

# 수면센터에서의 응급상황



강 경 욱

전남대병원 신경과

## Sleep center emergencies

Kyung Wook Kang, MD, PhD

Chonnam National University Hospital Department of Neurology

### How safe is PSG ?

- 1991, US HHS  
PSG as "an entirely non-invasive procedure, and would have the same degree of risk as, for example an ECG (electrocardiogram) examination."
- AASM  
Awareness of emergency  
Training in emergency procedure  
Written policy for emergencies

SLEEP 2004;27(7):1379-1382

### How safe is PSG ?

**Objectives:** The purpose of the study was to verify whether minimal concern is warranted in regard to serious adverse effects in the sleep laboratory.

**Design:** A prospective multicenter study.

**Participants:** Three scoring teams for 17 sleep laboratories.

**Methods:** Reports of adverse events occurring during polysomnography or identified upon scoring a study were collected over an 18-month time period. Incidence of mortality and adverse events were evaluated using a binomial distribution based on the Bernoulli process.

**Results:** Of 16,084 studies, the mortality rate during or 2 weeks after an adverse event, as noted, was 0.005%, and the overall rate of adverse events was 0.26%.

**Conclusions:** Adverse event rates are low; however, procedures for handling medical emergencies or adverse events during or after polysomnography are prudent, and those studies performed for research should include preparedness for the possibility of adverse events.

**Key Words:** Adverse events, polysomnography, obstructive sleep apnea

**Citation:** Mehra R, Strihl KP. Incidence of serious adverse events during nocturnal polysomnography. SLEEP 2004;27(7):1379-83.

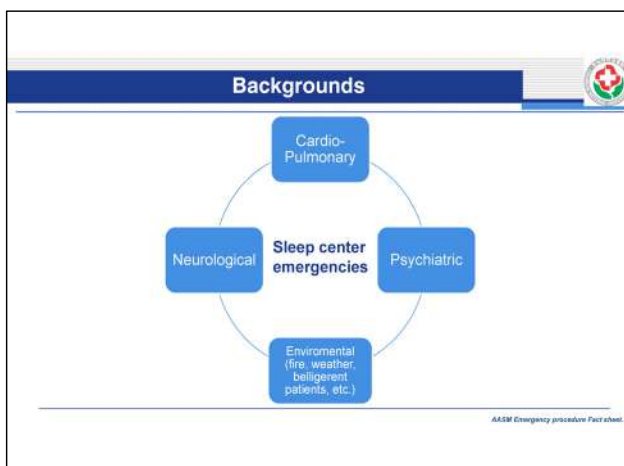
1 fatal event at fifth month

30 min

1 event / 287 PSG

Outcome	Patients, no. (n=16084)	Percentage [95% confidence interval]
Overall deaths	1	0.0062 [0.0-0.019]
Events prompting immediate evaluation	28	0.17 [0.0-0.24]
Events noted as concerning after a study	28	0.17 [0.0-0.24]
All events	56	0.35 [0.26-0.45]

SLEEP 2004;27(7):1379-1382



### Patient Safety Incidents During Overnight Polysomnography: A Five-Year Observational Cohort Study

**Introduction:** Abnormal polysomnography (PSG) is a common procedure and is regarded as relatively safe. There have been few systematic evaluations of adverse events occurring during PSG. An understanding of the frequency and type of the adverse events during PSG should inform risk mitigation plans and the development of guidelines for sleep center accreditation. We aimed to identify, tabulate, and classify all adverse events that occurred during overnight PSG conducted at an accredited sleep center over a five-year period.

**Methods:** All adverse events occurring from Jan 1, 2008, to Dec 31, 2012, at the Center for Sleep Medicine, Mayo Clinic, were identified; information was obtained from calls made to emergency responders, to the adverse event reporting system, and events forwarded to the medical director.

**Results:** A total of 38,541 PSGs were performed over the study duration. Fifty-eight adverse events occurred during the study period (1 event/623 PSGs). Most adverse events were cardiac in nature (17/58; 29.3%), a majority involving acute chest pain. Falls were the next most common (20/58; 34.3%), followed by neurologic (8/58; 13.8%), pulmonary (3/58; 5.0%), and psychiatric (2/58; 3.4%) events. The rest were classified as miscellaneous. There were no patient deaths during PSGs. The majority of patients experiencing an adverse event were transported to the emergency room (27/58; 46.7%), or home (15/57; 40.5%) were admitted to the hospital, and 3 required an ICU bed.

**Conclusion:** Adverse events during a PSG were relatively uncommon. Previous emphasis on cardiac arrhythmias may be reconsidered, as chest pain and patient falls were commonest.

**Keywords:** Polysomnography, adverse events

**Citation:** Kolla BP, Lam E, Olson E, Mergenthaler T. Patient safety incidents during overnight polysomnography: a five-year observational cohort study. J Clin Sleep Med 2013;9(11):1201-1206.

**Safety Incidents**

- reported to the medical director & "event line"
- resulted in summoning emergency medical personnel
- resulted in the patient being transferred to the ER

110 EMS Calls  
39 Calls to Event Line  
27 Events reported to Medical Director

12 No further information regarding the event available in medical record

85 Events not during overnight PSG

35 Duplicate Events

58 Events for review

1 event / 623 PSG

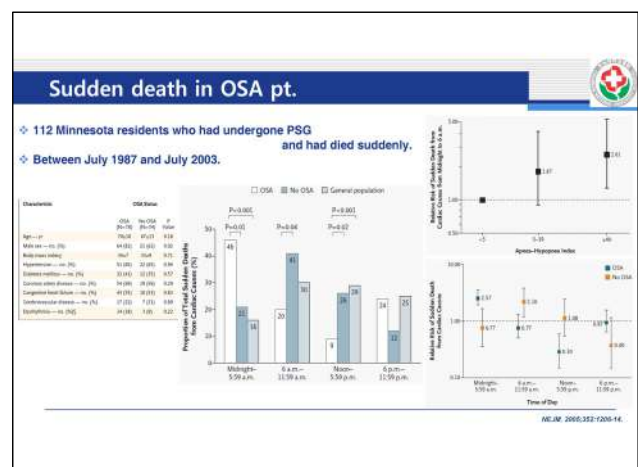
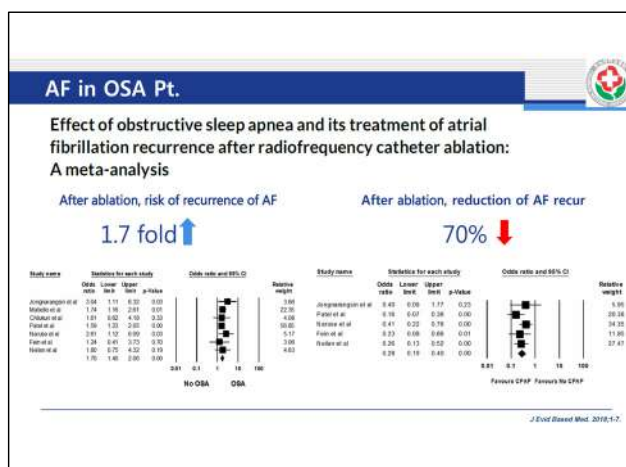
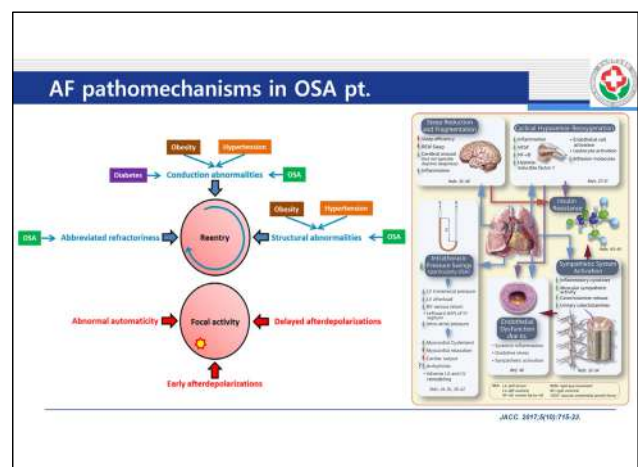
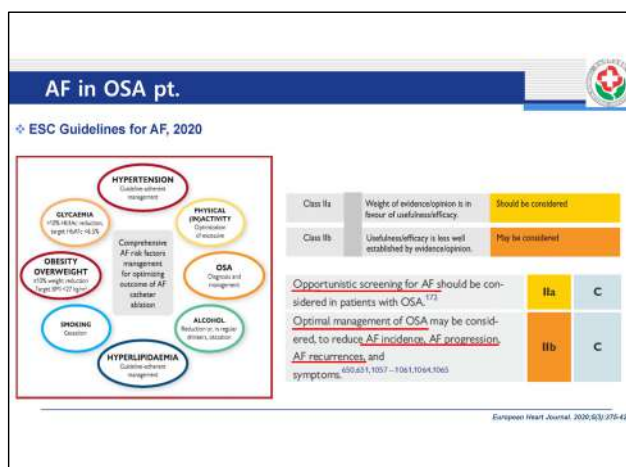
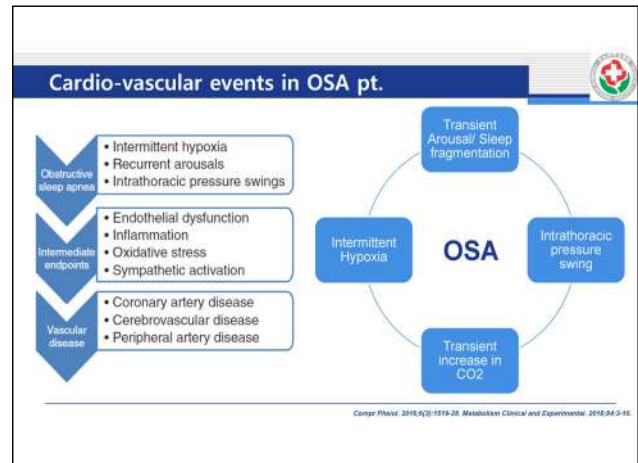
JCSM 2013;9(11):1201-1206

### Patient Safety Incidents During Overnight Polysomnography: A Five-Year Observational Cohort Study

KSMM Journal of Clinical Sleep Medicine

Event	Specification	No. of event (%)	ER visits (%)	No. of adm. (%)
Cardiovascular	Chest pain (12)	17 (29.3%)	15 (40.5%)	7 (46.7%)
	Arrhythmia (4)	Sinus tachycardia (1), 1st AV block (1), A-fib(2)		
	Cardiogenic syncope (1)			
Falls	Zolpidem (42%), Fall precautions (58%)	12 (20.6%)	2 (5.4%)	0 (0)
Neurological	Seiz (1), Syncope (2), TIA (1), Migraine (1)	5 (8.6%)	3 (8.1%)	1 (6.7%)
Psychiatric		2 (3.4%)	1 (2.7%)	1 (6.7%)
Pulmonary		2 (3.4%)	2 (5.4%)	1 (6.7%)
Others	Epistaxis (2), Hyperglycemia (2), Child abuse (2), Others (14)	20 (34.5%)	14 (37.8%)	5 (33.3)

KSMM 2013;9(1):1201-1205



### Sudden death in OSA pt.

**Objectives** This study sought to identify the risk of sudden cardiac death (SCD) associated with obstructive sleep apnea (OSA).

**Background** Risk stratification for SCD, a major cause of mortality, is difficult. OSA is linked to cardiovascular disease and arrhythmias and has been shown to increase the risk of nocturnal SCD. It is unknown if OSA independently increases the risk of SCD.

**Methods** We included 10,701 consecutive adults undergoing their first diagnostic polysomnogram between July 1997 and July 2008. During follow-up to 35 years, we assessed incident nonfatal or fatal SCD in relation to the presence of OSA, physiological data including the apnea-hypopnea index (AHI), and nocturnal oxygen saturation (O<sub>2</sub>sat) parameters, and relevant comorbidities.

**Results** During an average follow-up of 5.3 years, 142 patients had nonfatal or fatal SCD (annual rate 0.27%). In multivariate analysis, independent risk factors for SCD were age, hypertension, coronary artery disease, cardiomyopathy or heart failure, ventricular tachycardia or non-sustained ventricular tachycardia, and lowest nocturnal O<sub>2</sub>sat (per 10% decrease, hazard ratio [HR], 1.4;  $p < 0.025$ ). SCD was best predicted by age >40 years (HR, 1.53), apnea-hypopnea index >20 per hour (HR, 1.66), mean nocturnal O<sub>2</sub>sat <93% (HR 2.93), and lowest nocturnal O<sub>2</sub>sat <70% (HR, 2.60, all  $p < 0.0003$ ).

**Conclusions** In a population of 10,701 adults referred for polysomnography, OSA predicted incident SCD, and the magnitude of risk was predicted by multiple parameters characterizing OSA severity. Nocturnal hypoxemia, an important pathophysiological feature of OSA, strongly predicted SCD independently of well-established risk factors. These findings implicate OSA, a prevalent condition, as a novel risk factor for SCD. (J Am Coll Cardiol 2013;62:510-6) © 2013 by the American College of Cardiology Foundation

❖ Factor associated with an increased risk of SCD.

- Age (>60yrs, HR 5.53), AHI (>20/hr, HR 1.6), Mean nocturnal O<sub>2</sub> sat, (<93%, HR 2.93), Lowest O<sub>2</sub> sat, (<78%, HR 2.6)

JACC. 2013;62:510-616

### ASSM Cardiac rule

❖ Technical Specifications (Version 2.6)

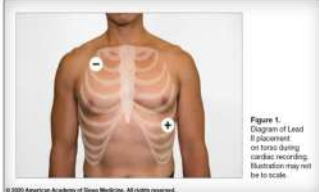


Figure 1. Diagram of Lead II placement on torso during cardiac recording. Illustration may not be to scale.

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- Additional leads may be placed.
- Increasing the image size on the display may improve detection of arrhythmia.
- Standard ECG electrode applications are superior to EEG electrodes in minimizing artifact.

JCSM. 2007;3(2):147-154.

### ASSM Cardiac rule

❖ Classification of Arrhythmia

```

graph TD
    RD[Rhythm disorders] --> FD[Formation disorders]
    RD --> CD[Conduction disorders]
    FD --> BR[Bradyarrhythmias]
    FD --> TR[Tachyarrhythmias]
    BR --> SSS[Sick sinus syndrome]
    SSS --> SB[Sinus bradycardia]
    SSS --> SP[Sinus pause]
    SSS --> SEB[Sinoatrial exit block]
    SSS --> TCB[Tachycardia-bradycardia syndrome]
    TR --> SO[Site of origin?]
    SO --> ST[Sinus tachycardia]
    SO --> AT[Atrial tachycardia]
    SO --> AF[Atrial fibrillation]
    SO --> PSVT[PSVT; AVNRT, AVRT]
    SO --> JT[Junctional tachycardia]
    SO --> VT[Ventricular tachycardia]
    SO --> TP[Torsades des pointes]
    SO --> VF[Ventricular fibrillation]
    CD --> BR2[Bradyarrhythmias]
    BR2 --> SB2[Site of block?]
    SB2 --> AVB[Atrioventricular block]
    AVB --> D1[1st degree]
    AVB --> D2[2nd degree; Mobitz 1, 2]
    AVB --> D3[3rd degree = complete]
    SB2 --> BBB[BBB; right, left]
    SB2 --> LFB[LFB; anterior, posterior]
  
```


JCSM. 2007;3(2):147-154.

### ASSM Cardiac rule

❖ Bradycardia

- Unpublished data from 2,607 adults subjects (F: 1,448, M: 619, Mean age: 62.1yrs)
- Minimum normative value (F: 47.5 bpm, M: 43 bpm)
- In nocturnal holter study from 50 healthy young males: Mean HR (43 bpm), minimum HR of <40bpm in 24%.
- In the SHHS data, females have consistently been shown to have higher average HR than male.
- Scoring: sustained heart rate < 40bpm for ages 6 years through.

$118.1 - (0.57 \times \text{age}) = X \pm 14\%$  (normal heart rate)



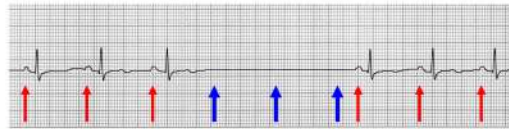
Heart Rate	Rhythm	P wave	PR interval	QRS
<40 bpm	Regular	Before each QRS, identical	0.12 to 0.20 sec	< 0.12 sec

ASSM Scoring Manual V 2.6 © JCSM. 2007;3(2):147-154.

### ASSM Cardiac rule

❖ Asystole


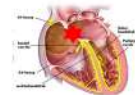
- In young healthy subjects, sinus pause is longer during sleep than wakefulness.
- More prolonged in males than in females
- 37 percent of trained athletes have been reported between 2-3 sec during sleep.
- Scoring: cardiac pause greater than 3 sec for ages 6 years through.





ASSM Scoring Manual V 2.6 © JCSM. 2007;3(2):147-154.

### Tachyarrhythmia

Narrow QRS tachycardia (QRS < 120msec, 작은눈금 3칸 이내)

Wide QRS tachycardia (QRS > 120msec, 작은눈금 3칸 이상)







### ASSM Cardiac rule

#### ❖ Sinus tachycardia

- HR: >90 bpm during sleep or >100 bpm during wake (100-150 bpm during wake)
- P wave appearance: similar with NSR
- Rhythm: Regular
- Action: Monitor closely. In most cases, no action is needed.  
If symptomatic, notify physician on call



ASSM Scoring Manual V 2.0 & JCSM 2007-2021:147-154


### ASSM Cardiac rule-Tachyarrhythmia other than sinus

#### ❖ Narrow complex tachycardia (작은 눈금 3칸 이내)

- Scoring: lasting a minimum of 3 consecutive beat at a rate > 100bpm with QRS duration < 120msec.

#### ❖ Atrial flutter

- Rapid well organized contraction of atrium at a rate of 250-350 bpm.
- Atrial activity is represented by sawtooth-like deflections.
- Usually the AV conduction is 2:1.
- Rarely, the AV conduction is 3:1, 4:1 or variable.
- Sudden onset or symptomatic: Notify physician on call




ASSM Scoring Manual V 2.0 & JCSM 2007-2021:147-154

### ASSM Cardiac rule-Tachyarrhythmia other than sinus

#### ❖ Atrial Fibrillation

- Scoring: Irregular irregular QRS complexes +  
Replacement of P waves by rapid oscillation (vary in size, shape, and timing).
- Irregularly irregular.
- When rate of QRS complex > 100 bpm,  
atrial fibrillation is described as having a rapid ventricular response.
- Acute hemodynamic instability (i.e. syncope, acute pul. Edema, ongoing MI, symptomatic hypotension, or cardiogenic shock) → needed prompt intervention.




Recommendations	Class <sup>a</sup>	Level <sup>b</sup>
Emergency electrical cardioversion is recommended in AF patients with acute or worsening haemodynamic instability. (NICE 2014)	I	B
In AF patients with haemodynamic instability, amiodarone may be considered for acute control of heart rate. (ACC/AHA 2011)	IIb	B

European Heart Journal 2020. ASSM Scoring Manual V 2.0 & JCSM 2007-2021:147-154

### ASSM Cardiac rule-Tachyarrhythmia other than sinus

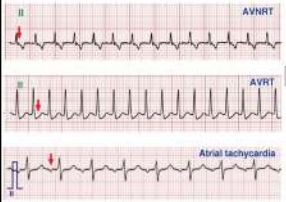
#### ❖ Atrial Fibrillation



### ASSM Cardiac rule-Tachyarrhythmia other than sinus

#### ❖ Other supraventricular tachycardia

- In general, the term SVT does not include Atrial Fibrillation.



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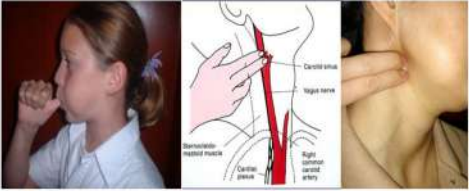
graph TD
    A[Regular tachycardia] -- Yes --> B[Visible P waves]
    A -- No --> C[Atrial fibrillation, Atrial tachycardia/flutter with variable AV conduction, MAT]
    B -- Yes --> D[Atrial rate greater than ventricular rate]
    B -- No --> E[AVNRT or other mechanism with P waves not identified]
    D -- Yes --> F[Atrial flutter or Atrial tachycardia]
    D -- No --> G[RP interval short (RP-PPR)]
    F -- Yes --> H[RP < 90ms]
    F -- No --> I[Atrial tachycardia, PAVRT, or Atrial AVNRT]
    H -- Yes --> J[AVNRT]
    H -- No --> K[AVRT, Atypical AVNRT, or Atrial tachycardia]
    
```

European Heart Journal 2020:41:655-720

### ASSM Cardiac rule-Tachyarrhythmia other than sinus

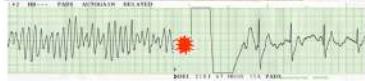
#### ❖ Other supraventricular tachycardia

##### 미주신경 항진술 (Vagal Maneuver)



**Valsalva술**      **Carotid Sinus Massage**

## Defibrillation



## ASSM Cardiac rule-Wide QRS complex Tachyarrhythmia

## ❖ Ventricular tachycardia

- Scoring: **fasting a minimum of 3 consecutive beat at a rate > 100bpm with QRS duration ≥ 120msec.**
- Can occur with many variations of the QRS morphology, depending on where the arrhythmia originates.

- 지속 기간  
비지속성 (nonsustained): persisting less than 30sec  
→ 증상 있을 시, 검사자는 바로 보고가 필요함.  
지속성 (sustained) - 30초 이상, 혈액학적 하탈 동반



- QRS파 모양  
단형 (monomorphic) 심실 빈맥  
다형 (polymorphic) 심실 빈맥

- 구조적 심질환의 유무  
특발성 (idiopathic) - RVOT VT, ILVT  
구조적 (structural) - MI, Cardiomyopathy, Brugada, ARVC

European Heart Journal 2016; ASSM Scoring Manual V 2.0 & JCSM 2007;30:147-154

## ASSM Cardiac rule-Wide QRS complex Tachyarrhythmia

## ❖ Ventricular fibrillation



- ✓ Mechanism  
→ Multiple wavelets of reentry
- ✓ ECG  
→ Irregular with no discrete QRS

## Cardiac Events reports

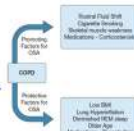
- ❖ Average HR, Highest HR during sleep, Highest HR during recording
- ❖ Occurrence of bradycardia; lowest HR
- ❖ Occurrence of asystole; longest pause *If observed,*
- ❖ Sinus tachycardia, (Narrow or Wide) complex tachycardia during sleep; highest HR
- ❖ Occurrence of AF; average HR
- ❖ Occurrence of other arrhythmia....

ASSM Scoring Manual V 2.0

## Respiratory emergencies

## ❖ Persistent low oxygen saturation

- Adults with sleep disordered breathing commonly tolerate SpO<sub>2</sub> levels between **80 and 90%** for prolonged periods.
- SpO<sub>2</sub> <88% in patients with COPD: oxygen therapy can be administered.
- SpO<sub>2</sub> <85% in patient without a history of hypoxemia: potential medical emergency.
- COPD exacerbation signs: Activate emergency medical systems.
- Never start supplemental oxygen therapy routinely, especially in patient with history of COPD.



Chest. 2017;152(5):1219-1226. & Thoracic Society of Australia and New Zealand Clinical Practice guidelines.

## Summary

## ❖ Cardiopulmonary emergencies


- Cardiac arrest (Asystole greater than 10 sec)
- VT > than 10 seconds
- VF
- Apnea greater than 2 minutes
- Changes in cardiac rhythms: Persistent bigeminy or trigeminy, AF, Atrial, > 6 PVCs per min for > 2min, Tachycardia or Bradycardia

## ❖ Neurological emergencies: Seizure or Stroke

## ❖ Psychiatric emergencies: Suicide ideation, Acute psychosis, etc.

## ❖ Environmental-Non-medical emergencies

ASSM Emergency procedures Fact Sheet.

Summary		
		
❖ Emergency Plan		
2	시설기준의 '독립된 수면 검사실' 이란?	주변환경에 방해 받지 않고 환자가 충분한 수면을 취하면서 검사가 실시될 수 있도록 독립된 공간으로서 시설기준에 열거된 모든 장치, 조형설 및 <u>응급상황시 대처할 수 있는 장비</u> 등을 갖춰야 하며, 가벽 등으로 임시로 구분한 공간은 인정되지 않음.
3	시설기준에서 응급상황에 관한 응급상황시 심폐소생술 등이 가능하여야 한다는 의미는?	수면다원검사 중 응급상황이 발생할 경우 심폐소생술 등을 <u>지체없이</u> 실시하는데 필요한 장비 등을 갖추어야 함을 의미함.  보건복지부 고시 제2018-135 호(18.7.1.시행) 관련

ASSM Emergency procedures Fact Sheet.