THE IMPACT OF CONTINUOUS QUALITY IMPROVEMENT ON SLEEP DISTORTION IN CRITICAL PATIENTS

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INTRODUCTION

Intensive care unit (ICU) patients were shown to have poor quality of sleep over the last three decades.However, to improve the sleep distortion in critical patients remains challenging. The aim of this study is to investigate the impact of continuous quality improvement on sleep distortion in critical patients in critical patients.

METHOD

All consecutive patients form 2019-2021 in 6 adult ICUs were enrolled. The key interventions include novel sacral suspended decompression recumbent care, simple air pressure turning device, remote warning care system and using big data to monitor critical care warning indicators. The patients were divided into three periods: pre-intervention period from Jan to Dec 2019, intervention period from Jan to Dec 2020, and post-intervention period from Jan to Dec 2021.

Figure 1
Fishbone diagram

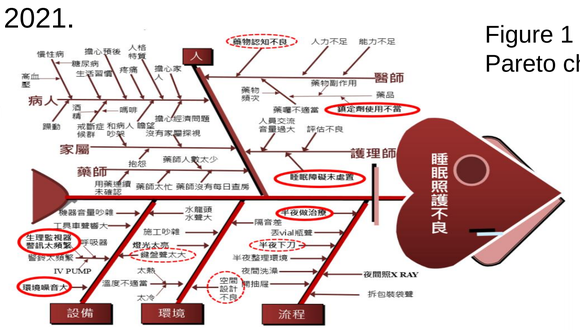

Figure 1
Pareto chart

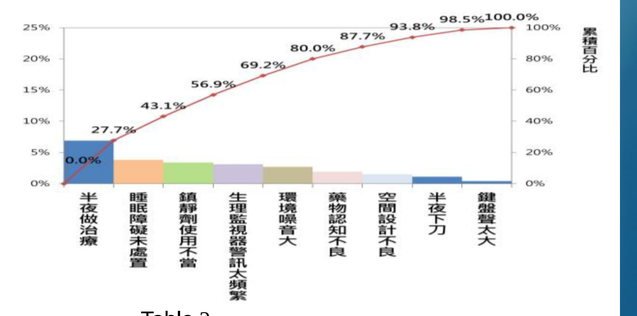

Table 1
Development of Countermeasures

What	Why	What	Evaluation					Who	When	Where
→Question points	Main Causes	Root Causes	Countermeasures	Feasibility	Economy	Benefits	Total Score	Adoption	Proposed by	Person in charge	Expected implementation date	Location
Improving the quality of sleep care for critically ill patients	Poor sleep care	1 Nocturnal treatments	1-1 Implementing a customized bathing schedule for critically ill patients in three shifts	115	99	69	283	V	Li Chia-ching (Nurse)	Huang Ya-hui (Deputy Nursing Director)	9/2020	Adult ICU
			1-2 Adjusting the repositioning time for intravenous catheters	107	89	89	285	V	Wu Su-chen (Nurse)	Yu Wen-chuan (Nurse)	9/2020	
			1-3 Establishing a nap time for critical care patients at KVGH	115	99	95	309	V	Wu Su-chen (Nurse)	Yu Wen-chuan (Nurse)	9/2020	
			1-4 Promoting good sleep at night for critical care patients at KVGH	105	89	95	289	V	Li Chi-chieh (Nurse)	Li Chun-man (Nurse)	9/2020	
			1-5 Replacing peripheral venous catheters that have been in use for more than 96 hours with a PICC (Peripherally Inserted Central Catheter)	100	90	93	283	V	Chung Fan-ni (Nurse)	Wang Hsing-chih (Deputy Nursing Director)	9/2020	
			1-6 Using arterial blood pressure monitoring instead of non-invasive blood pressure monitoring	101	92	94	287	V	Chen Hsiu-chun (Nurse)	Wang Hsing-chih (Deputy Nursing Director)	10/2020	
			1-7 Providing education and training on fast-flush tests for arterial catheters	90	103	88	281	V	Li Chia-ching (Nurse)	Huang Ya-hui (Deputy Nursing Director)	10/2020	
			1-8 Providing care with sacrum suspension and pressure-reducing bed positions	99	94	90	283	V	Chen Hsiu-chun (Nurse)	Huang Ya-hui (Deputy Nursing Director)	10/2020	
			1-9 Providing simple pneumatic turnover devices	105	87	107	299	V	Chia-ching (Nurse)	Chun-man (Nurse)	9/2020	
			1-10 Implementing a time-controlled lighting system for critical care patients	113	95	87	295	V	Chia-ching (Nurse)	Li Chun-man (Nurse)	11/2020	
			1-11 Adjusting medical care times	105	115	87	307	V	Chi-chieh (Nurse)	Tsai Fan-an (Nurse)	12/2020	
			1-12 Shifting bathing time for patients with multiple catheterizations to the night shifts	41	69	55	165	X	Chi-chieh (Nurse)			
			1-13 Adjusting the repositioning time for intravenous catheters to the night evening shifts	59	63	71	193	X	Tang Yu-i (Nurse)			
			1-14 Placing comatose (UVPSID) patients in a supine position during the night shift	69	55	53	177	X	Tang Yu-i (Nurse)			
		2 Unmet assessment needs	2-1 In-service education and training on sedation for critically ill patients.	113	95	87	295	V	Chen Hsiu-chun (Nurse)	Chang Hsing-chih (Nursing Director)	9/2020	
			2-2 Development of a "KVGH Sleep Kit"	99	95	87	281	V	Chen Hsiu-chun (Nurse)	Wu Su-chen (Nurse)	9/2020	
			2-3 Research and development of acupoint infrared heat sleep therapy	107	95	105	307	V	Chang Li-ping (Nurse)	Yu Wen-chuan (Nurse)	9/2020	
			2-4 Creating a comfortable environment based on patients' thermal comfort	103	113	71	287	V	Chang Li-ping (Nurse)	Huang Hsing-chih (Nursing Director)	9/2020	
			2-5 Customized music therapy to improve sleep quality	111	95	67	273	V	Chang Li-ping (Nurse)	Huang Hsing-chih (Nursing Director)	9/2020	

Table 2
Benchmarking and innovative approaches

	Categories	Innovative Approaches	Inspired by
1	National first	New evidence-based practice	Providing sacrum suspension and pressure-reducing bed position care; first in the country to adopt this measure	The magician's "Cloud Nine" act
2	National first	Patent innovation	A simple pneumatic turnover device adopted for the first time in the country	Car jack
3	Innovation	Integrated Innovation	KVGH Sleep Kit	Business class travel kit
4	National first	Traditional Chinese medicine evidence-based practice	Acupoint infrared heat sleep therapy adopted for the first time in the country for critically ill patients	SPA stress relief therapy
5	National first	Meta-analysis	Using big data for meta-analysis of sedative use in critically ill patients and establishing guidelines for sedative use	Internet
6	National first	New evidence-based practice	Providing physicians with evidence-based guidelines for selecting appropriate sedatives	TV shopping
7	National first	AI patent	The first in the country to develop an intelligent HIS medication order system for sedative use in critically ill patients	blind spot monitoring system
8	National first	Artificial intelligence	The first in the country to develop an intelligent nursing information system for sedative use in critically ill patients	LINE sticker caring reminders
9	National first	Artificial intelligence	The first in the country to develop a critical care system for sedative use	Smart watch
10	National first	Big data	The first in the country to adjust critical alarm indicators based on big data analysis	Amazon e-commerce platform
11	National first	Remote monitoring	The first in the country to adopt the remote warning and care system for critically ill patients	An intelligent floor cleaning robot

RESULTS

The sleep assessment ratio improved from 49.0% in pre-intervention period, to 67.5% in intervention period and to 95.1% in post-interventional period (p<0.0001). The good quality sleep ratio improved from 70.4% in pre-intervention period, to 74.2% in intervention period and to 87.8% in post-interventional period (p<0.0001). Average ICU stay decreasefrom 7.9 days to 6.9 days after intervention (p<0.05). The incidence of ventilator-associated pneumonia decreased from 0.7‰ to 0.4‰(p<0.05). The mortality decreased from 7.6‰ to 5.2‰ (p<0.05).

Figure 1 Ratio of sleep evaluations performed for critically ill patients

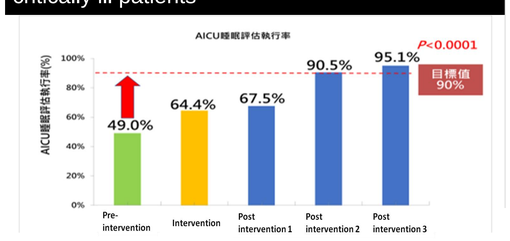

Figure 2 Ratio of high-quality sleep in critically ill patients

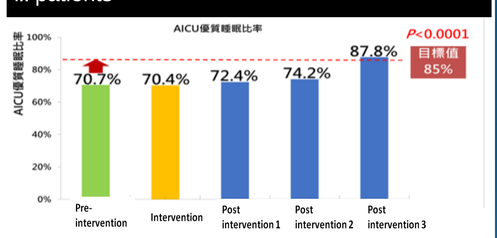

Table 1 Target attainment rate

Main Goals	Unit	Before Improvement	During Intervention	After Intervention Period 1	After Intervention Period 2	After Intervention Period 3	Target Values	*P*-value	Target Attainment Rate	Improvement Rate
		(11/2018–10/2019)	(11/2019–06/2020)	(07/2020–12/2020)	(01/2021–06/2021)	(07/2021–12/2021)				
All patients	%	(*N* = 13,076)	(*N* = 9,810)	(*N* = 8,212)	(*N* = 7,971)	(*N* = 6,930)				
Ratio of sleep evaluations performed for critically ill patients	%	49.0%	64.4%	67.5%	90.5%	95.1%	90%	< 0.0001	112 %	94%
Ratio of high-quality sleep in critically ill patients	%	70.7%	70.4%	72.4%	74.2%	87.8%	85%	< 0.0001	119 %	24%

Note: The formula for goal attainment rate is (post-improvement value - pre-improvement value) / (target value - pre-improvement value) x 100%; the formula for improvement rate is (post-improvement value - pre-improvement value) / pre-improvement value x 100%.

Figure 3 Ratio of good sleep in critically ill patients

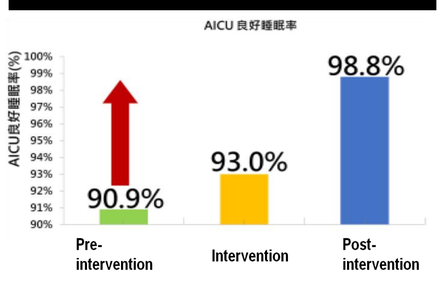

Figure 4 Ratio of precedex or propofol sedative use in hypotensive patients

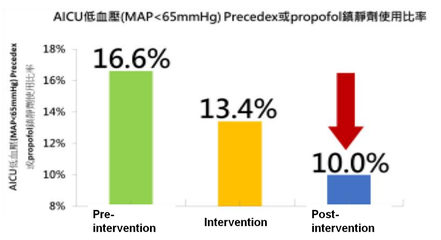

Figure 5 Ratio of good sleep in critically ill patients

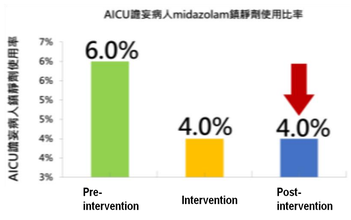

Figure 6 Rate of poorly controlled pain

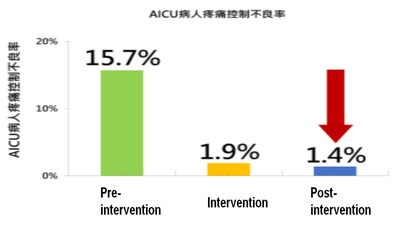

Figure 7 Rate of poorly controlled agitation

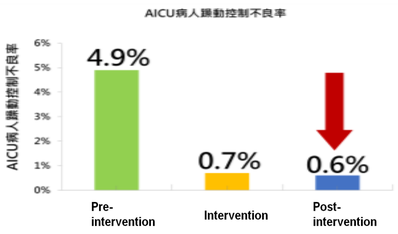

Figure 8 Rate of poorly controlled agitation

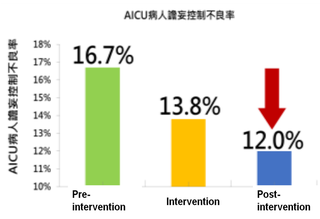

Figure 9 Number of ventilator-associated pneumonia infections

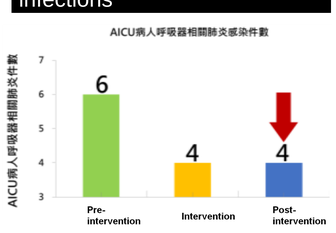

Figure 10 Ventilator-pneumonia infection density

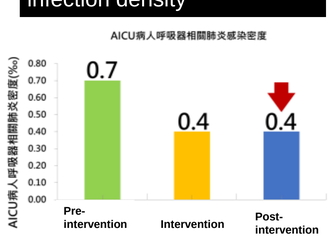

Figure 11 Number of early rehabilitations per month

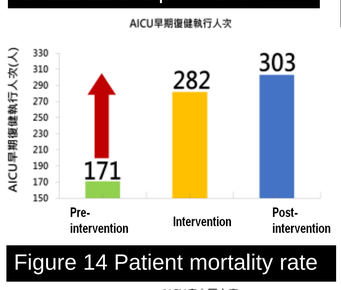

Figure 12 Implementation rate of early rehabilitation per month

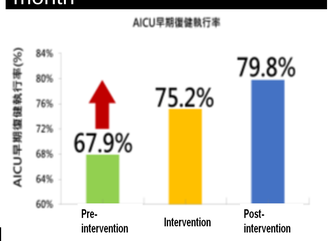

Figure 13 Average hospital stay

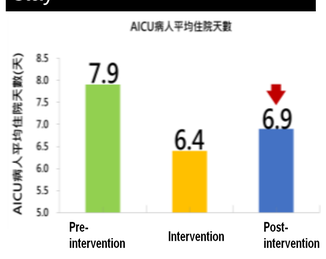

Figure 14 Patient mortality rate

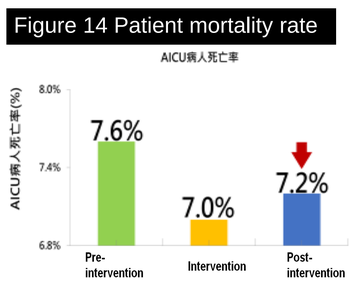

Table 2 Economic benefits

Items	Improvement Rate	Daily Economic Benefits	Annual Patient-times	Calculation Formula	Annual Economic Benefits
Economic benefits from decreased length of stay	A decrease of one day	Daily hospitalization cost of around NT$ 10,000	Total number of annual hospitalizations on average is 3590	1 day x NT$ 10,000 x 3,590	Annual savings NT$ 35,900,000
Economic benefits from decreased ventilator-associated pneumonia	Two fewer cases annually	The cost of each case is approximately NT$ 952,941	Two fewer cases annually from ventilator-associated pneumonia	2 cases x NT$ 952,941	Annual savings NT$ 1,905,882
Total economic benefits	The total economic benefits of the improvement measures amounted to more than NT$ 37.8 million (37,805,882) annually.				

Figure 2 The first in the country to provide sacrum suspension and pressure-reducing bed position care

Figure 3 The first in the country to adopt this simple pneumatic turnover device

Figure 4 Patent certificate for the simple pneumatic turnover device

Figure 5 KVGH Sleep Kit

Figure 6 Acupoint infrared heat sleep therapy for critically ill patients; the first in the country to adopt it

Figure 7 The first in the country to develop an intelligent HIS medication order system for sedative use in critically ill patients

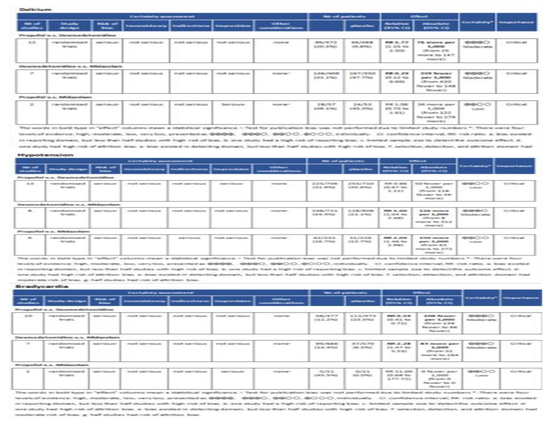

Table 8 Using big data to obtain sedative drug use data and provide medication guidelines for healthcare professionals.

Figure 8 The first in the country to develop an intelligent nursing information system for sedative use in critically ill patients

Figure 9 The first in the country to develop a critical care system for sedative use

Figure 10 Adjusting critical alarm indicators based on big data analysis

	改善前	改善中	改善後
所有警告次數	1279.5	1248.0	581.2
黃色警告	1117.7	1093.9	512.6
紅色警告	161.7	154.1	68.6
心律不整相關警告	1261.4	1215.0	556.6
SpO2相關警告	3.4	10.4	6.4
呼吸相關警告	13.8	20.6	16.9
ABP disconnet	0.9	1.3	1.3

所有警告次數=黃色警告+紅色警告
所有警告次數=心律不整相關警告+SpO2相關警告+呼吸相關警告+ABP disconnet

Figure 11 The first in the country to adopt a remote warning and care system for critically ill patients

Figure 12 The first in the country to adopt a remote warning and care system for critically ill patients

CONCLUSIONS

The study showed that implementation of continuous quality improvement using novel critical care system could increase sleep assessment ratio and good quality sleep ratio, and reduce average ICU stay. Furthermore, the incidence of ventilator-associated pneumonia and mortality also improved.