



臺中榮民總醫院  
Taichung Veterans General Hospital

# Effect of application of online early warning system in a medical center of Central Taiwan

## How to do this study

**Chieh Liang Wu, MD, PhD**  
**Taichung Veterans General Hospital, Taiwan**  
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# Taichung Veterans General Hospital (TCVGH)

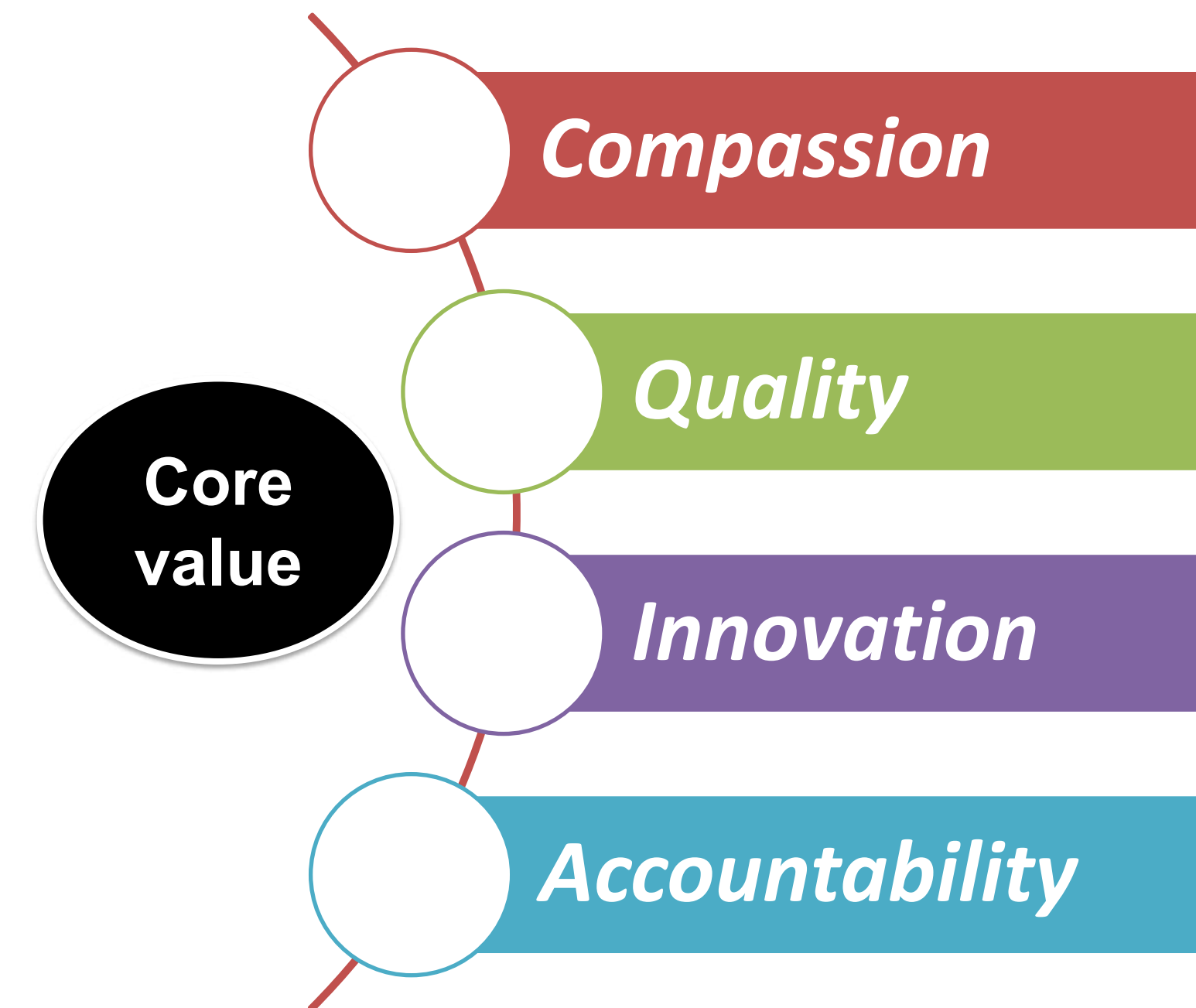


## Mission:

To deliver intelligent and holistic medicine and to provide the best healthcare



Facility	1,576	beds
Employees	3,968	members
Outpatients Service	7,558	patients/day
Emergency Service	185	patients/day
Admission Service	4,945	patients/ month
Surgery Service	3,741	patients/month



# Background: We have rapid response team (RRT), but .....

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- **The criteria to call RRT**
  - sPO<sub>2</sub> < 90%,
  - Tachycardia > 125/min and bradycardia < 45/min, associated with conscious change
  - Systolic blood pressure > 220 mmHg, or < 80mmg
  - Consciousness change (GCS decrease < or = 3)
  - Physicians or nurses judgement
  - The family call help
- **Results:**
  - **Few cases rescued by RRT**
  - **The criteria are non-specific**

# Clinical deterioration is common among hospitalized patients

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- A total of 107,868 patient admissions
  - experienced 160 cardiac arrests, 938 deaths, and 5,044 ICU transfers
  - **with 5.1% (n=5,485) of patients experiencing any adverse outcome.**
- A total of 269,999 patient admissions
  - 13,188 ICU transfers, 424 cardiac arrests, and 2,840 deaths on the ward
  - **with 6.1% (n=16,452) of patients experiencing any adverse outcome.**

Churpek MM, Yuen TC, Winslow C, Robicsek AA, Meltzer DO, Gibbons RD, et al. Multicenter development and validation of a risk stratification tool for ward patients. *Am J Respir Crit Care Med.* 2014;190(6):649-55. doi: 10.1164/rccm.201406-1022OC. PubMed PMID: 25089847; PubMed Central PMCID: PMC4214112.

Green M, Lander H, Snyder A, Hudson P, Churpek M, Edelson D. Comparison of the Between the Flags calling criteria to the MEWS, NEWS and the electronic Cardiac Arrest Risk Triage (eCART) score for the identification of deteriorating ward patients. *Resuscitation.* 2018;123:86-91. doi: 10.1016/j.resuscitation.2017.10.028. PubMed PMID:

# What we do....

## Establish an on-line early warning system



- Team:
  - In 2018, **4 doctors, 2 nurses and 4 engineers** to participate in the 18-week intensive training of Taiwan Artificial Intelligence Academy.
- Data source:
  - **40,000 patients** with a total of 100,000 admissions from 2007~2017
- Analysis:
  - statistical analysis
  - machine learning and deep learning



# Data source



## What is adverse events (AEs)

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- Patients staying in the general wards from 2007 to 2017
  - pulmonary, gastroenterology, general surgery, hematology, nephrology, and colorectal surgery
- Adverse event:
  - Receiving cardiopulmonary resuscitation (CPR)
  - Transfer to ICU due to unexpected deterioration
  - Death
- AEs
  - The AE rate among all admissions was 6.2%
  - The highest was for pulmonary, at 8.3%, and the lowest was for general surgery, 3.0%).

# What is NEWS?

## National Early Warning Score (NEWS)



- The NEWS standardizes the assessment of acute-illness severity and has been used for all adult patients globally.
- Early detection of sepsis: NEWS  $\geq 5$  and a known infections, signs and symptoms of infection or at risk of infection

Physiological parameter	Score						
	3	2	1	0	1	2	3
Respiration rate (per minute)	$\leq 8$		9–11	12–20		21–24	$\geq 25$
SpO <sub>2</sub> Scale 1 (%)	$\leq 91$	92–93	94–95	$\geq 96$			
SpO <sub>2</sub> Scale 2 (%)	$\leq 83$	84–85	86–87	88–92 $\geq 93$ on air	93–94 on oxygen	95–96 on oxygen	$\geq 97$ on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	$\leq 90$	91–100	101–110	111–219			$\geq 220$
Pulse (per minute)	$\leq 40$		41–50	51–90	91–110	111–130	$\geq 131$
Consciousness				Alert			CVPU
Temperature (°C)	$\leq 35.0$		35.1–36.0	36.1–38.0	38.1–39.0	$\geq 39.1$	

Repeated calculating EWS is necessary but is time consuming, and the early warning score (MEWS) were usually calculated incorrectly by Manual calculation.

**We calculated NEWS at 3, 6, 12, 24, 48, and 72 hours before AE onset.**

[1] Smith ME, Chiovaro JC, O'Neil M, Kansagara D, Quinones AR, Freeman M, et al. Early warning system scores for clinical deterioration in hospitalized patients: a systematic review. *Ann Am Thorac Soc.* 2014;11:1454-65.

[2] Royal College of Physicians. National Early Warning Score (NEWS) : standardising the assessment of acute-illness severity in the NHS. London: Royal College of Physicians; 2012.

[3] Royal College of Physicians. National Early Warning Score (NEWS) 2: Standardising the assessment of acute-illness severity in the NHS. Updated report of a working party. London: Royal College of Physicians 2017.

# Area under the curve to predict AEs by NEWS is time- and department-dependent

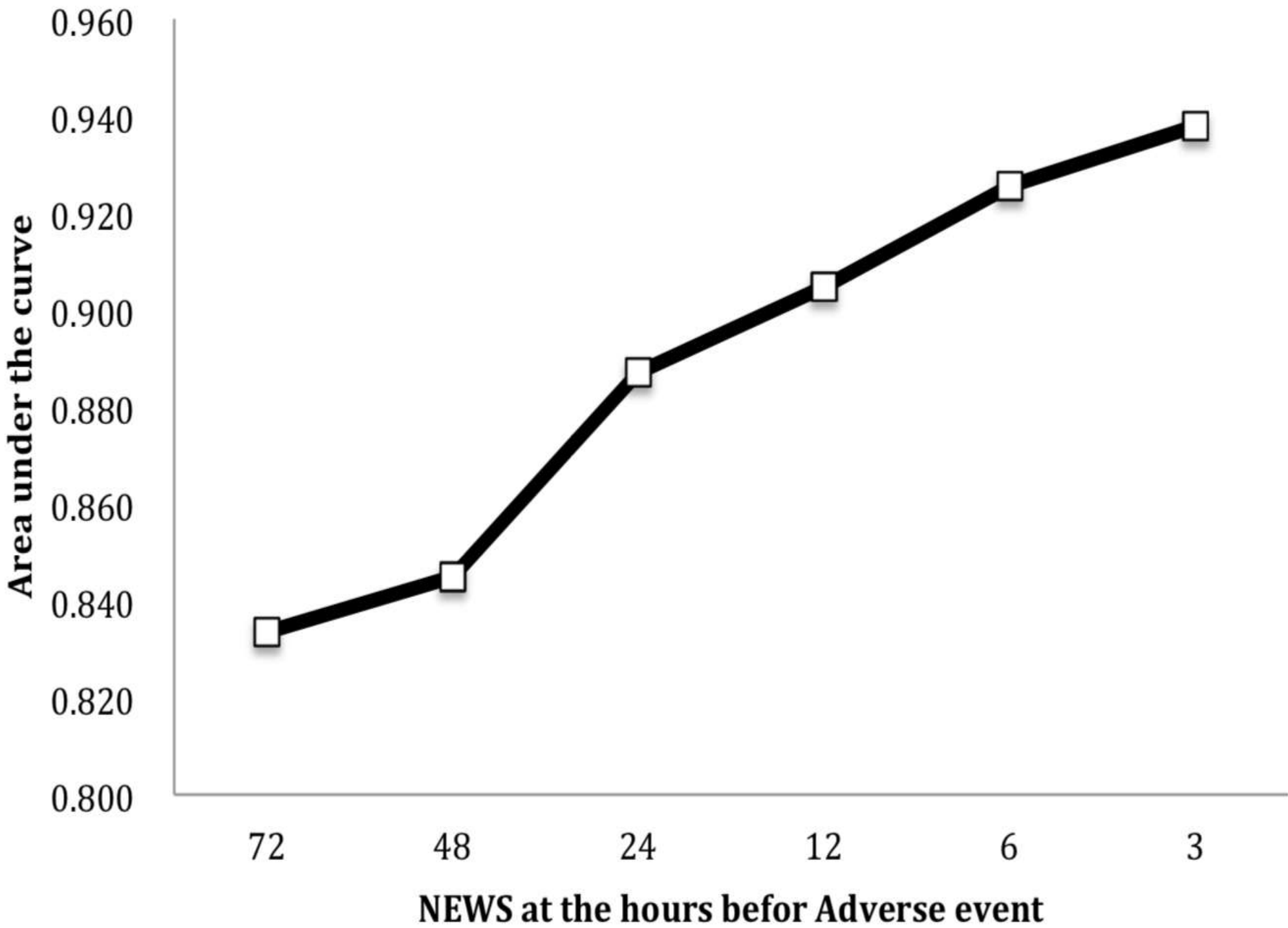


Figure 1. Using the cut-off value equal to 3, the area of under the curve (AUC) of NEWS (TCVGH) was increasing with the time near to the onset of adverse events.

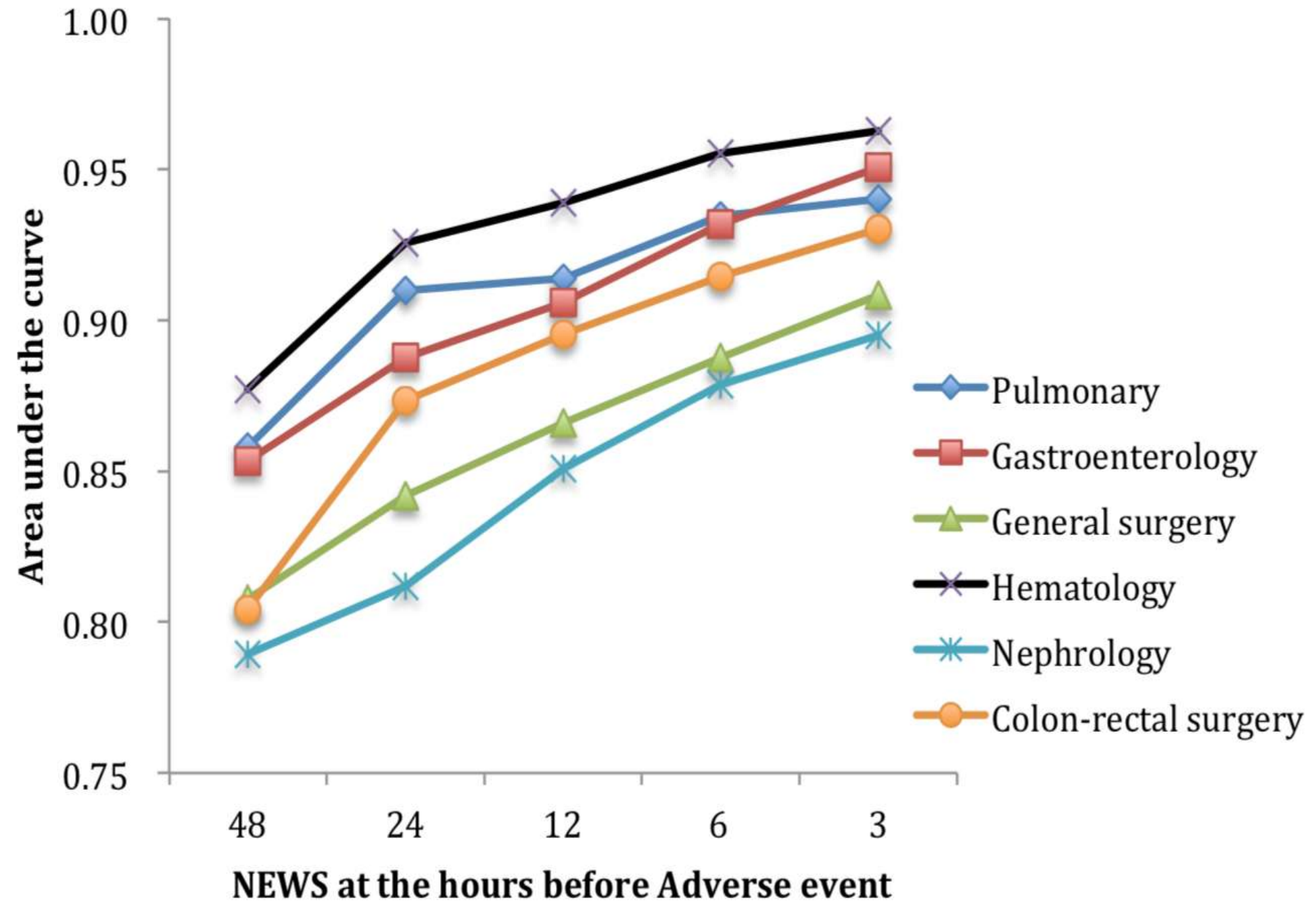
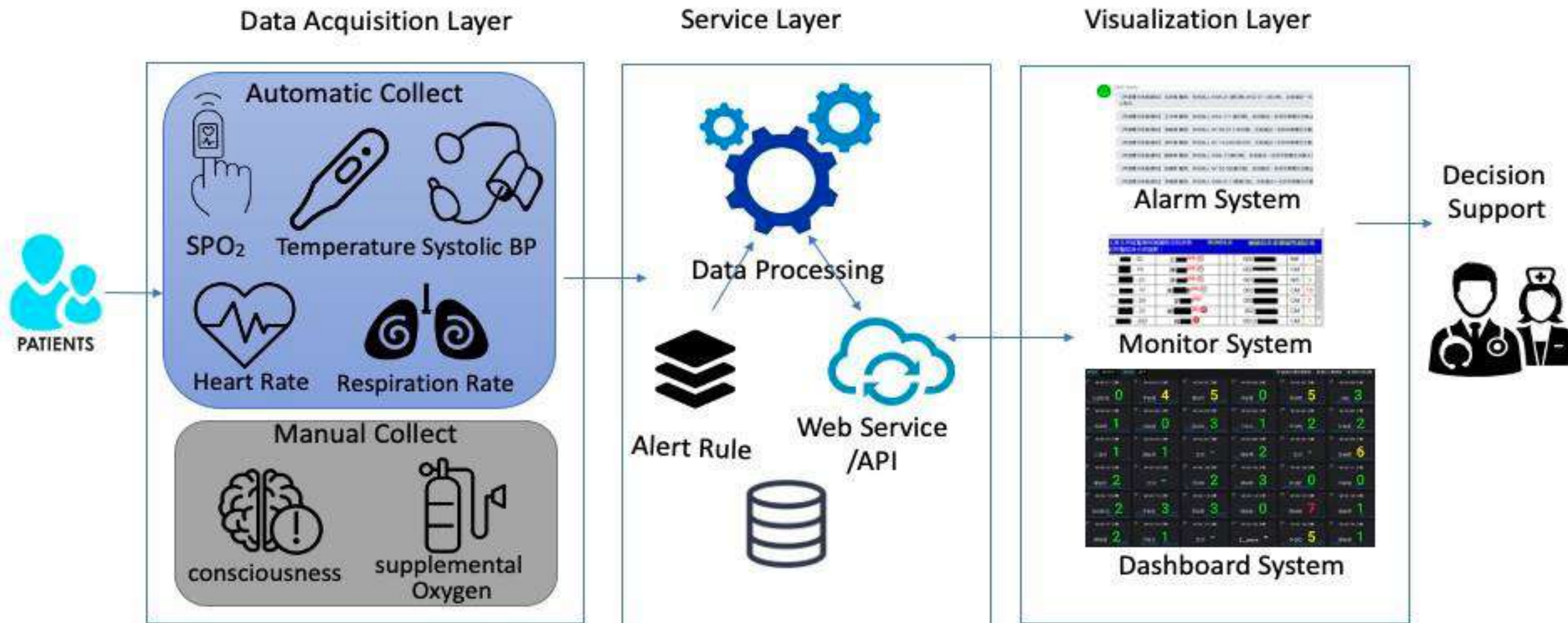


Figure 2. The performance of NEWS at the different time to adverse events varied among the patients from each department. NEWS (TCVGH) predicted adverse event best in the patients from hematology.



# NEWS in electronic Healthcare Information System

## Architecture of E-NEWS





# Providing the NEWS to our physicians

InPatient Order System

主頁及同組醫療照護團隊住院病患 BUNDLE 細菌抗生素敏感性統計表

住院醫師身份照護數：

RICU - 23	黃	(24)	000379836F	CM	7
RICU - 26	白	(24)	002763402C	CM	5

查詢住院病患

查詢住院病患

依護理站(含空床) 依護理站 各科住院名單查詢 依科別 **早期警示分數(科別)**

依醫師章號 依日期 交接班系統 CRAB床位查詢 一日內RCC轉入查詢

依病歷號 依姓名 依身分證字號 依就診號

查詢病患清單

非在院病患7天內危險值清單(0/0) 負壓隔離病房病患名單 病患住CU天數查詢

各科實習醫師病人查詢 共同照護醫師病患名單

病患通用查詢 病患住院動態查詢



ScoreByCaseno - Grafana

以顏色表徵

7

早期警示分數

score

15

10

5

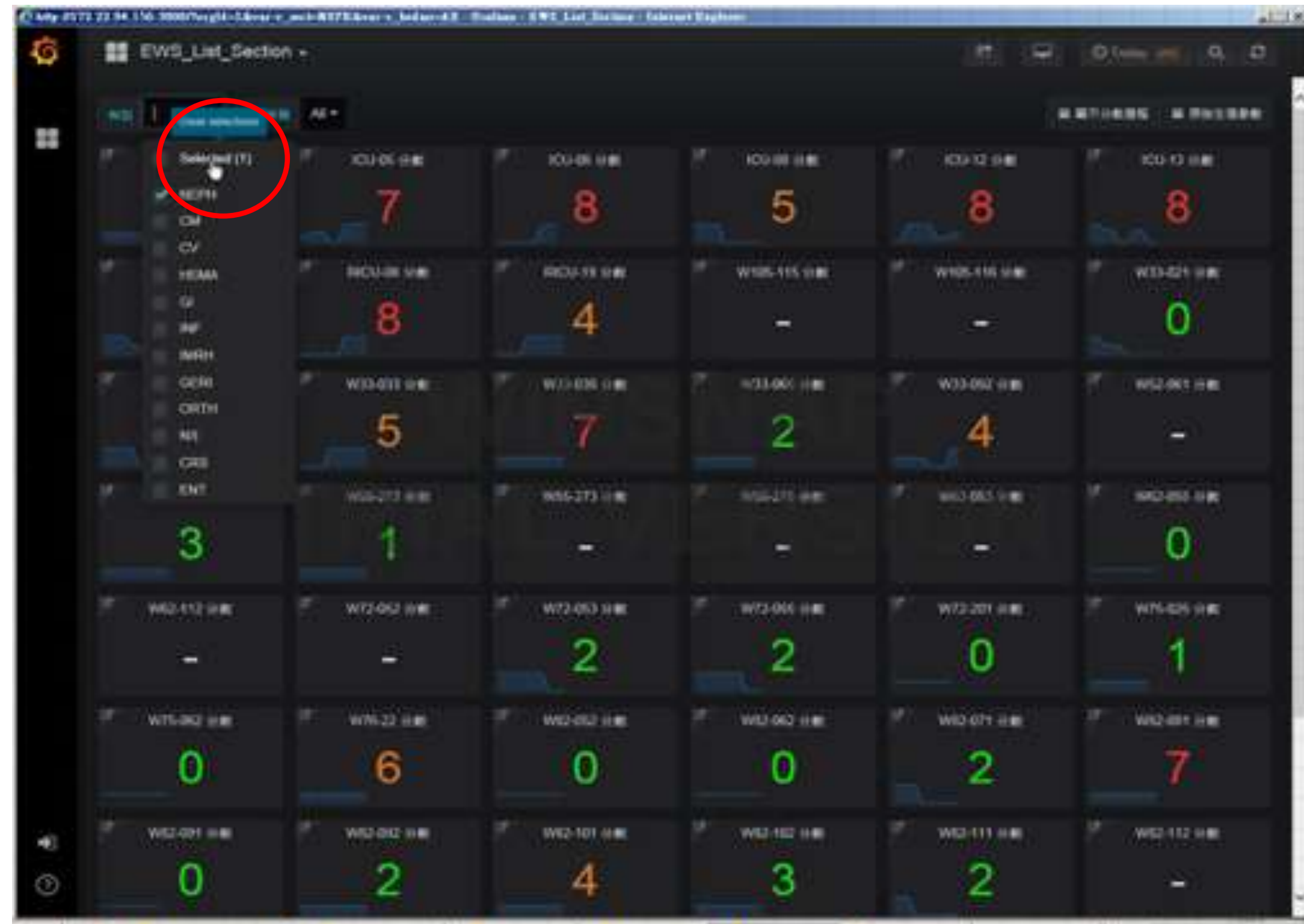
0

16:00 20:00 00:00 04:00 08:00 12:00

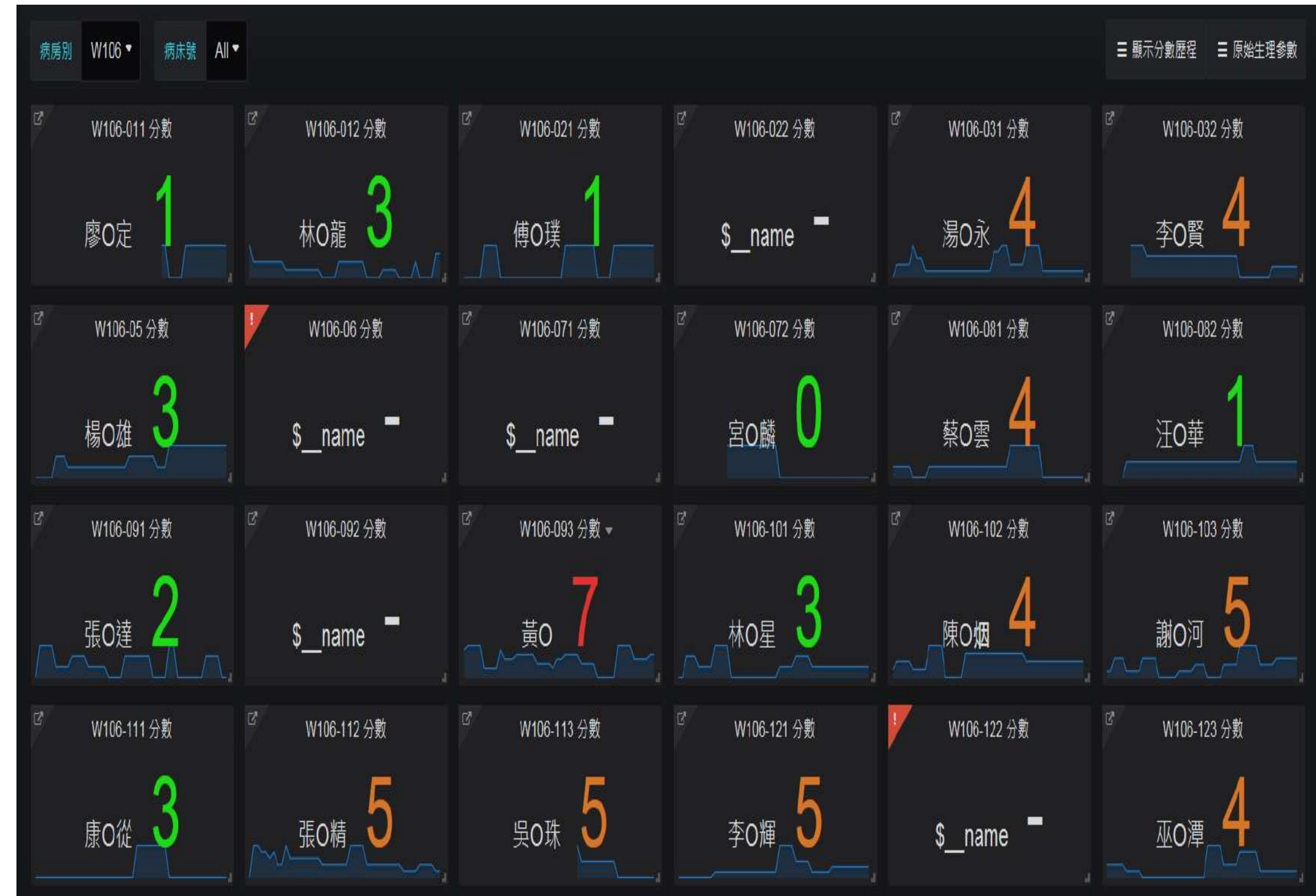
min max current

7 11 7

# NEWS Dashboard

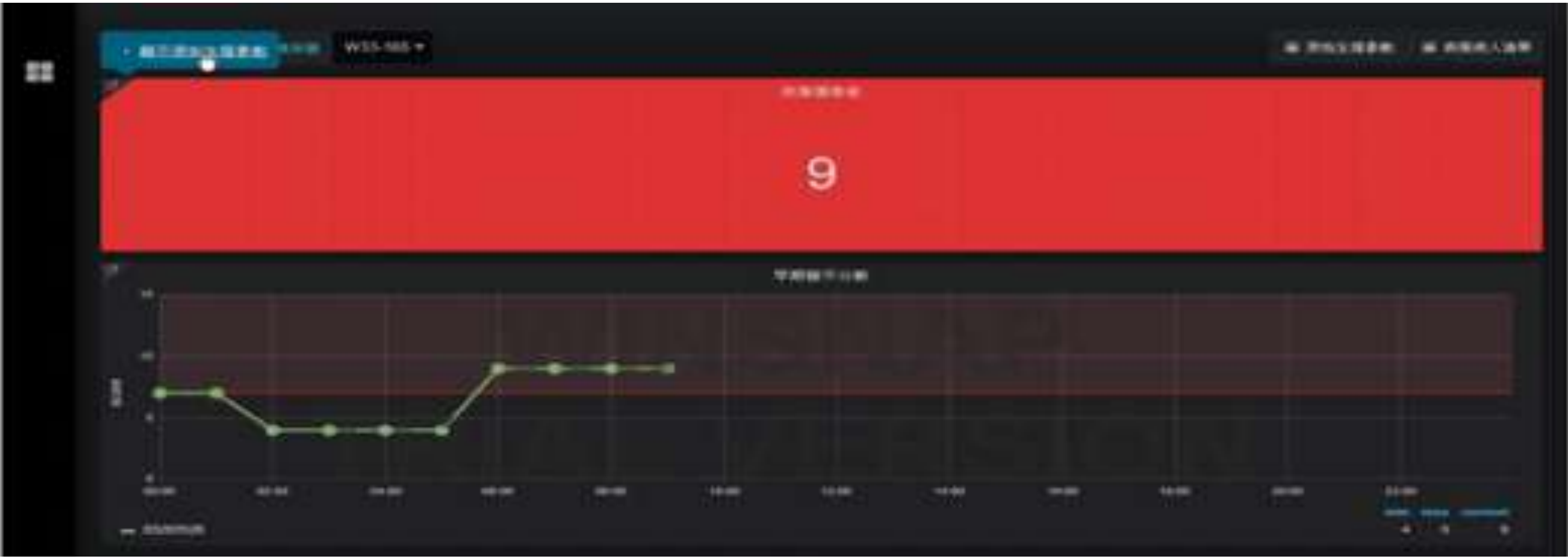


Displayed by a department for physicians



Displayed by a ward for nurses

# Tracing the trend of NEWS



# Explore the individual features of NEWS



Button to explore the source data  
點選右方「原始生理參數」的儀表板，可顯示各構面曲線圖



# E-NEWS is integrated into the nurse's hand-off system: Review the NEWS during their shifts



W106	32H	63/09/13 (45歲)	主治醫師	醫師 曾國軒 呼叫	胸腔內科 (CM)										
診斷	Hyperkalemia	病人註記	查詢	住院日期	108/10/06 (23天)	轉床資訊	查詢								
藥物不良反應	無藥物不良反應史			個管收案	載入中	KM	PST								
生理監測	執行記錄	查詢	會診	藥劑	檢體	血庫	列印	評估	計劃	記錄	出院計畫	入出院	行政	管理	營
2019/10/23	CAR:右工腫瘤仔、雙側肺浸潤增加 K:6.2--> Lactate: EKG:SF 今安寧 會診心診									powder、Lactul syr >>> 10/24 LAB(K:5.6mEq/L、					修改
2019/10/24	心跳快、 LDH 38 K:5.3 m 病況不佳									BUN 29 mg/dL、Na 131 mEq/L。					修改
2019/10/25	clear DNR(+)														修改
2019/10/27	(白)Fe HR:14									Bipap use					修改
2019/10/27	2019/10/27 2300 早期警示分數: 7分														修改
2019/10/28	安寧共照探視,病人與家屬知曉病況不佳,希望緩解不適感為主,教導家屬床旁陪伴技巧/安寧蓮馨#61850														修改
2019/10/29	2019/10/29 0700 早期警示分數: 10分														修改
2019/10/29	(大)跌倒,頭部、右手著地,無外傷 >> 三班評值(10/29 -11/1 0200)														修改
															新增資料

不需協助
  瀕臨死亡返家 地區: , 車程約 分鐘
  DNR

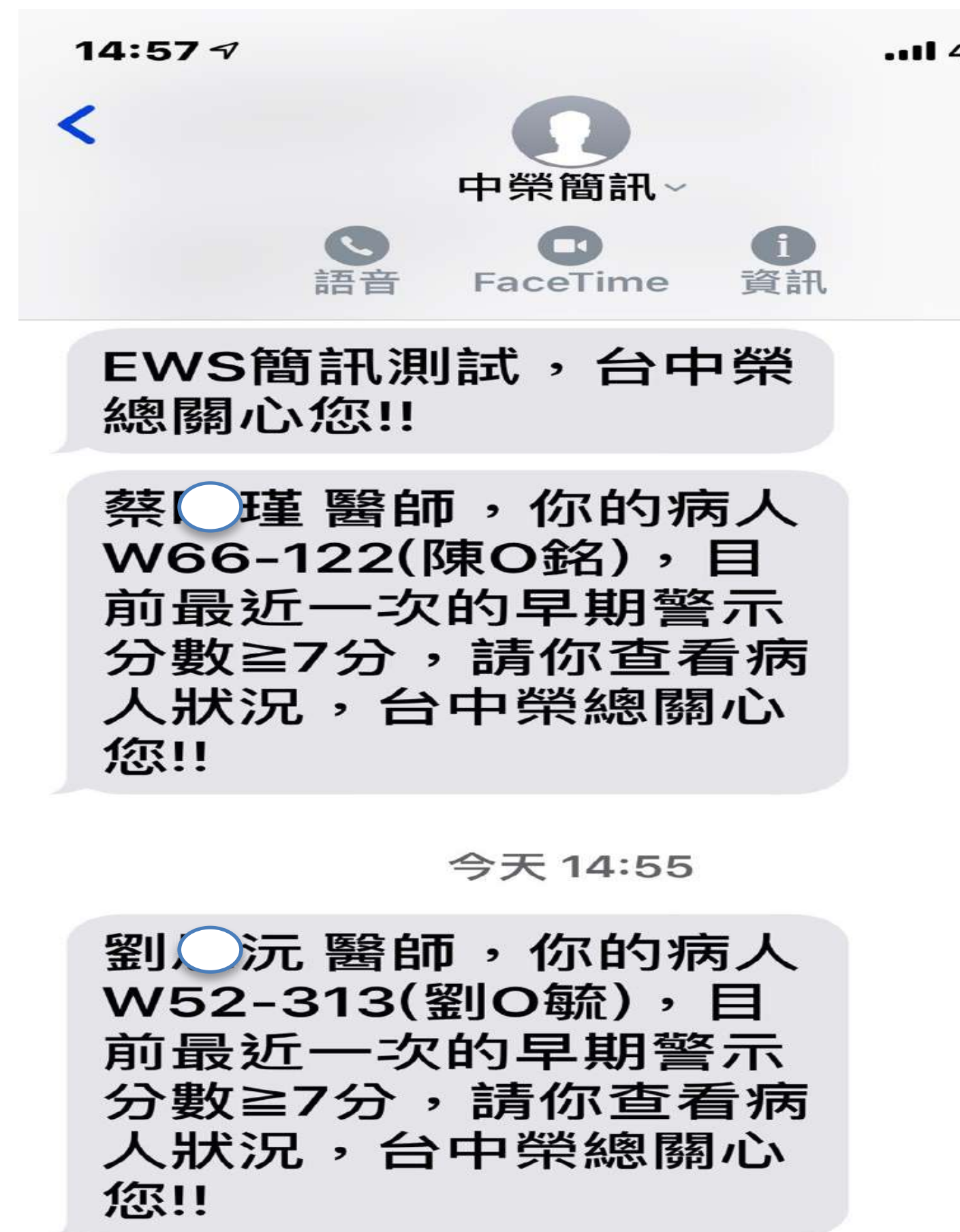
# Send the risk message to the care team or in-charge physicians by Line or Mobile phone



Send the risk message to the care team by Line



Send the risk message to in-charge physicians

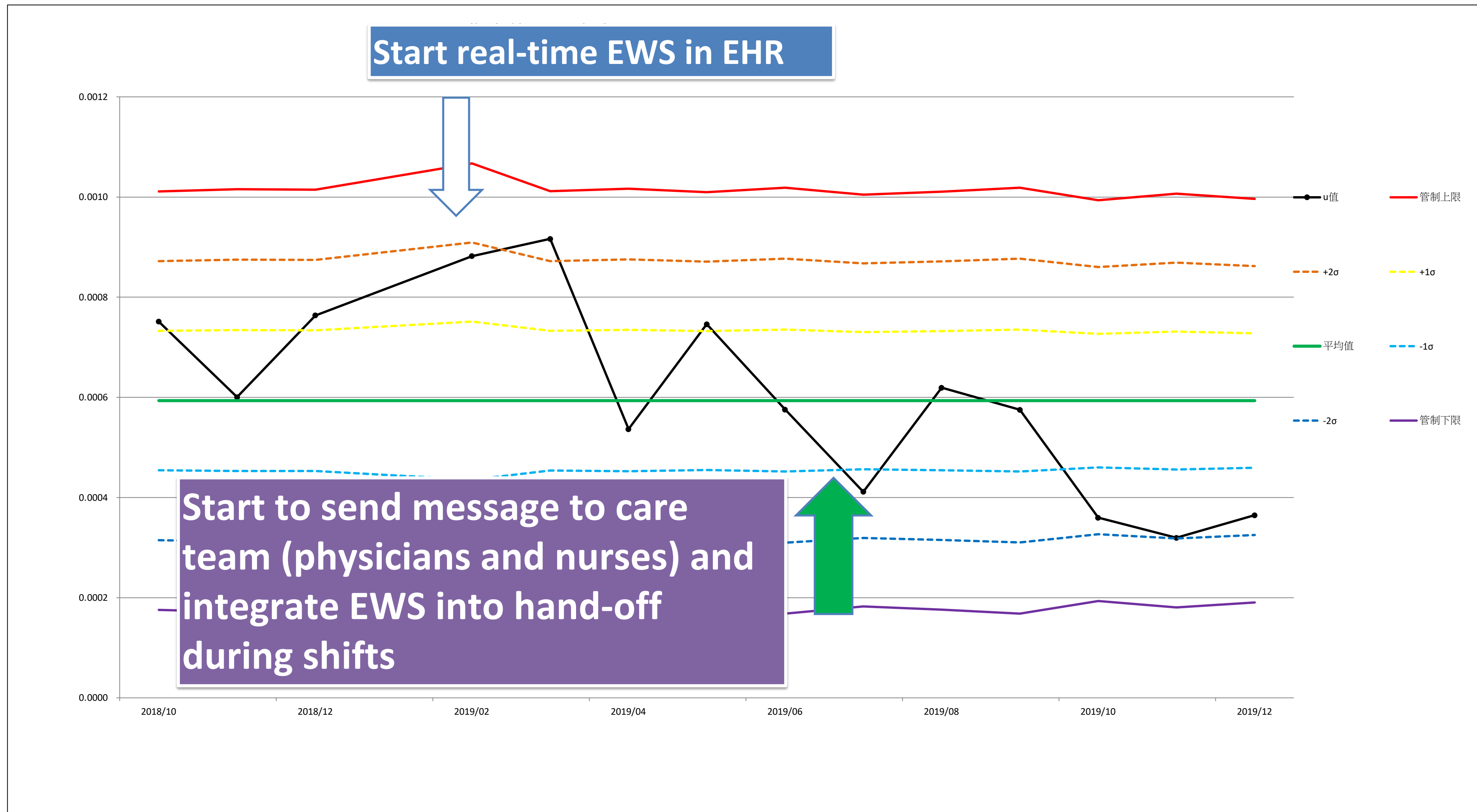


Send the message 7:00 and 17:00

$EWS \geq 7$  in the last 12 hours

$EWS$  increase  $\geq 4$  in the last 12 hours

# The number of CPR at wards decreased gradually



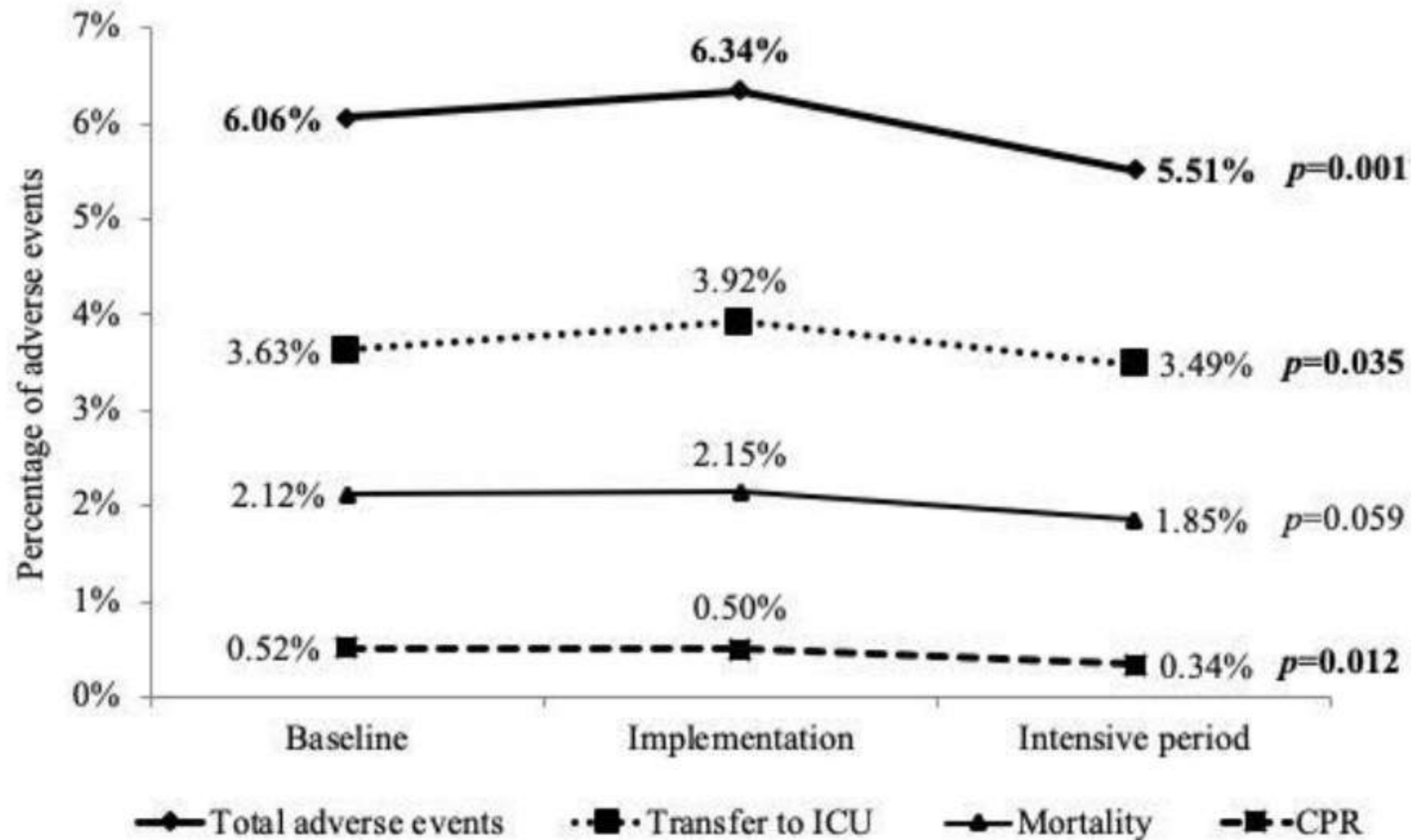


# Demographic data at the different periods of implementation



	Total ( <i>n</i> = 73,674)		Baseline ( <i>n</i> = 23,543)		Implementation ( <i>n</i> = 30,035)		Intensive Period ( <i>n</i> = 20,096)		<i>p</i> Value
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
Age (mean ± SD)	57.9	17.1	58.1	17.3	57.8	17.2	57.9	16.8	0.165
Gender-Male	37,543	(50.96%)	12,036	(51.12%)	15,415	(51.32%)	10,092	(50.22%)	0.044 *
Diagnosis groups at discharge									
Cancer	31,462	(42.70%)	9843	(41.81%)	12,945	(43.10%)	8674	(43.16%)	0.003 **
Cardiovascular disorder	12,083	(16.40%)	3874	(16.45%)	4910	(16.35%)	3299	(16.42%)	0.944
Neurological (non-stroke)	11,998	(16.29%)	3788	(16.09%)	4929	(16.41%)	3281	(16.33%)	0.597
Neurological (stroke)	3240	(4.40%)	1040	(4.42%)	1290	(4.29%)	910	(4.53%)	0.452
Respiratory disorder	7791	(10.57%)	2564	(10.89%)	3250	(10.82%)	1977	(9.84%)	<0.001 **
Diabetes	10,012	(13.59%)	3113	(13.22%)	4135	(13.77%)	2764	(13.75%)	0.137
Gastroenterology	9571	(12.99%)	3041	(12.92%)	3895	(12.97%)	2635	(13.11%)	0.823
Renal disorder	6961	(9.45%)	2256	(9.58%)	2839	(9.45%)	1866	(9.29%)	0.572
DNR code	4751	(6.45%)	1515	(6.44%)	1990	(6.63%)	1246	(6.20%)	0.164
Settings of clinical care									0.994
Medical departments	39,452	(53.55%)	12,600	(53.52%)	16,087	(53.56%)	10,765	(53.57%)	
Surgical departments	34,222	(46.45%)	10,943	(46.48%)	13,948	(46.44%)	9331	(46.43%)	

# Reduction in AEs in Implementing E-NEWS





# Conclusions

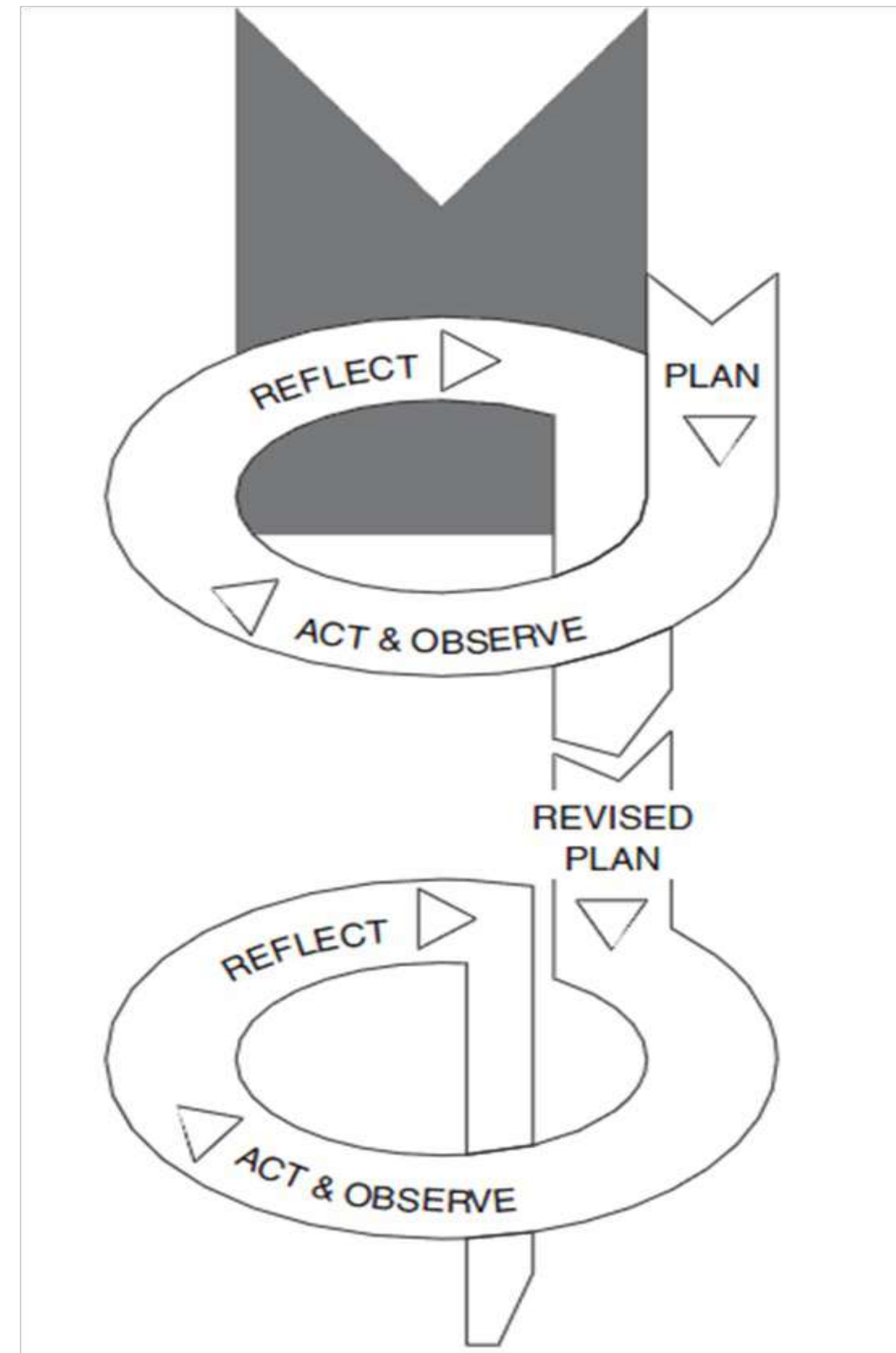
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- Establish an on-line early warning system.
  - By NEWS and/or By AI algorithm
- Realtime update information of risk signal every hour
  - Obtain risk signal with accuracy, quick and less workload
- Risk signal embed into EHR and dashboards
  - Integrate the risk signal into the workflow of care team
- Expected Outcomes
  - Significant decrease of CPR at wards by statistical process control chart

**Technique supports physicians and nurses  
Improve patient safety**

# Study design: Action Research Spiral

1. Planning in order to initiate change
2. Implementing the change (acting) and observing the process of implementation and consequences
3. Reflecting on processes of change and re-planning
4. Acting and observing
5. Reflecting



<https://research-methodology.net/research-methods/action-research>

# Step I : Summarize the evidence



Identify interventions associated with improved outcomes

確認足以改善結果的介入

Select interventions with the largest benefit and the lowest barriers to use

選擇最有效果最低障礙的介入

Convert intervention to behavior

轉化介入成為常規照護的行為

# Step II: Identify local barriers to implementation



## Observe staff performing the interventions

- 觀察同仁執行介入措施

## “Walk the process” to identify defects in each step of implementing the intervention

- 親自進入執行介入措施照護的現場，找出缺點

## Enlist all stakeholders to share concerns and identify potential gains/losses associated with implementing the intervention

- 利益相關者共同關心介入措施後的得與失

Respir Care 2010;55(7):922-928

# Step III : measure the performance

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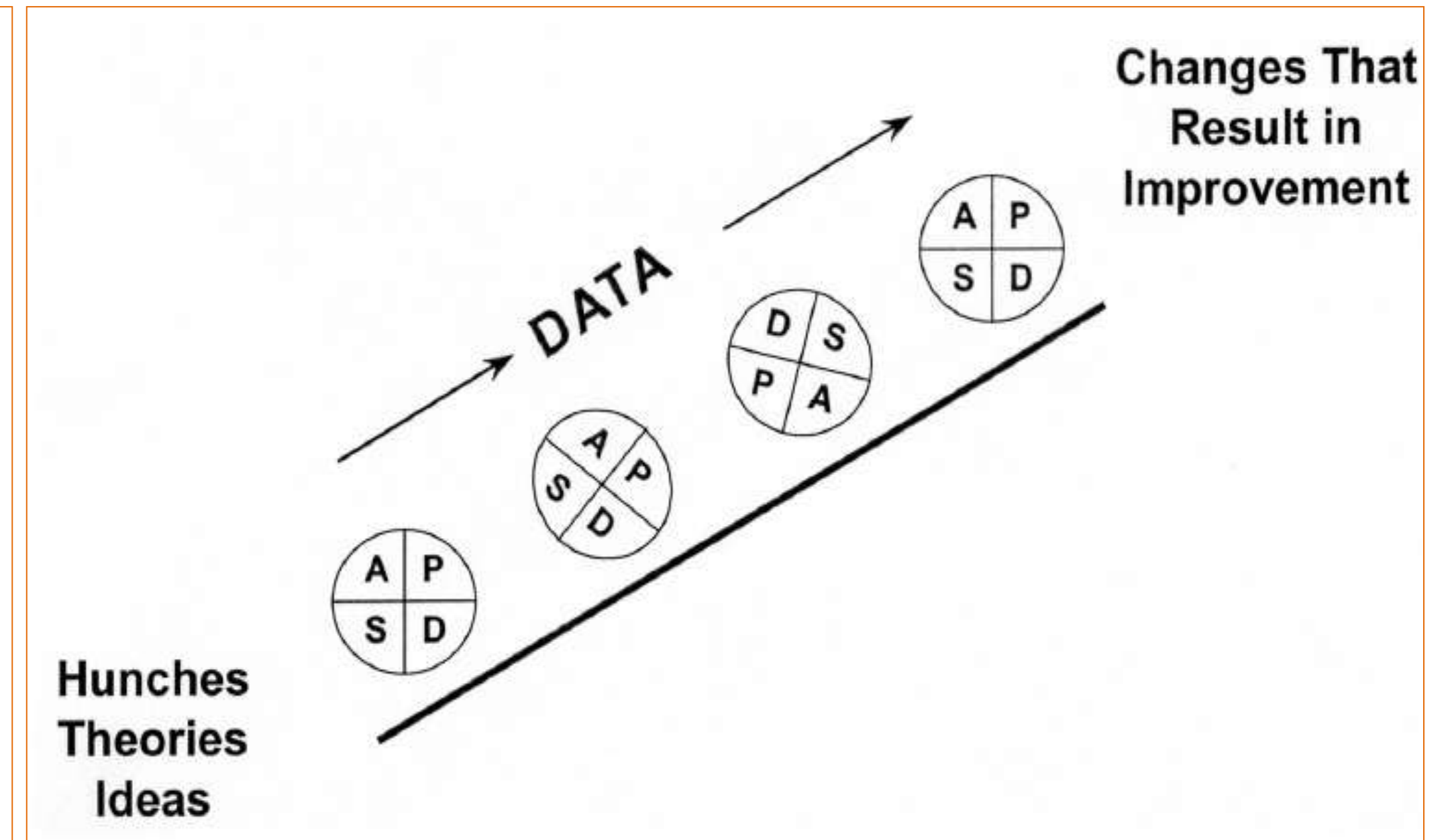
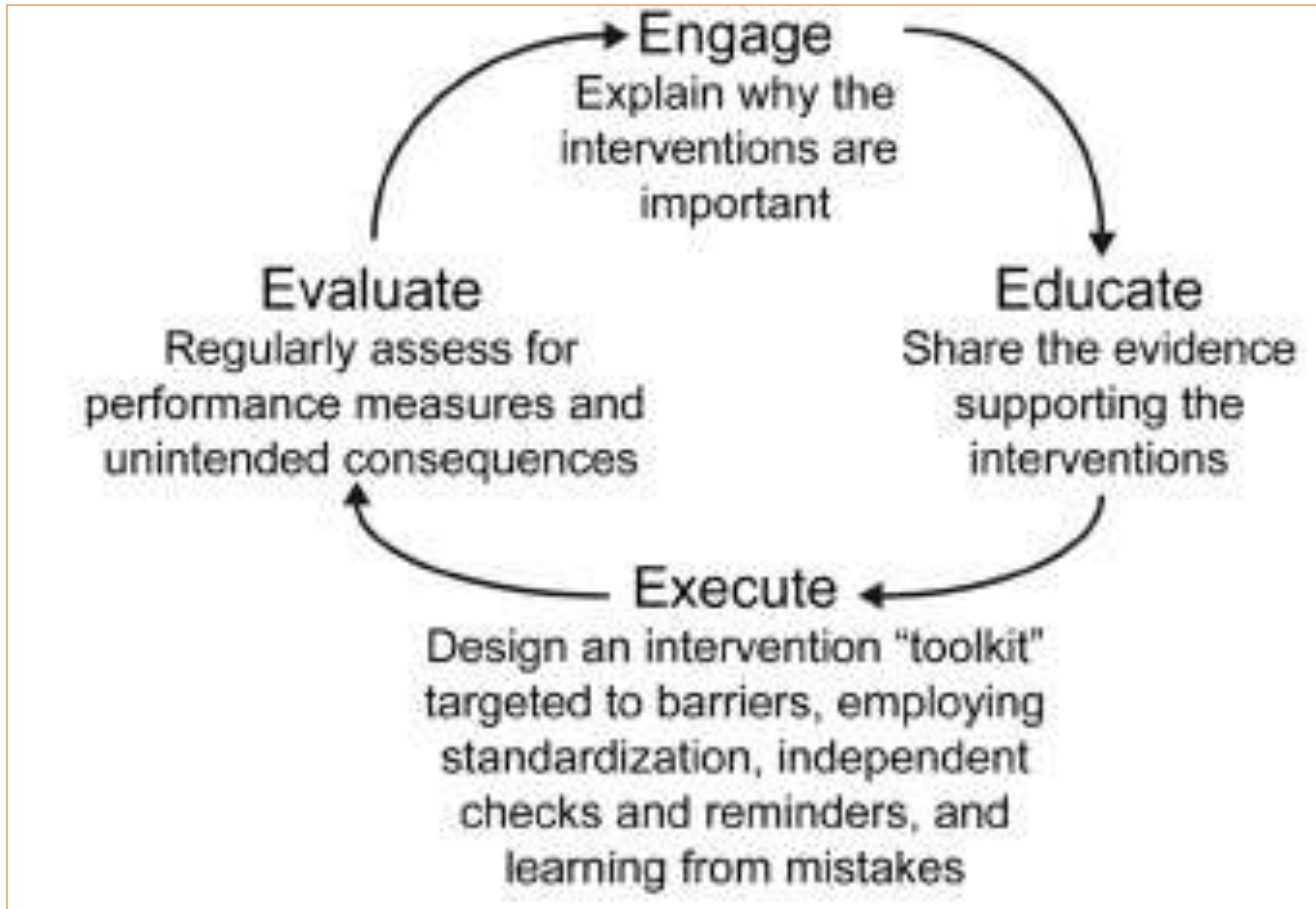
Relevance to the knowledge translation project

Validity as a measure of the underlying problem

Reliability when repeatedly measured

Feasibility for measurement as part of routine practice

# Step IV : Ensure all patients receive the interventions



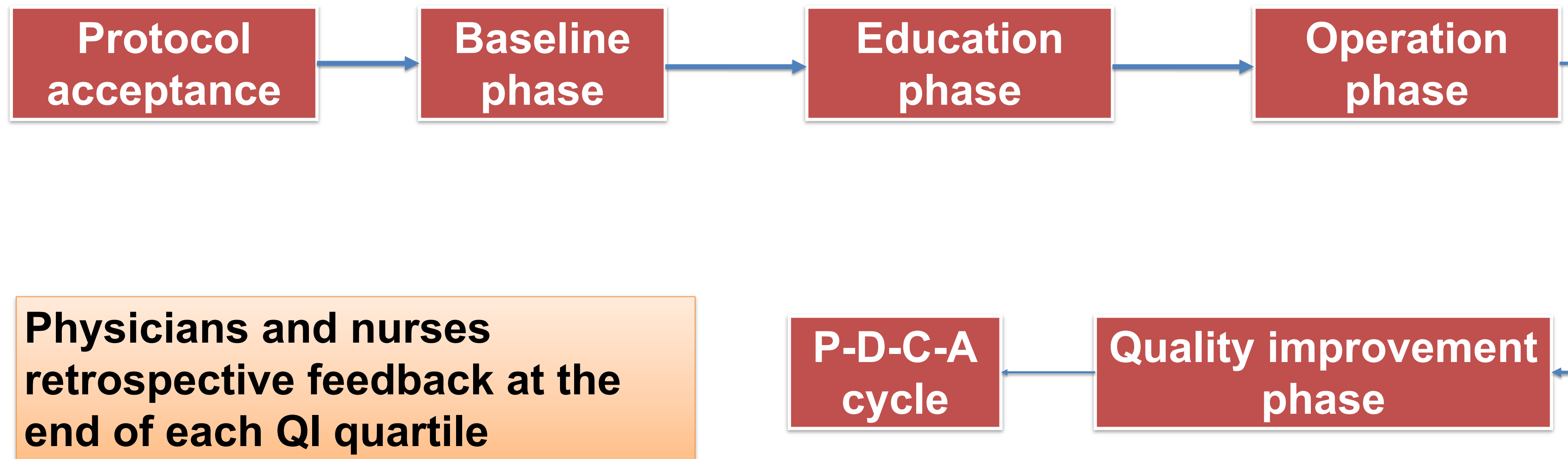
**Respir Care 2010;55(7):922-928**



# A quality improvement bundle in bridging the gap between research and standard care



- Creation of a protocol
- Implement the protocol via quality improvement



Nguyen et al 2007; 1079



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# 感謝您的聆聽！

## Thank you !