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Traditional Nurse Triage vs. Physician Tele-Presence in a Pediatric Emergency Department

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Abstract

Objectives—To compare traditional nurse triage (TNT) in a Pediatric Emergency Department (PED) to physician tele-presence (PTP).

Methods—Prospective, 2×2 crossover study with random assignment using a sample of walk-in patients seeking care in a PED at a large, tertiary care children's hospital, from May 2012 to January 2013. Outcomes of triage times, documentation errors, triage scores, and survey responses were compared between TNT and PTP. Comparison between PTP to actual treating PED physicians regarding the accuracy of ordering blood and urine tests, throat cultures, and radiologic imaging was also studied.

Results—Paired samples t-tests showed a statistically significant difference in triage time between TNT and PTP ($p=0.03$), but no significant difference in documentation errors ($p=0.10$). Triage scores of TNT were 71% accurate, compared to PTP, which were 95% accurate. Both parents and children had favorable scores regarding PTP and the majority indicated they would prefer PTP again at their next PED visit. PTP diagnostic ordering was comparable to the actual PED physician ordering, showing no statistical differences.

Conclusions—Utilizing physician tele-presence technology to remotely perform triage is a feasible alternative to traditional nurse triage, with no clinically significant differences in time, triage scores, errors and patient and parent satisfaction.

Keywords

triage; physician tele-presence; pediatric emergency medicine

Introduction

Emergency Departments (EDs) around the country have become strained to capacity. Within the last decade, the number of EDs have decreased, while the number of ED visits have

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increased [1]. In April 2009, the United States Government Accountability Office submitted a report to the Chairman of the Committee of Finance in the U.S. Senate indicating that EDs nationwide have become more overcrowded with longer wait times and lengths of stay [2]. ED overcrowding has been associated with decreased patient satisfaction [3], decreased staff satisfaction and productivity [4,5], and most importantly, worse patient outcomes [6,7]. With limited healthcare resources, innovations to improve patient safety and efficiency are needed [8,9].

The implementation of physician tele-presence (PTP) in the field of medicine might be an innovation helpful in providing care. Currently, there is limited literature on the use of PTP in an ED or pediatric setting. Thus far, adult and geriatric-related research indicates that tele-presence and robotic technology may productively be used in post-stroke rehabilitation [10], postoperative rounding on patients [11], and personal services for the elderly [12]. Regarding attitudes, a 2010 study by Broadbent, et al. showed that individuals over 40 years of age viewed the use of this technology in healthcare as having benefits, but some participants had concerns about reliability, safety and loss of personal care [13]. With the advent of the Internet and video games, the pediatric population may be more willing to accept physician tele-medicine and more apt to assimilate to changing technology in healthcare than the adult patient population [14].

Up until now, innovations to improve ED efficiency have mostly concentrated on throughput; moving patients efficiently and safely upon their arrival to the ED [15,16]. Studies have shown sporadic decreased lengths of stay with modifications, such as diagnostic ordering beginning at triage [17,18] and having interchangeable physician and nurse presence in triage [19–22].

The primary goal of this study is to compare the utility of traditional nurse triage (TNT) in a pediatric ED to PTP in triage. Additionally, a secondary goal of the study is to compare the diagnostic ordering of PTP to the actual PED physician. This study is an initial step in demonstrating the feasibility of PTP as an alternative to standard nurse triage without physically placing a physician in triage.

Methods

Study Design

This 2×2 crossover study was conducted utilizing a sample of walk-in patients seeking care in the PED from May 2012 to January 2013. The study was submitted and approved by the Institutional Review Board (IRB) at the study institution. Prior to data collection, reliability of PTP was performed by 3 study physician-investigators. This assessment began with the 3 physicians observing the same 11 TNT sessions consecutively and independently reporting a triage score for each patient triaged. The study physician-investigators performed these assessments without discussing the scoring decisions with each other. Two intraclass correlation coefficients were computed, (i.e., mixed model ICCs), one for the absolute agreement (i.e., degree to which all physicians assigned exactly the same triage score for each TNT session) and the other for consistency (i.e., degree to which all physicians shared the same reporting pattern, such as consistently assigning high or low triage scores) [23].

Study Setting and Population

The study was performed at a large, tertiary care children's hospital with an approximate annual PED visit volume of approximately 65,000. Patients arriving with a parent or legal guardian to the PED who appeared stable as assessed by the ED nurse screener, were approached by a study investigator or research assistant to participate in the study. Patients were excluded if they arrived via an ambulance or air transport, appeared in significant

respiratory distress were in imminent need of cardiopulmonary resuscitation, or if they appeared unstable to the ED nurse screener based on their clinical impression.

Study Protocol

After informed consent was obtained, patients were randomized to receive either TNT or PTP first. Computer-generated randomization lists were constructed using the website *random.org* [24]. After completing the first triage, patients were accompanied to an adjacent room to complete the alternate triage method. No patient was denied standard of care (TNT), and parents or patients who declined to participate, received TNT. Parents could voluntarily withdraw their child from the study at any time.

TNT was performed according to standard ED triage protocols using the Emergency Severity Index (ESI) Triage System [25]. Triage procedures included gathering vital signs, administering antipyretics or analgesics as indicated, providing triage first aid, obtaining a brief history, and performing a tailored physical examination. Triage nurses documented their findings on the institutional paper triage form as part of the medical record. The 5-level ESI system is designed to triage patients based on the number of resources potentially needed and acuity level. Table 1 shows the different levels of the ESI system.

PTP was performed in the adjacent triage room using a RP-7i robot, which is a mobile, remote-controlled tele-presence technology with full audio and video capabilities, including a built-in stethoscope (InTouch Health, Santa Barbara, CA). The RP-7i combines remote control robotics and remote presence technologies, allowing a remote clinician to see and interact with patients and staff while managing care delivery [26]. The investigators controlling the RP-7i were ED physicians, board-certified in Pediatrics or Pediatric Emergency Medicine. PTP performed the same tasks as the triage nurse, including documenting findings on an identical blank paper triage form. In addition, the PTP documented the decision to perform various tests, such as asking for urine testing, a throat swab for rapid streptococcal testing, blood tests and radiographs, all of which could potentially be performed in the ED, if ordered by the treating ED physician. A comparison was made between the tests ordered by the treating physician in the ED and the tests ordered by PTP during the triage evaluation. The patient's treating physician made the actual decision to order the tests performed. Physical tasks requiring touch, such as the placement of a stethoscope were performed by a Patient Care Service Assistant (PCSA), or similarly trained research assistant (RA) in concert with the remotely stationed physician. The PCSAs were employees of the hospital and the RAs were volunteers, and all were EMT trained. Vital signs – including temperature, heart rate, blood pressure, respiratory rate, oxygen saturation, and weight of patient and administration of medications, such as antipyretics or analgesics were not repeated during PTP.

The triage nurse was separated from the RP-7i in a separate, soundproof triage room. The monitoring of time for both versions of triage included measuring history taking and the triage physical examination; time taken for vital signs and medication administration, which were not necessarily done concurrently, was subtracted from the total TNT timing. To ensure accurate timing, 2 research assistants independently measured all versions of triage using stopwatches for all study patients. The triage nurse and PTP were blinded to the ordering of the 2 forms of triage and details obtained in the alternate method of triage. Once both triage assessments were completed, the patient and family exited the triage area and entered the ED as per standard of care, and a survey interview regarding their views about PTP vs. TNT was read to them while awaiting treatment in the ED. The survey consisted of nine 5-point Likert items and one yes-no item for assessing appropriateness, feasibility, enjoyment, and acceptability of the RP-7i, which was completed by each parent and also by patients older than 7 years. Survey questions were derived and developed by the primary

investigator, with collaboration from all co-investigators. Parents and patients were separated when surveys were conducted in order to assure independent, non-influenced responses. Item scores greater than three on the Likert represented positive responses to PTP [27].

Documentation errors were counted for both forms of triage. Errors were defined as information missing or skipped on the triage form (e.g., date, start and stop time of triage, patient name, date of birth, past medical history, and the different parts of the physical examination separated by systems). There were 27 separate items on each triage form that were required by the institution for complete triage documentation; missing values on any of the 27 items counted as errors. Because vital signs and weight were not measured by PTP, these items were not counted as errors if missing.

Measures and Outcomes

The primary outcome variables were triage time, documentation errors, triage scoring, parent and patient attitudes toward PTP. A secondary outcome evaluated was diagnostic testing agreement between PTP and the treating ED physician.

Rationale

To show the utility of tele-presence in medicine, the scope of this pilot study included evaluating PTP as an alternative method to TNT in a PED. Although it was not the aim of the study, one might possibly surmise the generalizability of using PTP to help out a rural healthcare setting lacking subspecialists, accepting facilities coordinating critical care transports or disaster and surge conditions. Costs and efficiency were beyond the scope of this study. The design of the study utilized 2 groups (TNT and PTP) that were inherently not equivalent. Only 3 physicians were trained in using the tele-presence equipment. Given the cross-over design, a 3rd arm, in addition to the physicians who were trained in operating the tele-presence equipment, was not possible. By necessity, the study was a first attempt to show that PTP could be effective and useful in triage. Although nurse triage and physician triage are not equal, within the framework of the PED and the inability to compare like personnel, it was our hope to show that PTP can be useful modality.

Data Analysis

IBM Statistical Package for the Social Sciences (SPSS) for Windows (Version 19, IBM Corp., Armonk, NY, 2010) was used for all analyses. Since the study was a 2×2 crossover design, the Hills-Armitage approach was used to test for period effects and unequal carryover effects, which are limitations of the crossover design [28]. The *conditions* in this study were TNT and PTP. A *period* is defined as an occasion on which a condition is applied. In our study there was only one period per condition. A potential *period effect* in the study was considered to be whether the PTP or TNT condition was implemented first or second and if this affected outcomes. In other words, sequences could affect the outcomes. To test for period effects, crossover differences (i.e., difference between PTP and TNT) were compared between sequences. *Unequal carryover effects* were considered to be outcomes of one condition that were affected by the condition from the previous period. To test for unequal carryover effects, the sums between the first period and the second period were compared between sequences. If no period effects and no unequal carryover effects were found, the paired samples t-test could be used to compare PTP and TNT outcomes within each patient. Regarding the sample size calculation, based on the two-tailed paired samples t-test, setting $\alpha=0.05$ and power at 80% to detect a small effect size would require at least 70 participants.

For both parent and patient surveys, internal consistency of the nine Likert items altogether were analyzed using Cronbach's α , and one item per version was deleted if its item-total correlation was <0.10 so that mean total scores were computed based on 8 items altogether. Summary statistics (e.g., means) were used to examine parent and patient attitudes toward PTP.

Finally, Fisher's exact test and kappa were used to examine diagnostic testing agreement between PTP and the treating physician. All statistical tests were two-tailed at $\alpha=0.05$.

Results

The reliability of PTP was evaluated using ICCs prior to data collection. Absolute agreement ICC (single measure) was 0.97 (95% CI 0.93–0.99). Consistency ICC (average measures) was 0.99 (95% CI 0.96–0.98). Both ICCs were high, thereby representing high PTP reliability.

Overall, a total of 132 families were approached to participate in the study. During this 8-month study period, 100 patients (54 males, 46 females) agreed to participate (76% of total approached), of which the mean age was 5.99 years (SD=4.34, range 1 to 15). Given the 2×2 crossover design of the study with random assignment, 54 of 100 participating patients were seen by PTP first and TNT second, and the remaining 46 were seen by TNT first and PTP second. Among the 32 patients who declined (13 males, 19 females), the mean age was 5.77 years (SD=4.61, range 1 to 17). There were no statistically significant differences in gender distribution ($p=0.27$) and age ($p=0.81$) between patients who accepted and declined participation. The most common reason for refusing participation was that the parent felt that their child was too sick to be a study participant.

Table 2 shows means for TNT and PTP triage time and documentation errors. Mean TNT triage time was 2.79 minutes and mean documentation errors were 0.32 per 27 potential errors. Mean PTP triage time was 3.00 minutes and mean documentation errors were 0.18 per 27 potential errors. There were no period effects and no unequal carryover effects found for triage time ($p=0.63$ and $p=0.53$, respectively) and documentation errors ($p=0.29$ and $p=0.10$, respectively). Therefore, the paired samples t-test showed a statistically significant difference in triage time between TNT and PTP ($p=0.03$). The paired samples t-test showed no significant difference in documentation errors ($p=0.10$).

Table 3 shows the TNT and PTP triage scoring compared to the actual triage score, verified by what was actually done by the treating PED physician for the patient following the patient's ESI triage assignment.

Table 4 shows the difference between TNT and PTP for survey scores. The mean total scores for parents and patients showed a positive overall response to PTP. Patients were more likely than parents to request PTP again at their next visit to the ED.

Table 5 shows diagnostic orders by PTP and the actual treating PED physician. Overall, PTP was comparable to the treating ED physician.

Discussion

PTP has been shown to be an effective method to allow physicians stationed off-site to perform effectively in triage with diagnostic capabilities. This had been shown in adult medicine for burns [29] and myocardial infarctions [30], but PTP has not been studied extensively in general triage situations, particularly in a PED. Overall, PTP is comparable to TNT in terms of triage time, errors and scoring. Additionally, PTP diagnostic ordering

practices are comparable to the treating PED physician. The option to start patient care in triage may have many advantages including, improved care, patient flow, wait times, lengths of stay and cost effectiveness. PTP has the capability of functioning from alternative locations; even from another state or country. This pilot study is an initial evaluation demonstrating the feasibility of PTP in a unique clinical setting.

There was a statistically significant difference in triage time between TNT and PTP. TNT nurses have more triage training than PTP, which might be one factor explaining the faster performance by TNT. Moreover, physicians are trained to take a more extensive history and perform a more comprehensive exam. Nonetheless, a clinical implication of this finding is that having physicians in triage evaluating patients and starting patient care might offset the slight delay in triage duration [31].

Our study showed no statistically significant difference in documentation errors made on the triage form between TNT and PTP, whereby both showed low rates of errors. Documentation errors are one of the many reasons medical errors occur within an ED [32]. Errors made on triage documentation may carry-on or contribute to subsequent documentation errors by the treating physician throughout the ED course; hence the importance of accurate documentation at the start of triage.

Triage scoring for PTP had higher agreement with actual triage score, in contrast to TNT who had lower agreement. Since triage scoring is linked to resource utilization (e.g., consultants called or bloodwork performed), the high agreement between actual and PTP triage scores may be interpreted as representing the more accurate and advanced knowledge PTP might have, which parallels patient care orders regularly occurring within the ED [33,34].

PTP was perceived as favorable on survey responses. As expected, patients were more likely to favor PTP than their parents. It is possible that children regularly exposed to new technologies, possibly more than their parents, are more open to accepting new technologies, including those offered in our study [35].

When comparing PTP to actual order entry by the treating PED physician, there were low frequencies of blood and throat testing ordered by both, which suggest that comparisons between the two regarding diagnostic testing should be considered tentative. Capturing data from more patients requiring blood and throat testing may clarify the difference in ordering patterns between PTP and the actual treating ED physician.

Although, our study used tele-presence technology to assist with triage, a alternative technology is being developed which shows promise in triage. A group of computer engineers at Vanderbilt University have created an automated robotic system, coined Triagebot, to perform many of the duties a traditional triage nurse would perform in an ED [36]. Because the system is not yet operational and it is not anticipated to be widely available for the next several years, the future of this form of technology is imminent. Therefore, there is great potential for tele-triaging in PEDs possible for several technological devices.

As with all new technologies, future studies are needed to look more directly at the impact of efficiency and cost savings with the implementation of PTP. Additionally, future research comparing TNT with a nurse tele-presence triage may offer another practical approach to triaging. In addition, PTP in triage might be beneficial in hospitals and other clinical care settings that do not routinely care for children by having a pediatrician or emergency physician on the premises. PTP may also provide a significant benefit to patients cared for in rural, small town hospitals that are not staffed with trained pediatricians or emergency

physicians. Similarly, PTP might be useful when transferring a patient to another institution, allowing the accepting physicians to see the patient prior to arrival.

Limitations

This was a pilot study looking at the feasibility of PTP to perform the duties of a triage provider within a PED. Because of the limited scope and relatively small population of patients studied, results may not be generalizable to other ED settings.

The design of the study compared TNT and PTP, not equivalent groups. Working within the already established design of the institution's ED, our control group (TNT) could not be changed or altered for patient care making it difficult to change the design of the study to make a more direct comparison.

The tele-presence technology used did not have arms making vital sign acquisition and providing first aid impossible without a human provider. The design of triage done in this study required a PCSA or RA to be with the patient and to assist with the functions the tele-presence technology could not perform independently. Vital signs and medication administration were done only during TNT. This made the timing of each form of triage less precise. Since vital signs and medication administration were not necessarily done concurrently, we used 2 research assistants to measure triage times independently using stopwatches. They each stopped the triage duration timing during TNT while vital signs were taken or medications, such as Tylenol or Motrin were given.

We did not enroll for critical (ESI Level 1) and emergent (ESI Level 2) patients, and only included participants who were triaged as urgent, semi-urgent, and non-urgent. By excluding true critical and emergent patients, we removed an aspect of triaging that might have defined other differences between TNT and PTP. Ethically, it was not appropriate to "double triage" those patients requiring immediate care.

Conclusions

Utilizing physician tele-presence technology to perform triage is a feasible alternative to traditional nurse triage, with no clinically significant differences in time, triage scores, errors and patient and parent satisfaction. Physician tele-presence is comparable to test ordering practices by the treating physician.

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References

1. Hsia RY, Kellermann AL, Shen YC. Factors associated with closures of emergency departments in the united states. JAMA. 2011; 305(19):1978–1985. [PubMed: 21586713]
2. Government Accountability Office. Hospital emergency departments: crowding continues to occur, and some patients wait longer than recommended time frames. Report to the Chairman, Committee of Finance, U.S. Senate; April 2009;
3. Bursch B, Beezy J, Shaw R. Emergency department satisfaction: what matters most? Annals of Emergency Medicine. 1993; 22:586–591.

4. Derlet RW, Richards JR. Overcrowding in the nation's emergency department: complex causes and disturbing effects. *Annals of Emergency Medicine*. 2000; 35:63–68.
5. Rondeau KV, Francescutti LH. Emergency department overcrowding: the impact of resource scarcity on physician job satisfaction. *Journal of Healthcare Management*. 2005; 50:327–340.
6. Bernstein SL, Aronsky D, Duseja R, et al. The effect of emergency department crowding on clinically oriented outcomes. *Academic Emergency Medicine*. 2008; 16:1–10. [PubMed: 19007346]
7. Fee C, Weber EJ, Maak CA, et al. Effect of emergency department crowding on time to antibiotics in patients admitted with community-acquired pneumonia. *Annals of Emergency Medicine*. 2007; 50:501–509.
8. Panda A, Dorairajan LN, Kumar S. Application of evidence-based urology in improving quality of care. *Indian Journal of Urology*. 2007; 23(2):91–96. [PubMed: 19675781]
9. Miyakis S, Karamanof G, Lontos M, et al. Factors contributing to inappropriate ordering of tests in an academic medical department and the effect of an educational feedback strategy. *Postgraduate Medical Journal*. 2006; 82:823–829. [PubMed: 17148707]
10. Mataric MJ, Eriksson J, Feil-Seifer DJ, et al. Socially assistive robotics for post-stroke rehabilitation. *Journal of NeuroEngineering and Rehabilitation*. 2007; 4(5):10.1186/1743-0003-4-5
11. Ellison LM, Nguyen M, Fabrizio MD, et al. Postoperative robotic telereounding. *Archives of Surgery*. 2007; 142(12):1177–1181. [PubMed: 18086984]
12. Roy, N.; Baltus, G.; Fox, D., et al. [Accessed 6/24/13.] Towards personal service robots for the elderly. *Computer Science and Robotics*. 2003. Available at: <http://www.cs.cmu/-nursebot>
13. Braodbent E, Kuo IH, Lee YI, et al. Attitudes and reactions to a healthcare robot. *Telemedicine and e-Health*. 2010; 16(5):608–613. [PubMed: 20575729]
14. Beran TN, Ramirez-Serrano A. Can children have a relationship with a robot? *Human-Robot Personal Relationships*. 2011; 59:49–56.
15. Asplin BR, Magid DJ, Rhodes KV, et al. A conceptual model of emergency department crowding. *Annals Emergency Medicine*. 2003; 42(2):173–180.
16. Yen K, Gorelick MH. Strategies to improve flow in the pediatric emergency department. *Pediatric Emergency Care*. 2007; 23(10):745–749. [PubMed: 18090112]
17. Copper JJ, Datner EM, Pines JM. Effect of an automated chest radiograph at triage protocol on time to antibiotics in patients admitted with pneumonia. *American Journal of Emergency Medicine*. 2008; 26(3):264–269. [PubMed: 18358934]
18. Kvriacou DN, Yarnold PR, Soltysik RC, et al. Derivation of a triage algorithm for chest radiography of community-acquired pneumonia patients in the emergency department. *Academic Emergency Medicine*. 2008; 15(1):40–44. [PubMed: 18211312]
19. Li J, Caviness AC, Patel B. Effect of a triage team on length of stay in a pediatric emergency department. *Pediatric Emergency Care*. 2011; 27(8):687–692. [PubMed: 21811202]
20. Parvoti SN, Nelson BK, Bryan ED, et al. Faculty triage shortens emergency department lengths of stay. *Academic Emergency Medicine*. 2001; 8(10):990–995. [PubMed: 11581086]
21. Choi YF, Wong TW, Lau CC. Triage rapid assessment by doctor TRIAD) improves waiting time and processing time of the emergency department. *Emergency Medicine Journal*. 2006; 23(4): 262–265. [PubMed: 16549569]
22. Travers JP, Lee FC. Avoiding prolonged waiting time during busy periods in the emergency department: Is there a role for the senior emergency physician in triage? *European Journal of Emergency Medicine*. 2006; 13(6):342–348. [PubMed: 17091056]
23. McGraw KC, Wong SP. Forming inference about some intraclass correlation coefficients. *Psychological Methods*. 1996; 1(1):30–46.
24. Haahr, M. [Accessed 4/15/12.] Random.org: True random number service. 2012. Available at: <http://www.random.org>
25. Gilboy, N.; Tanabe, T.; Travers, D., et al. Emergency Severity Index (ESI): A Triage Tool for Emergency Department Care, Version 4. Implementation Handbook 2012 Edition. Rockville, MD: Agency for Healthcare Research and Quality; Nov. 2011 AHRQ Publication No.12-0014
26. InTouch Health. [Accessed 12/9/13.] RP-7i Robot. Available at: <http://www.intouchhealth.com/products-and-services/products/rp-7i-robot/>

27. Wyatt RC, Meyers LC. Psychometric properties of four 5-point likert type responses scales. *Educational and Psychological Measurement*. 1987; 47(27):27–35.
28. Diaz-Uriarte R. Incorrect analysis of crossover trials in animal behavior research. *Animal Behaviour*. 2002; 63:815–822.
29. Saffle JR, Edelman L, Theurer L, et al. Telemedicine evaluation of acute burns is accurate and cost-effective. *Journal of Trauma*. 2009; 67(2):358–365. [PubMed: 19667890]
30. Chen KC, Yen DH, Chen CD, et al. Effect of emergency department in-hospital tele-electrocardiographic triage and interventional cardiologist activation of the infarct team on door-to-balloon times in ST-segment-elevation acute myocardial infarction. *American Journal of Cardiology*. 2011; 107(10):1430–1435. [PubMed: 21414598]
31. Rogg JG, White BA, Biddinger PD, et al. A long-term analysis of physician triage screening in the emergency department. *Academic Emergency Medicine*. 2013; 20:374–380. [PubMed: 23701345]
32. Fordyce J, Blank F, Pekow P, et al. Errors in a busy emergency department. *Annals of Emergency Medicine*. 2003; 42(3):324–333. [PubMed: 12944883]
33. Brillman JC, Doezema D, Tandberg D, et al. Triage: limitations in predicting need for emergency care and hospital admission. *Annals of Emergency Medicine*. 1996; 27(4):493–500. [PubMed: 8604869]
34. Chen SS, Chen JC, Ng CP. Factors that influence the accuracy of triage nurse judgment in emergency departments. *Emergency Medical Journal*. 2010; 27:451–455.
35. Oblinger, DG.; Oblinger, JL. Is it age or IT: first steps toward understanding the net generation. In: Oblinger, Diana G.; Oblinger, James L., editors. *Educating the Net Generation*. New York: EDUCAUSE; 2005. p. 2.1-2.20. Available at: <http://net.educause.edu/ir/library/pdf/pub7101b.pdf> [Accessed 7/3/13.]
36. Wilkes, DM.; Franklin, S.; Erdemir, E., et al. Heterogeneous artificial agents for triage nurse assistance. *Humanoid Robots, 2010 10th IEEE-RAS International Conference*; 2010. p. 130-137.

Table 1

Description of ESI Levels

Triage Level	Triage Coding	Description
1	Critical	Patients requiring immediate life-saving intervention
2	Emergent	Patients in high-risk situations; confused, lethargic, or disoriented or in severe pain or distress. OR Patients requiring many resources and have vital signs that exceed critical criterion
3	Urgent	Patients requiring many resources
4	Semi-urgent	Patients requiring 1 resource
5	Non-urgent	Patients requiring no resources

Table 2

TNT and PTP for triage errors and time

		TNT	PTP
Time (minutes)	Mean	2.79	3.00
	SD	0.90	0.63
	Range	1.17–6.00	1.70–5.28
	95% CI of mean	2.61, 2.97	2.87, 3.12
	P value	0.03	
Errors (total number)	Mean	0.32	0.18
	SD	0.63	0.50
	Range	0–3	0–3
	95% CI of mean	0.19, 0.45	0.08, 0.28
	P value	0.10	

Table 3

TNT and PTP triage score accuracy compared to the actual triage score

Triage Scoring	TNT	PTP
Incorrect Scoring (count)	29	5
Accuracy (%)	71%	95%
95% CI of Accuracy	62–80%	91–99%

Table 4

TNT and PTP survey results

		Parent (n=100)	Patient (n=36)
Survey	Cronbach's α *	0.73	0.69
	Mean Total Score	30.75	29.95
	SD	4.19	4.69
	Range	20–38	22–40
	95% CI	29.50, 31.33	29.16, 32.34
Preferred PTP next ED visit		59%	83%

* One item deleted per parent and patient survey due to item-total correlation <0.10; maximum total possible score for both versions (8 items each) is 40

Table 5

Diagnostic orders by PTP and treating PED physician

		Blood studies	Throat culture	Urine studies	Radiographic studies
PTP	Total ordered	5	2	20	25
	Total not ordered	95	98	80	75
Actual ED physician	Total ordered	2	4	17	19
	Total not ordered	98	96	83	81
P-value		0.445	0.683	0.716	0.394
Kappa		0.56	0.66	0.83	0.83