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Original Article

The ABCD patient classification tool for nurse-to-patient assignment to improve nursing workload balance: a multi-center study

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Abstract: Objective: The ABCD patient classification tool was established based on the patients' disease status and nursing needs with the aim of better nursing resource allocation. The objective of this study was to determine the effectiveness of the ABCD classification tool in balancing workload of intensive care unit (ICU) nurses. Methods: A multi-center before-after study including adult and senile patients admitted to the general ICU was conducted. During the before phase between May 20th and June 24th 2012, the nurses for day shifts were allocated by nursing managers according to the standard practice. Subsequently, the nursing managers and relevant nurses received education and training for the ABCD patient classification tool. The after phase included consecutive eligible patients between August 1st and September 4th 2012 that was classified into four-grade groups (A, B, C, D) and the patients in A group needed supreme care. Thereafter, the nurses were matched with patient classification and allocated through the enumeration method. The actual nursing workload for every day shift was evaluated using the mini-version of the Therapeutic Intervention Scoring System (TISS-28). The differences in inter-phase outcome measures including the coefficient of variation, the percent of nurses with normal workload (TISS-28 score, 40-50), and nurses' satisfaction score were compared. A two-level fitting model was further utilized to estimate the influence of ABCD classification tool on the probability of a normal workload. Results: After using the ABCD patient classification tool, the coefficient of variation in nurses' workload decreased from 32.40% to 28.50% and the percent of nurses with normal workload increased from 23.64% to 37.5%. The probability of a normal workload increased by 43% ($\beta 1$=-0.358, $P<0.01$) when both day shift and nurse staffing based on the ABCD patient classification tool were fitted. No significant inter-phase difference in nurses' satisfaction about workload was found (P=0.486). Conclusion: The ABCD patient classification tool is helpful in balancing nurses' workload in the general ICU.

Keywords: Intensive care unit (ICU), ABCD patient classification tool, nurses' workload, two-level model

Introduction

Nursing shortage is becoming a major healthcare issue worldwide and will not change in the near future [1]. The insufficient nursing usually means increased workload to existing nurses, which might be a serious threat to nursing quality and safety of patients in the intensive care unit (ICU) [2, 3]. Moreover, the increased labor demand is positively related with nurses' job dissatisfaction, stress and burnout [4]. In these situations, a better nurse staffing method that optimizes match of nursing workload with patient needs as well as balance of workload among nurses is required [5].

A fair distribution of tasks that meets nurses' expectation can help reduce complaints and increase motivation [16]. In the general ICU, complexity of nursing practice, hemodynamic instability of patients as well as demands from doctors, patients and relatives results in a huge variation of patient needs [6, 7]. These changing factor adds difficulty to predicting workload and subsequent balancing of workload among nurses [8]. Several nursing workload measurement tools such as Therapeutic Intervention Scoring System (TISS), Nursing Activities Score (NAS) and Nine equivalents of nursing manpower use score (NEMS) have been implemented to optimize the utilization of nursing resources

Table 1. The ABCD patient classification tool

Item	Description
Grading standards	Grade A: vital signs unstable; ICU support measures in use
	Grade B: vital signs stable; ICU support measures in use
	Grade C: vital signs stable; no support but potentially dangerous
	Grade D: vital signs stable; ready to leave ICU
Number of nurses required at day shift	Grade A: no less than 3/4 nurse
	Grade B: no less than 1/2 nurse
	Grade C: no less than 1/3 nurse
	Grade D: no less than 1/4 nurse

Note: day shift refers to 08:00-16:00; ICU support measures including ventilation, the use of vasoactives and hepatic/renal replacement therapy.

[9-13]. However, these tools are flawed at complexity or invalidity which hinders the wide application of these tools in determining nursing assignment [14].

Patient classification tools with the capacity of predicting patient needs for nursing and connecting patient needs with nursing workload, have often been tried to guide patient-to-nurse assignment [15-17]. The four-grade ABCD classification of ICU patients is a self-developed tool in China which helps classify nursing tasks into four grades of care reflecting patients' actual nursing needs [18]. The purpose of this study is to evaluate the effectiveness of the ABCD patient classification tool for guiding patient-to-nurse assignment for ICU nurses and the effects on balancing nursing workload.

Methods

Study design and sample

An approval from the Ethics Committees of Sun Yat-sen University & the Sixth Affiliated Hospital of Sun Yat-sen University was got before the initiation of this prospective before-after study, and the Ethics Research Grant Number was 2012016. Six general ICUs (Center 1 to 6) from five hospitals in Guangdong Province, China participated in this multi-center study which was conducted from May 20th to September 4th 2012. The first five-week (May 20th to June 24th) study served as control (before phase) during which the nursing administrators allocated nurses at day shift to ICU patients based on traditional standard practice. This was followed by five-week training of administrators and nurses about the ABCD patient classification tool to ensure full understanding and right application. From August 1st and September 4th 2012, the nursing administrators utilized the ABCD patient classification tool to complete nursing staffing and the interphase differences in nursing workload distribution and nurses' satisfaction score about workload was compared.

Four-grade ABCD patient classification tool for nurse staffing

The ABCD patient classification tool was designed to predict nurse workload and guide nurse staffing [18]. Specifically, the adult and senile patients admitted to general ICU were classified into four-grade A, B, C and D groups based on patients' disease status and nursing needs. Patients who needed ICU support with unstable life signs were grouped into A grade in which at least 3/4 nurse per patient was needed. The severity of disease and the need for ICU support decreases from grade A to D corresponding to decreased need of nursing. The classification criteria and the corresponding nursing assignment proposal are shown in **Table 1**.

There were three steps when the ABCD patient classification tool was used for patient-to-nurse assignment. First, the patients were grouped according to disease status and nursing needs. Then, total nursing demand was calculated based on patients' grading. Scores of TISS-28 were used to calculate the number of nurses needed. Based on results from Miranda, *et al.* [19], a TISS-28 score of 1 corresponded to 10.6 min of nursing work time. Therefore, our study limited the TISS-28 scores between 40 and 50 points for each nurse at the day shift which was consistent with suggestions from British Association of Critical Care [14]. At last, the

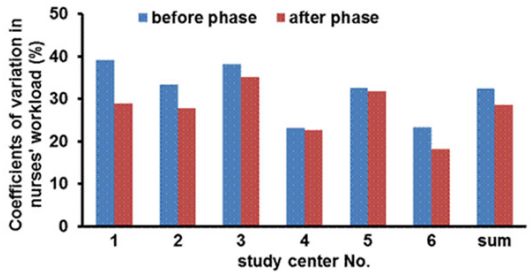

Figure 1. Coefficients of variation in nurses' workload in each study centers. The nurses' workloads were evaluated using the TISS-28 score during both the before and after phases. The ABCD patient classification tool was used to guide nurse-to-patient assignment during the after phase. A smaller coefficient of variation in workload indicated a more balanced workload distribution.

nurses were matched with and allocated to patients by managers using the enumeration method. Two factors were considered when nurses were matched with patients: 1) the beds of multiple patients served by the same nurse should be as close as possible to minimize travel distance; 2) patients with protective isolation or segregation should not be served by the same nurses to avoid cross-infection. Every match was checked to ensure it was reasonable.

Outcome measures

The changes of coefficients of variation in nurses' workload evaluated using TISS-28 was chosen as the main outcome measure. TISS-28 scores were collected at the end of the day shift by trained student nurses recruited as assessment personnel. A smaller coefficient of variation in workload indicated a more balanced workload distribution.

Other outcome measures included the percent of nurses with normal workload (40-50 patient TISS-28 scores), the probability of a normal workload based on 2-level model and the interphase difference in nurses' satisfaction score.

Nurses' satisfaction score about nurse staffing was got using a six-item questionnaire which included satisfaction with their own workload, balance of workload, the fairness of task assignments, the efficiency of patient care, patient care needs, and the method of task assignment. Each item was scored between 1 and 10 with 10 as fully satisfied and 1 as the least satisfied. The sum of scores from each item was used as the overall satisfaction score with a range from 6 to 60 theoretically.

Statistical analysis

Statistical analyses were performed using SPSS 19.0 (SPSS Inc., Chicago, IL, USA) or MLwiN Version 2.02 (Centre for Multilevel Modelling, University of Bristol, UK). Nurses' satisfaction scores were expressed as mean ± standard deviation (SD) and other outcome measures were expressed as percent.

For the percent of nurses with normal workload, a Chi-square (χ^2) test was used to detect the effects of intervention. For satisfaction score changes, one-way ANOVA was adopted to calculate the interphase difference. A *P* value of less than 0.05 was considered statistically significant.

For the prediction of probability of a normal workload, a two-level fitting model was used in which nurses' workload was the dependent variable. The workload was defined as a binary variable with 0 representing high or low workload and 1 representing normal workload. The ABCD patient classification tool guided nurse-to-patient assignment was set as level 1 and day shift was set as level 2. Considering that the average sample size was 3-7 nurses per shift in level 1, level 2 was set as 420 day shifts to ensure that the total sample number of level 1 was approximately at least 1680 (4*420).

Results

During the study periods, data from a total of 3800 patient/shift with 1981 nurse/shift were collected (802 patients in 6 centers). A total of 627 questionnaires were distributed and all were collected with valid scores. 99 questionnaires were excluded because of shift turnover and was not on day shift 10 days before the survey. Among the rest 528 questionnaires, 258 were from the control period.

Coefficients of variation in nurses' workload

As shown in **Figure 1**, the coefficient of variation of the workload decreased from 32.4% (before phase) to 28.5% (after phase) (3.9%). All the six centers saw a drop of coefficient of variation with Center 1 showing the greatest decrease.

Table 2. The percent of nurses with normal workload in each study center

Center	% of nurses with low, normal and high workload						χ^2	P
	Before Phase			After Phase				
	Low	Normal	High	Low	Normal	High		
1	26.67	17.78	55.56	16.32	40.81	42.86	6.132	0.047*
2	26.31	23.68	50.00	25.00	27.50	47.50	0.149	0.928
3	41.30	13.04	45.65	36.54	19.23	44.23	0.726	0.695
4	32.00	28.00	40.00	27.87	50.82	21.31	6.915	0.032*
5	36.36	30.30	33.33	38.89	36.11	25.00	0.616	0.735
6	17.39	30.43	52.17	17.65	58.82	23.53	7.718	0.021*
Total	29.80	23.64	46.51	28.10	37.50	34.40	13.040	0.001**

Note: *P<0.05 and **P<0.001, before phase *vs.* after phase.

The percent of nurses with normal workload

Table 2 describes the percent of nurses with normal workload in each study center. After application of the ABCD classification tool, the proportion of normal workload increased from 23.64% (before phase) to 37.50% (after phase). The high and low workload percentage decreased from 46.51% to 34.40% and from 29.80% to 28.10% respectively. Single-center analysis found that the percent of nurses with normal workload was significantly increased in center 1, 4, and 6 (all P<0.05).

Probability of normal workload

The null model for the probability of normal workload found that the fixed effect of the intercept (β0) was -0.725 (P<0.001) and the residual variation of level 2 was 0.236 (P=0.004), suggesting a significant inter-group variation in level 2 (day shift) and a need for a multi-level model. After adding the intervention (ABCD patient classification tool) variable, a significant main effect was found (P<0.001). The ABCD classification method could significantly increase the proportion of normal work load compared with the traditional task assignment method (OR=1.43). The residual variation using 2-level model (P=0.012) suggested other factors still involved (**Table 3**).

Nurses' satisfaction score

As shown in **Table 4**, after introducing the ABCD patient classification tool, the mean nurses' satisfaction score did not change significantly (37.55 *vs.* 38.20; before vs. after; P=0.486). None of the six-item satisfaction score observed a significant change with the application ABCD classification tool.

Discussion

The current study showed that the use of the ABCD patient classification tool in guiding nurse staffing at the day shift was related with improved balance of nurses' workload and increased probability of normal workload. Nurses' satisfaction score did not change after application of the ABCD classification tool.

We found that by using the ABCD patient classification method, the coefficient of variation of the workload decreased from 32.4% to 28.5% suggesting a more balanced nursing assignment. Mullinax *et al.* [20] used the range instead of the coefficient of variation as an indicator of workload distribution. One problem of using range to evaluate workload distribution was that it only accounts for the difference between the maximum and minimum values and did not contain information of other values. Thus, the conclusion from range might be influenced by extreme values. Compared with range, the coefficient of variation was calculated using all the data and was more stable than range. Taken together, we thought the coefficient of variation was superior to range in evaluating balance degree of workload.

We found that the percent of nurses with normal load increased after using the ABCD patient classification tool. Dykstra *et al.* [21] used the self-designed Intensity Index to level nurses assignments in general wards and found the percent of shifts during which the nurses perceived their workload as within target was increased from 76% to 86%. The percent of nurses with normal workload in our study was much lower than reports from Dykstra *et al.* Two reasons might help explain the difference. Firstly, the current study was conducted with nurses working in ICU which was typically linked with nursing shortage and over workload [22, 23]. Secondly, the definition of normal work-

Table 3. Stochastic intercept model of nurses' workload distribution

Parameter	Estimated Value	Standard Error	Test Value	P
Intercept	-0.900	0.077	137.759	<0.001**
Intervention (ABCD patient classification tool)	0.358	0.106	11.289	<0.001**
Residual	0.200	0.080	6.243	0.012*

Note: *P<0.05 and **P<0.001.

Table 4. Nurses' satisfaction score during the before and after phase

Item	Before phase	After phase	P
Individual workload	6.37±1.91	6.35±1.90	0.886
Balance of workload	6.31±1.88	6.36±1.88	0.781
Fairness of staffing	6.35±1.91	6.33±1.90	0.926
Efficiency of patient care	6.20±1.99	6.39±1.83	0.269
Patient care needs	6.06±1.88	6.37±1.84	0.055
Nurse assignment method	6.27±1.91	6.41±1.85	0.380
Total	37.55±10.67	38.20±10.58	0.486

load was different. In our study, the normal range of nurses' workload was set as a TISS-28 score of between 40-50 which was based on data accumulated over 10 years development of TISS [24] and clinical trials in 22 Dutch ICUs [19]. In the study by Dykstra *et al.* [21], the range of a normal workload was defined based on data derived from a 26-bed and 20-day condition and set as one-third of the upper limit.

van Oostveen *et al.* [25] developed a computerized decision support system to guide nurse-to-patient assignment and used the nurse satisfaction score as an outcome measure. They found that although the more nurses' workload dropped, the nurses' satisfaction with the group of patients assigned to each nurse decreased. Similarly, the satisfaction score of nurses on the ABCD classification method was similar to that on the standard task assignment method (P=0.380). No difference in satisfaction score was found for individual workload, staffing fairness or workload balance in our study. These subjective results were also different from our results about workload distribution evaluated using the TISS-28 score. One problem might be that the questionnaire for satisfaction evaluation might not be sensitive enough to detect a small difference. Another explanation might be the relatively small sample size of current study and short duration of observation. More data from large-sized trials was needed to confirm our results. Last but not least, nurses' job satisfaction might be influenced by multiple factors including emotion, workload, salary and so on [26].

The current study did not test the effects of ABCD patient classification tool on nurse-to-patient assignment for evening and night shifts. Moreover, the intervention period of current study was short. These shortcomings discouraged us to observe patients' satisfaction about the new nurse staffing using the ABCD patient classification tool. Further studies using ABCD patient classification to guide ICU nurse staffing for all shifts with longer intervention duration were still needed.

In conclusion, nurse-to-patient assignment guided by the ABCD patient classification tool promotes more balanced workload among general ICU nurses. The nurses experience similar degree of acceptance to the new nurse staffing method as routine practice. More well-designed large-scaled studies are needed to further confirm the usefulness of the ABCD patient classification tool in ICU nurse staffing.

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Disclosure of conflict of interest

None.

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