

# Does Robotic Telerounding Enhance Nurse–Physician Collaboration Satisfaction About Care Decisions?

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## Abstract

**Background:** Delivering healthcare using remote robotic telepresence is an evolving practice in medical and surgical intensive critical care units and will likely have varied implications for work practices and working relationships in intensive care units. Our study assessed the nurse–physician collaboration satisfaction about care decisions from surgical intensive critical care nurses during remote robotic telepresence night rounds in comparison with conventional telephone night rounds. **Materials and Methods:** This study used a randomized trial to test whether robotic telerounding enhances the nurse–physician collaboration satisfaction about care decisions. A physician randomly used either the conventional telephone or the RP-7 robot (InTouch<sup>®</sup> Health, Santa Barbara, CA) to perform nighttime rounding in a surgical intensive care unit. The Collaboration and Satisfaction About Care Decisions (CSACD) survey instrument was used to measure the nurse–physician collaboration. The CSACD scores were compared using the signed-rank test with a significant *p* value of  $\leq 0.05$ . **Results:** From December 1, 2011 to December 13, 2012, 20 off-shift nurses submitted 106 surveys during telephone rounds and 108 surveys during robot rounds. The median score of surveys during robot rounds was slightly but not significantly higher than telephone rounds (51.3 versus 50.5;  $p=0.3$ ). However, the CSACD score was significantly increased from baseline with robot rounds (51.3 versus 43.0;  $p=0.01$ ), in comparison with telephone rounds (50.5 versus 43.0;  $p=0.09$ ). The mediators, including age, working experience, and robot acceptance, were not significantly ( $p>0.1$ ) correlated with the CSACD score difference (robot

versus telephone). **Conclusions:** Robot rounding in the intensive care unit was comparable but not superior to the telephone in regard to the nurse–physician collaboration and satisfaction about care decision. The working experience and technology acceptance of intensive care nurses did not contribute to the preference of night shift rounding method from the aspect of collaboration with the physician about care decision-making.

**Key words:** telenursing, telecommunications, telemedicine, telehealth

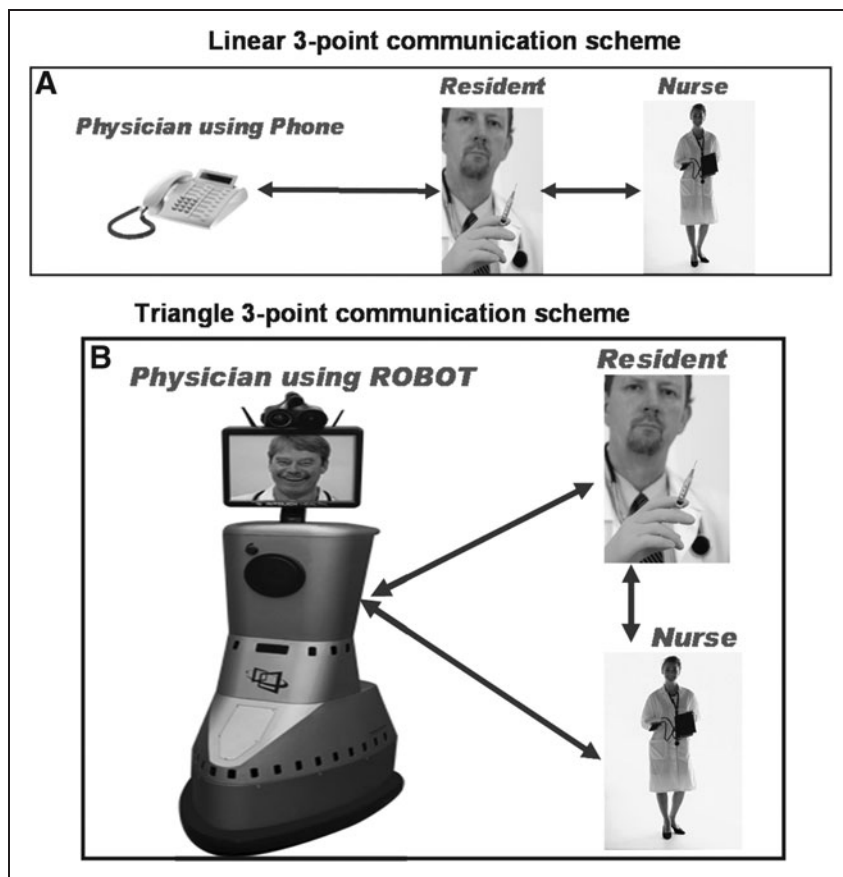
## Introduction

The use of remote robotic telepresence (RTP) technology in the healthcare industry is a relatively new and exciting subfield of telemedicine. RTP is defined by Vespa<sup>1</sup> as a form of telemedicine that enables a fast and face-to-face response by a physician, located remotely, using a mobile robot. The demand for intensive care unit (ICU) services is increasing as the average acuity of hospitalized patients rises with growth in the elderly population. However, the shortfall of ICU intensivists is projected to worsen.<sup>2</sup> This shortfall has been compensated for with increasing use of tele-ICU coverage.<sup>3</sup> Delivering healthcare using RTP is an evolving practice in medical ICUs and surgical ICUs (SICUs).<sup>4–6</sup> The tele-ICU was generally accepted by physicians and nurses, as reviewed by Young et al.<sup>7</sup> Some studies have shown that robotic telerounding matched the performance of standard bedside rounding.<sup>5</sup> Most studies about tele-ICU coverage evaluated patient satisfaction and outcomes.<sup>4,8,9</sup> An observational study concluded that a tele-ICU program was cost-effective when used to care for the sickest patients.<sup>10</sup> One of the RTP products is the RP-7 robot manufactured by InTouch<sup>®</sup> Health, Inc., of Santa Barbara, CA. The robot has teleconference capabilities using a sophisticated camera, an amplifying stethoscope, and a printer. It allows a remote clinician to see and interact with patients and staff while proactively and independently managing care delivery just as if he or she was physically present on-site. The RP-7 robot has been recognized for the enhanced efficiency and coordination of care and, therefore, improved patient outcomes and reduced healthcare cost.<sup>9,11,12</sup>

The clinical, technical, and economic aspects of telemedicine have been much more intensively studied than the social aspects.<sup>13</sup> In an ethnographic study, Nicolini<sup>13</sup> concluded that telemedicine could induce major changes in coordination mechanism, work processes, and power relations in the healthcare sector. Better caregiver interaction and coordination in the ICU are significantly associated with better patient outcomes such as lower mortality and length of ICU stay.<sup>14–16</sup> A meta-analysis suggested that nurse caring is directly associated with patient satisfaction.<sup>17</sup> A quantitative study demonstrated that telenursing improved nursing collaboration in the ICU by better communication and utilization of nurse expertise, and therefore improved patient outcomes.<sup>18</sup> The collaboration between physician and nurse was studied from the perceptions of either physicians or nurses.<sup>19,20</sup> Many instruments were used to measure the nurse–physician collaboration as reviewed by Dougherty and Larson.<sup>21</sup> Among them, the Collaboration and Satisfaction About Care Decisions (CSACD) survey instrument had satisfactory internal consistency.<sup>22</sup> CSACD is suitable to evaluate the work satisfaction from perceptions of either physicians or nurses.

In our hospital, during the night shift in the SICU, telephone rounds had been the standard practice in the unit for over 20 years. Nurses gave patient information (e.g., laboratory results and vital signs) to the medical resident on call, who was then responsible for presenting this information to the attending physician via telephone at 9 p.m. (Fig. 1A). The off-shift nurses only rarely interacted with the attending physician by telephone. Nurses defined nurse–physician collaboration as the effective preparation and handoff of patient information to medical residents, who then passed the information to a senior physician and gave that feedback to nurses. This indirect nurse–physician collaboration was changed by replacing the telephone with the RP-7 robot. Instead of the three-point (physician, resident, nurse) linear communication scheme by telephone, there was direct physician–nurse interaction when using RP-7 in the triangle scheme (Fig. 1B). We assumed that direct communication with the physician would enhance efficiency of patient information transfer and physician feedback and, hence, the nurse–physician collaboration satisfaction. The purpose of this study was to evaluate the impact of RTP on nurse–physician collaboration during off-shift hours from the perceptions of nurses. This was a validation study to evaluate the impact of RP-7 on nurse work practice in the SICU and the feasibility of our research method. We hope to expand the study to the organizational level in the near future.

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**Fig. 1.** Two off-shift rounding schemes: (A) nurses transferred information to the physician through a resident by telephone, or (B) nurses transferred information to the physician either directly or through a resident by robot.

## Materials and Methods

### STUDY DESIGN AND PARTICIPANTS

This study was a prospective, randomized, crossover-controlled trial in our hospital from December 1, 2011 to December 13, 2012. The protocol and informed consent form were reviewed and approved by the local institutional review board. Twenty off-shift nurses in the SICU voluntarily signed the consent form. All participants attended two educational meetings for demonstrating the InTouch Health RP-7 robot (Fig. 1B). An attending physician received a randomization envelope each morning to determine the evening rounding method to be either telephone or RP-7 robot. To reduce the confounding variables, including age, gender, work experience, technology acceptance, and preference of collaborators, the 20 participating

nurses were asked to submit CSACD surveys in both telephone and robot rounding night shifts (self-controlled).

**DATA COLLECTION AND ANALYSIS**

The research team used the CSACD survey instrument (*Table 1*)<sup>22</sup> at each telephone or robot round to assess the collaboration satisfaction about care decisions from nurses in an SICU. We labeled each question in the order as shown in the article by Baggs,<sup>22</sup> from Q1 to Q9. In addition, we added a 10th question (Q10) to assess the nurse’s intention to leave related to collaboration as “I have considered seeking other employment outside this unit or hospital related to an incident that occurred while collaborating with a physician.” Each question was evaluated with a 7-point Likert-type scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Questions Q1–Q9 measured a critical attribute of collaboration, and a higher score indicated a higher satisfaction. Q10 measured the opposite of satisfaction, and the lower score indicated higher satisfaction.

The CSACD was developed to measure collaboration and satisfaction with decision-making in the ICU in general working environment and settings. We used these general questions to measure the possible difference (telephone versus robot rounding) in collaboration and satisfaction with decision-making in the ICU. To reduce bias and confounders, all settings (survey questions, participants, ICU environment, attending physician) were kept the same except for switching telephone and robot rounding methods randomly.

There are two major reasons we chose the CSACD instrument: (1) the survey is short and easy to complete in a high-intensity environment (the ICU), and (2) both physicians and nurses can use the same instrument. Our current study was a validation study focused on nurses and the SICU. We intend to expand the study to both physicians and nurses in other units in the near future.

The CSACD questions were developed from a review of the literature for a theoretical base and were reviewed by multiple nursing and medical experts in collaborative practice. The instrument included proper psychometrics to measure the collaboration in the ICU and was well tested and validated.<sup>21</sup> The original article<sup>22</sup> that developed the CSACD was cited 66 times from the Thomson Reuters Web of Science, with an average of 3.14 times per year, since publication in 1994.

Before the experiment, participants submitted a survey as baseline. After each evening rounding (telephone or robot), each participating nurse was asked to submit a CSACD questionnaire into a locked survey box. The research assistant collected the surveys and entered the data into a database. The question score was averaged within multiple surveys submitted by each nurse. The median CSACD scores were compared between telephone and robot rounds using the signed-rank test, which is the nonparametric equivalent to the one-sample paired *t* test. Repeat-measures mixed model logistic regression was used to evaluate the influence of residents’ medical field on the collaboration between nurses and the physician. Possible mediators, including participants’ age, profession years, and robotic experience, were analyzed with linear regression and the Wilcoxon rank-sum test. A *p* value of ≤0.05 indicates statistical significance. The statistical analysis for this article was generated using Statistical Analysis Software (SAS), version 9.2 for Windows (© 2002–2008; SAS Institute Inc., Cary, NC).

**Results**

**PARTICIPANTS’ CHARACTERISTICS AND BASELINE**

In *Table 2*, the top entries describe characteristics of the 20 participating nurses. Most of the participants were young female registered nurses who worked only the night shift. Although the majority of them (65%) did not have working experience with the robot system, they felt fairly comfortable with the RP-7 robot (72%). The bottom entries of *Table 2* show the baseline score of each CSACD question. The scores for Q1–Q9 were skewed to the higher value side, indicating a fairly satisfied collaboration at the onset of the study (7 is the highest score). Q10 was skewed to the lower value side (1 is the lowest score), indicating that it was very unlikely a nurse would seek another employer because of dissatisfaction with collaboration.

**Table 1. The Collaboration and Satisfaction About Care Decisions Questionnaire Used in the Survey**

ITEM	QUESTION
Q1	Top panel Question 1 in <i>Table 1</i> in Baggs <sup>22</sup>
Q2	Top panel Question 2 in <i>Table 1</i> in Baggs <sup>22</sup>
Q3	Top panel Question 3 in <i>Table 1</i> in Baggs <sup>22</sup>
Q4	Top panel Question 4 in <i>Table 1</i> in Baggs <sup>22</sup>
Q5	Top panel Question 5 in <i>Table 1</i> in Baggs <sup>22</sup>
Q6	Top panel Question 6 in <i>Table 1</i> in Baggs <sup>22</sup>
Q7	Bottom panel Question 1 in <i>Table 1</i> in Baggs <sup>22</sup>
Q8	Bottom panel Question 2 in <i>Table 1</i> in Baggs <sup>22</sup>
Q9	Bottom panel Question 3 in <i>Table 1</i> in Baggs <sup>22</sup>
Q10	Added one question to measure the discount of collaboration and satisfaction: "I have considered seeking other employment outside this unit or hospital related to an incident that occurred while collaborating with a physician."

The questionnaire used in this survey was adapted with permission from the 1994 publication by Baggs.<sup>22</sup>

**Table 2. Characteristics of Participating Nurses and the Baseline Scores of the Collaboration and Satisfaction About Care Decisions Survey from Nurses**

CHARACTERISTIC	VALUE
Number of nurses	20
Age (years) (mean ± SD)	38.4 ± 8.8
Female (%)	90%
Employment (%)	
Full-time	78%
Part-time	22%
Shift work (%)	
Day	4%
Day/night rotation	14%
Night	82%
Profession years (mean ± SD)	13.4 ± 8.5
SICU working years (mean ± SD)	7.4 ± 5.3
Robot experience (%)	
Yes	35%
No	65%
Comfort level with robot (%)	72%
CSACD baseline (n=20) surveys [median (range)]	
Q1	5 (2-7)
Q2	5 (3-7)
Q3	4.5 (3-7)
Q4	5 (3-7)
Q5	5 (2-7)
Q6	5 (2-7)
Q7	5 (3-6)
Q8	4 (2-6)
Q9	4 (1-6)
Q10	2 (1-7)
Sum	43 (30-62)

CSACD, Collaboration and Satisfaction About Care Decisions; SD, standard deviation; SICU, surgical intensive care unit.

**CSACD SCORE**

During the 1-year study period, 146 nights were randomized to 78 telephone rounds and 68 robot rounds. From the 20 nurses, 106 telephone and 108 robot surveys were collected. As shown in *Table 3*, the score of each question in robot rounding nights was not different from that in telephone

**Table 3. Comparison of the Survey Scores of Each Question Between Telephone and Robot Rounds**

QUESTION	TELEPHONE (N= 106 SURVEYS)	ROBOT (N= 108 SURVEYS)	P VALUE <sup>a</sup>
Q1	5.6 (3.0-6.4)	5.6 (2.7-6.5)	0.33
Q2	5.6 (3.0-6.4)	5.5 (2.7-6.5)	0.59
Q3	5.1 (3.0-6.6)	5.2 (2.7-6.5)	0.14
Q4	5.0 (3.0-6.4)	5.2 (2.7-6.5)	0.53
Q5	5.1 (2.9-6.3)	5.3 (2.7-6.3)	0.18
Q6	5.0 (2.8-6.4)	5.2 (2.6-6.2)	0.20
Q7	5.1 (2.8-6.6)	5.1 (2.5-6.5)	0.97
Q8	5.0 (2.6-6.4)	5.2 (2.4-6.3)	0.27
Q9	4.9 (2.3-6.1)	5.0 (2.2-6.1)	0.29
Q10	3.5 (1.0-6.1)	3.9 (1.0-6.0)	0.80
Sum	50.5 (28.1-60.8)	51.3 (25.9-60.7)	0.30

Data are median (range) values.

<sup>a</sup>By signed-rank test.

**Table 4. Comparison of Survey Scores in the Presence of Anesthesia Residents Versus Surgery Residents During the Night Shifts in the Surgical Intensive Care Unit**

QUESTION	ANESTHESIA (N= 9 RESIDENTS)	SURGERY (N= 24 RESIDENTS)	P VALUE <sup>a</sup>
Q1	5.2 (4.7-5.7)	5.4 (4.9-6.0)	0.24
Q2	5.2 (4.7-5.6)	5.4 (4.8-5.9)	0.26
Q3	5.1 (4.6-5.6)	5.2 (4.7-5.8)	0.52
Q4	5.1 (4.7-5.6)	5.2 (4.7-5.8)	0.61
Q5	5.1 (4.6-5.6)	5.2 (4.7-5.7)	0.44
Q6	5.0 (4.5-5.5)	5.2 (4.6-5.7)	0.33
Q7	5.0 (4.5-5.5)	5.2 (4.7-5.8)	0.21
Q8	4.9 (4.4-5.4)	5.2 (4.6-5.8)	0.12
Q9	4.6 (4.1-5.1)	4.8 (4.2-5.4)	0.14
Q10	3.5 (2.7-4.2)	3.8 (3.0-4.6)	0.11
Sum	48.5 (44.2-52.8)	50.7 (46.1-55.4)	0.13

The analysis included all the surveys (n=214) collected in telephone and robot rounding night shifts. Data are mean (range) values.

<sup>a</sup>By logistic regression.

**Table 5. P Values by Univariate and Multivariate Analyses of the Association Between the Mediators and Survey Scores**

MEDIATOR, ANALYSIS	SUM SCORE		DIFFERENCE
	TELEPHONE	ROBOT	
Univariate			
Age	0.42	0.55	0.60
Profession years	0.07	0.19	0.23
SICU working years	0.13	0.11	0.89
Robot comfort level	0.004	0.0004	0.77
Multidiscipline level	0.12	0.37	0.14
Gender <sup>a</sup>	–	–	–
Employee status (full-time versus part-time)	1.00 (50.0 versus 49.30)	0.78 (51.3 versus 48.8)	0.65 (0.5 versus –0.06)
Working shift (day versus night)	0.85 (50.0 versus 49.3)	0.75 (49.7 versus 51.3)	0.13 (–0.3 versus 0.5)
Previous robot experience (yes versus no)	0.96 (51.0 versus 48.8)	1.00 (51.5 versus 50.5)	1.00 (0.5 versus 0.3)
Multivariate			
Profession years	0.09	0.34	0.16
SICU working years	0.65	0.54	0.22
Robot comfort level	0.001	<0.0001	0.76
Multidiscipline level	0.70	0.86	0.34
Working shift	0.56	0.19	0.52

A *p* value ≤0.05 indicates the survey score is associated with the mediator after control other variables. Those mediators with *p* ≤0.2 in univariate analysis were further examined by multivariate analysis.

<sup>a</sup>Gender was not included in the analysis because there was only one male participant.

SICU, surgical intensive care unit.

nights (*p* > 0.05). The sum scores of questionnaire were not statistically different between robot and telephone rounding nights (51.3 versus 50.5; *p* = 0.3). However, the CSACD sum score in robot nights increased significantly compared with baseline level (51.3 versus 43.0; *p* = 0.01). The score in telephone nights only showed a trend of increase in comparison with baseline (50.5 versus 43.0; *p* = 0.09).

The residents who worked with nurses during night shifts were divided into anesthesia and surgery specialties (Table 4). The CSACD surveys collected during both telephone and robot night rounds were included in the analysis. The survey sum score shows a trend of higher value during rounds with surgery residents than with anesthesia residents (50.7 versus 48.5; *p* = 0.13). No different score was observed with only telephone rounds (48.3 versus 47.8; *p* = 0.81) or with only robot rounds (51.7 versus 49.5; *p* = 0.29).

Table 5 in the top portion shows the *p* values from univariate analysis of the association between mediators (age, profession years, SICU working years, robot comfort level, multiple discipline level, employee status, working shift, and

previous robot experience), the CSACD scores during telephone or robot rounding, and the score difference. We selected the mediators with any *p* ≤ 0.2 to be included in multivariate analysis: profession years, SICU working years, robot comfort level, multiple discipline level, and working shift. The results are shown in the bottom portion of Table 5. Robot comfort level stands out as significantly affecting CSACD score during both telephone and robot rounds but still did not affect the score difference.

**Discussion**

During the night in the SICU, nurses’ presence is the most direct care that patients receive. The nurses’ job satisfaction and management of care directly affect the patient satisfaction and outcomes such as length of ICU stay.<sup>16</sup> In a before–after comparison study, Vespa et al.<sup>11</sup> credited the RP-7 robot for enhanced efficiency, coordination of care, and, therefore, reduced hospital stay and ICU cost. A report from the Ryder Trauma Center in Miami showed that the RP-7 had enhanced both care and training in their trauma ICU.<sup>12</sup> In a recent study

conducted at Winthrop University Hospital, 145 RP-7 and 154 telephone ICU rounds were compared.<sup>9</sup> They found significant difference in several aspects comparing RTP versus telephone rounds: longer rounding time (33 versus 15 minutes;  $p < 0.05$ ), higher therapeutic interventions (5 versus 1;  $p < 0.01$ ), higher user satisfaction (8 versus 6;  $p < 0.01$ ), and fewer unexpected events (0.1 versus 1.3;  $p < 0.05$ ). The authors concluded that the communication between the attending physician and staff was enhanced by the RP-7. We used the CSACD questionnaire (Table 1) to measure nurse–physician collaboration about care decision. The total scores did not show that the RP-7 robot enhanced nurse–physician collaboration satisfaction over the telephone.

We evaluated the effect of SICU residents' medical specialty on nurse–physician collaboration in decision-making (Table 4). The nurses showed slightly but not significantly ( $p = 0.1$ ) better collaboration with the physician when surgical residents were present instead of anesthesia residents. This effect might be related to the fact that the patients were admitted after surgery. Because we used a crossover study design, the 20 participating nurses are the same in the two arms (robot versus telephone). This design eliminated the other possible confounders, including age, gender, working experience, and technology acceptance. Multivariate analysis showed that robot comfort level affected both telephone and robot CSACD score but had no effect on the score difference. Profession year is not correlated to the CSACD score difference (robot versus telephone,  $p = 0.16$ ). Therefore, working longer or shorter did not make the participating nurses favor robot or telephone. Similarly, age, SICU working years, robot comfort level, multiple discipline level, employment status, working shift, and previous robot experience did not make the SICU nurses prefer one night shift rounding method to the other, from the aspect of collaboration with the physician about care decision-making.

The physician might favor the RP-7 robot (Fig. 1B) over the telephone (Fig. 1A) during nighttime rounding because of the possibility for face-to-face communication with both residents and nurses. The availability of face-to-face communication might improve the information transfer between nurses and the physician. McNelis et al.<sup>9</sup> demonstrated that the RP-7 enhanced clinical communication within the SICU staff and number of discussions with the patients or family regarding plan of care compared with the telephone. The RP-7 in our SICU should enhance clinical communication between the physician and participating nurses because of the direct face-to-face interaction (Fig. 1). We assumed that the enhanced clinical communication should increase the nurses' involvement in decision-making about care plan. However, from the nurses' perspective, the collaboration with the physician in patient care

decision-making was not different when the physician used the RP-7 robot or telephone. Compared with baseline, the RP-7 robot survey score increased more significantly than the telephone survey score. This effect could be attributed to the increased nurses' familiarity and comfort level with the RP-7 robot along the study period. Although reports suggested the fair overall acceptance of tele-ICU coverage, the specific effectiveness and dynamic impact on staff often have been neglected in studies.<sup>7</sup> Our study meant to evaluate the effectiveness of the RP-7 robot in nurse–physician collaboration in patient care decision from the perspective of nurses.

#### STUDY LIMITATION

There are several limitations in our study. First, we only carried out the trial in one SICU. The result and conclusion may not be generalizable to other hospital units. The sample size of 40 (20 nurses as their own controls) was too small to detect small difference between telephone and robot rounds. In average, each nurse only submitted four telephone and three robot surveys, which did not reach the expected numbers of surveys to fulfill the 80% statistical power. We stopped the study after 1 year because the survey submission had become an additional burden to off-shift nurses in the SICU. In addition, the nurses might check the score of each question while considering how they collaborated with the residents but not the rounding physician. The randomization of these two rounding methods over the 1-year period was intended to offset the bias introduced by patient conditions, seasonal elements, and nurses' preferences.

#### Conclusions

Our results demonstrated that the RP-7 robot did not enhance the nurse–physician collaboration in the SICU. An RTP system is a comparable but not superior off-shift rounding tool in regard to the collaboration about patient care decision between physicians and nurses in an SICU. The working experience and technology acceptance of ICU nurses did not contribute to the preference of night shift rounding method from the aspect of collaboration with the physician about care decision-making.

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#### Disclosure Statement

No competing financial interests exist.

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