed around a case in the medical safety literature where the patient was unstable due to a gastrointestinal bleed caused by a medical error and medicine interaction.[20,21] The patient scenario was complex and required expertise from multiple health professions for the best outcomes.

As part of the study, students were asked at the time of the activity orientation, to individually complete the Interdisciplinary Education Perception Scale (IEPS).[22] In addition to the IEPS items, this instrument also contained items to collect demographic information about the student: age, race, and gender. The IEPS instrument was used as a measure of students' attitudes toward collaboration since it has been widely used in the literature to assess learners attitudes.[23,24] It consists of 18 items and measures students' professional perceptions (scale used 1=strongly disagree; 5=strongly agreed)[25] relative to their own profession and other health professions through four scales: 1) competence and autonomy, 2) perceived need for cooperation, 3) perception of actual cooperation, and 4) understanding others' values. Since our unit of analysis was the team and the team's performance, students' individual responses to items were grouped by student interprofessional team and then averaged to determine a team IEPS score (IEPS).

A clinical outcomes checklist was developed by the investigators to determine the effectiveness of each team's decision making in the patient care process. The checklist was validated by interprofessional faculty experts in the fields of primary care, cardiology, and emergency medicine using a modified Delphi technique. The patient scenario was provided to the faculty experts along with potential clinical steps and each expert was asked to rate the importance of each clinical step for stabilizing the patient. The checklist consisted of 20 items and corresponded to clinical steps, including medication administration that would provide an optimal patient outcome. The clinical items were weighted depending on how critical they were for patient care to acutely stabilize the patient. For example, ordering intravenous fluids and Vitamin K were weighted more

TABLE 1. Regression Model of Teamwork Score and IEPS Score Predicting Clinical Outcome Score

Model	B	Std error	β	p
Constant	−60.276	25.526		0.028
Teamwork score (TWS)	0.440	0.099	0.659	<0.001
IEPS score (IEPS)	0.680	0.333	0.303	0.054

NOTE: adjusted R^2=0.495

TABLE 2. Respondent Demographic Characteristics

Age group	%	Race	%	Gender	%
20–25	55.6	Asian	7.8	Male	28.7
26–29	32.5	Black or African-		Female	71.3
30–35	10.3	American	2.9		
36–39	1.7	White	89.2		

heavily than ordering a cardiology consult. The clinical outcomes for each team was scored by a member of an interprofessional faculty pair (PharmD and MD or PharmD and PA) located in a simulation booth where one person controlled the computerized checklist. The clinical outcomes score (COS) was calculated for the teams' clinical performance using the weighted clinical outcomes checklist.

To assess teamwork performance of the interprofessional team of students, a teamwork evaluation instrument was created by the investigators. We were unable to locate reports of validated interprofessional teamwork ratings instruments designed for student assessment that evaluated teamwork and communication skills necessary in a clinical environment. Therefore, we modified the TeamSTEPPS team performance observation tool to create an assessment for students when they participate in a single interprofessional exercise in a newly formed team for a patient that was not in critical condition.[26] The rating scale used the same dimensions of TeamSTEPPS including: team structure, leadership, situation monitoring, mutual support, and communication. In some of the dimensions, team performance measures were removed if they were not applicable to our clinical scenario. The teamwork evaluation instrument is found in Appendix 1.

Two faculty members (from medicine and pharmacy) were trained to use the behaviorally anchored interprofessional teamwork scale and were blinded to the COS for each team. The trained faculty members independently rated the interprofessional teams using the teamwork rating scale by observing the recorded videos of the simulated rounding experience. They then met to discuss their independently rated scores and to reconcile any scores with a difference greater than 1 point between themselves. For five teams (20%), it was necessary to reconcile the scores. For each team, the scores for each of the dimensions were summed to calculate a total score. Each observer rated the overall team performance using the rating scale and their scores were averaged to determine a teamwork score (TWS) for each interprofessional team.

Descriptive statistics were conducted on demographic variables. Descriptive statistics were calculated for the IEPS, COS, and TWS. Regression analysis with COS as the dependent variable and the TWS and IEPS scores as independent variables was conducted. Additionally, regression analysis was conducted with each of the IEPS sub-scales from each of the teams. All data management and statistical analyses were performed using IBM SPSS Statistics version 19 software.

Results

Twenty-four teams of students were included in the analysis (see Table 2). A forced entry multivariate regression model with COS as the dependent variable and TWS and IEPS as independent variables was calculated (see Table 3) with an F=12.26 (p<.001). The IEPS was a not a significant predictor of COS (p=.054), however, the TWS was a significant predictor (p<0.001) of COS, and model R^2=.539 (see Table 1). When the IEPS four subscales were used within the model, none of the subscales was a significant predictor. Pearson correlation between TWS and IEPS was 0.032 and not significant. There was evidence of a positive relationship between teamwork scores predicting clinical outcomes in a simulated healthcare environment.

Discussion

Development of teamwork skills is an essential foundation for effective collaborative practice. Health care simulation using high-fidelity human patient simulators offers a unique learning environment for health professions students to practice interprofessional clinical care. Health care simulation has been associated with improving students' attitudes toward interprofessional collaboration and teamwork communication skills.[8–12] To our knowledge, there have been no reports in the literature that have demonstrated the relationship between interprofessional teamwork, including attitudes, and clinical outcomes in a simulated clinical environment for health professions students.

Table 3. Team Clinical Outcome, Teamwork and IEPS Scores

Measure	Mean	Range	SD
Clinical Outcomes Score (COS)	25.22 (out of 43)	13–37	7.44
Teamwork Score (TWS)	80.75 (out of 110)	61.5–97.5	11.13
IEPS Score (IEPS)	73.42 (out of 82)	68.75–79.0	3.31

Our results indicate that effective interprofessional teamwork skills applied in health care simulation are predictive of positive clinical outcomes, as measured within this setting. Work by Wright et al. indicated that medical student teamwork was associated with positive clinical performance in a simulated setting; however, the teams consisted of only one health profession.[17] Our work provides evidence that effective interprofessional teamwork is associated with positive clinical outcomes in a health care simulation setting in a large cohort of students. The results of our study go beyond other reports examining student learning in interprofessional simulated environments because we evaluated the effects on clinical outcomes and not student attitudes and satisfaction. These findings suggest that students were able to transcend their uni-professional training, including perhaps their unique professional identities, to apply teamwork skills and work collaboratively as effective interprofessional teams. Student teams that were able to draw upon members' unique professional knowledge and skills (i.e., medical student asking pharmacy student for medication-related information) appear to have performed better than those that were not able to do this.

Professionalization in health care training, with professions possessing distinct social identities, roles, and areas of expertise, has been cited as a significant barrier to interprofessional education and practice.[27–30] Whitehead describes aspects of medical education and socialization that impart the hierarchical characteristics found in health care, including power differentials between physicians and other health professionals.[28] These aspects hinder interprofessional education, and by inference, interprofessional teamwork. While our study sought to examine the relationship between interprofessional teamwork skills and clinical outcomes in a simulated environment, theoretical perspectives on professionalization, social categorization, and social identity, provide some context for possible interpretation of the findings and more importantly, for future work.[27, 30] Perhaps the traditional hierarchy within health care training may be more permeable in the emerging context of interprofessional education. Maybe a newer generation of practitioners will develop professional social identities and social categorizations that deconstruct the traditional hierarchy and permit more easily achieved interprofessional collaborative relationships. This is clearly one of the goals of interprofessional education.

Interestingly, we found that while students' attitudes toward interprofessional collaboration were closely associated with positive clinical outcomes, they were not significant predictors. Since we examined attitudes by team, it may be that there was an insufficient number of team observations ($n=24$) for sufficient analytical power. Or, examination of students' attitudes at the individual level, and not team level, may result in different findings. Debate exists in the field regarding assessment of student attitudes, including psychometric properties of the various instruments reported in the literature.[23] In light of the debate, we chose the IEPS because it has established psychometric properties and has been widely used in the literature.[23-25,] Other instruments measuring attitudinal aspects of collaboration may find a stronger relationship than our results indicated. While our hypothesis was that positive attitudes toward interprofessional collaboration would be associated with improved teamwork and positive clinical outcomes, it may be that positive attitudes toward interprofessional collaboration facilitate effective teamwork, but are not a necessary component if team members have the essential teamwork skills to work together. Clearly, the relationship of attitudes toward collaboration and outcomes needs further research.

While our findings add to the literature, this study is not without limitations. First, there was an unequal distribution of students representing different health professions in each team and this imbalance may not have authentically represented the interprofessional team dynamic in a real clinical setting. In addition, nursing students were not represented within the team due to scheduling conflicts. The student groups also had varying levels of didactic and clinical experience. It is unclear if these imbalances influenced clinical outcomes or teamwork scores. A validated teamwork rating scale would have improved our results; however, for educational purposes of the clinical scenario it was necessary to use a modified assessment instrument. The development and testing of teamwork instruments particularly for students to be used in a clinical environment, is an area for future research. Regarding the examination of student attitudes, teamwork and clinical outcomes, as discussed above, other instruments may have found a stronger relationship than our results indicated. Due to the regression analysis study design, we were unable to conclude that this interprofessional simulation produced students with improved teamwork skills. Debriefing data were not collected for purposes of this study; this information could have been used as an additional measure of student attitudes regarding interprofessional teamwork and collaboration. Different approaches to the study design including pre/post evaluation of teams undergoing training or randomizing teams consisting of a single health profession compared to teams consisting of interprofessional members would have strengthened our results. All of these limitations could be considered for areas of future research.

Conclusion

This study provides evidence that interprofessional teamwork, when used effectively, is associated with positive clinical outcomes in a simulated clinical environment for health professions students, including medical students. Interprofessional curricular models that produce effective teamwork skills can improve student performance in clinical environments and likely improve teamwork practice to positively affect patient care outcomes.

REFERENCES

1. Tully MP, Ashcroft DM, Dornan T, Lewis PJ, Taylor D, WassV. The causes of and factors associated with prescribing errors in hospital inpatients: a systematic review. *Drug Saf*. 2009; 32: 819–36.

2. Freitag M, Carroll VS. Handoff communication: using failure modes and effects analysis to improve the transition in care process. *Qual Manag Health Care*. 2011: 20: 103–9.

3. Woods DM, Holl JL, Angst D. Improving clinical communication and patient safety: clinician-recommended solutions. In Henriksen, et al. (Eds.), *Advances in Patient Safety: New Directions and Alternative Approaches* (Vol. 3: Performance and Tools). Rockville (MD): Agency for Healthcare Research and Quality; 2008.

4. Committee on Quality Health Care in America, Institute of Medicine. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academy Press; 2001.

5. Interprofessional Education Collaborative Expert Panel. *Core competencies for interprofessional collaborative practice: Report of an expert panel.* Washington, DC: Interprofessional Education Collaborative; 2011.

6. Schmitt M, Blue AV, Aschenbrener CA, Viggiano TR. Core competencies for interprofessional collaborative practice: reforming health care by transforming health professionals' education. *Acad Med*. 2011; 86: 1351.

7. Friedrich M. Practice makes perfect: risk-free medical training with patient simulators. *J Am Med Assoc*. 2002; 288: 2808–12.

8. Robins L, Brock DM, Gallagher T, et al. Piloting team simulations to assess interprofessional skills. *J Interprof Care*. 2008; 22: 325–8.

9. Ker J, Mole L, Bradley P. Early introduction to interprofessional learning: a simulated ward environment. *Med Educ*. 2003; 37: 248–55.

10. Kyrkjebo J, Brattebo G, Smith-Strom H. Improving patient safety by using interprofessional simulation training in health professional education. *J Interprof Care*. 2006; 20: 507–16.

11. Van Soeren M, Macmillan K, Cop S, et al. Development and evaluation of interprofessional care practices through clinical simulation. *J Interprof Care*. 2009; 23: 304–6.

12. Robertson B, Kaplan B, Atallah H, et al. The use of simulation and a modified TeamSTEPPS curriculum for medical and nursing student team training. *Simul Healthc*. 2010; 5: 332–7.

13. Catchpole K, Mishra A, Handa A, McCulloch P. Teamwork and error in the operating room: analysis of skills and roles. *Ann Surg*. 2008; 247: 699–706.

14. Leonard M, Graham S, Bonacum D. The human factor: the critical importance of effective teamwork and communication in providing safe care. *Qual Saf Health Care*. 2004; 13(Suppl 1): i85–i90.

15. Shapiro MJ, Morey JC, Small SD, et al. Simulation based teamwork training for emergency department staff: does it improve clinical team performance when added to an existing didactic teamwork curriculum? *Qual Saf Health Care*. 2004; 13: 417–21.

16. Siassakos D, Fox R, Crofts JF, et al. The management of a simulated emergency: better teamwork, better performance. *Resuscitation*. 2011: 82: 203–6.

17. Wright MC, Phillips-Bute BG, Petrusa ER, et al. Assessing teamwork in medical education and practice: relating behavioural teamwork ratings and clinical performance. *Med Teach*. 2009; 31: 30–8.

18. Blue A, Mitcham M, Smith T, et al. Changing the future of health professions by embedding interprofessional education with an academic health center. *Acad Med*. 2010; 85: 1290–95.

19. Hall PD, Zoller JS, West VT, et al. A novel approach to interprofessional education: Interprofessional Day, the four-year experience at the Medical University of South Carolina. *J Res Interprof Pract Educ* 2001; 2: 49–62.

20. Institute for Safe Medication Practices [internet]. ISMP Medication Safety Alert. Horsham (PA): 2011, Available at: http://www.ismp.org/newsletters/acutecare/articles/20080925-1.asp. Accessed: Mar 25, 2012.

21. Shrader S, McRae L, King W, Kern D. Simulated interprofessional rounding experience in a clinical assessment course. Am J Pharm Educ. 2011; 75: Article 61.

22. Luecht R, Madsen M, Taugher M, Petterson B. Assessing professional perceptions: design and validation of an interdisciplinary education perception scale. *J Allied Health*. 1990; Spring: 181–91.

23. Thannhauser J, Russell-Mayhew S, Scott C. Measures of inteprofessional education and collaboration. *J Interprof Care*. 2010; 24 :336–49.

24. Baker C, Pulling C, McGraw R, et al. Simulation in inteprofessional educaton for patient-centred collaborative care. *J Adv Nurs*. 2008; 64:372–9. Epub 2008 Sep 1.

25. Becker EA, Godwin EM. Methods to improve teaching interdisciplinary teamwork through computer conferencing. *J Allied Health*. 2005;34:169–176.

26. Agency for Healthcare Research and Quality [internet]. Team Performance Observation Tool; Rockville (MD): 2011, Available at: http://www.ahrq.gov/teamsteppstools/instructor/reference/tmpot.htm. Accessed: Mar 25, 2012

27. Friedson E. *Professionalism Reborn: Theory, Prophecy, and Policy*. Chicago, IL: University of Chicago Press, 2001.

28. Whitehead C. The doctor dilemma in interprofessional education and care: how and why will physicians collaborate? *Med Educ*. 2007; 41: 1010–16.

29. Ginsburg L., Tregunno D. New approaches to interprofessional education and collaborative practice: Lessons from the organizational change literature. *J Interprof Care*. 2005; 19: 177–87.

30. Sargeant J. Theories to aid understanding and implementation of interprofessional education. Journal of Continuing Education in Health Professions. *J Contin Educ Health Prof* 2009; 29: 178–84.

Appendix 1. Interprofessional Teamwork Evaluation.

Rating Scale:

1=very poor (basically did not occur); 2=poor (occurred minimally); 3=acceptable (occurred throughout but not consistently); 4=good (occurred majority of time); 5=excellent (occurred consistently).

Team Number: _____   Rater: _____

Team Structure	1	2	3	4	5
Team leader established and evident (ok to shift over course of interview, leader still clear)					
Roles and responsibilities established (support member roles clear; pharmacists give drug recommendations, a member transcribes chart orders, etc.)					
All clinical roles represented (e.g. patient interview, medication history/review; diagnostic exam; treatment plan)					
Clinical roles shared among members of the team (e.g. more than one person fulfills roles above)					
Actively share information among team members (e.g. shares results of EKG or physical exam with entire team)					
Leadership (the team leader)	1	2	3	4	5
Balances workload with team (team leader not dominating entire encounter)					
Delegates tasks, unanswered clinical questions as appropriate (e.g. MD/PA seeks drug information from pharmacy students)					
Conducts briefs, huddles and debriefs throughout the patient encounter (summarizes, team reviews thoroughly/systematically what has happened, what still needs to be addressed, etc)					
Empowers team members to speak freely and ask questions (minimal time spent dominating encounter and providing one-way orders just coming from leader)					
Situation Monitoring	1	2	3	4	5
Includes patient in conversation and the encounter (should occur throughout the scenario)					
Cross monitors fellow team members (other team members find out information being exchanged and decisions being made in side conversations)					
Update team members on patient status (e.g. blood pressure is dropping)					
Team members share focus on patient problem and outcome (e.g. all focused on bleeding rather than side issues)					
Mutual Support	1	2	3	4	5
Members provide task related support (e.g. PA may do diagnostic checks after MD to see if agree with findings, pharmacy student may help the order transcriber write appropriate med orders without using unapproved abbreviations)					
Advocates for the patient (e.g. "let's think about what's in the patient's best interest")					
Team members are properly assertive (e.g. willing to participate, speak up, acknowledge disagreement with team members assessment, actively and openly discuss alternatives)					
Collaborates with team members (e.g., discuss things among each other in smaller groups first)					
Communication	1	2	3	4	5
Introduction of team members to patient					
Members provide brief, clear, specific and timely information/recommendations to other members					
Members seek information from all available team members (e.g. ask for help; second set of eyes; solicit opinions)					
Verify information that is communicated is accurate (e.g. clarify when there uncertainty or disagreement, information is verified and confirmed)					
Member side conversations are openly communicated with team as a whole					
Overall Total Score					