

Iatrogenic and Preventable In-hospital Cardiac Arrest



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Korean Heart Rhythm Society COI Disclosure

Jong Sung Park, MD

The authors have no financial conflicts of interest
to disclose concerning the presentation





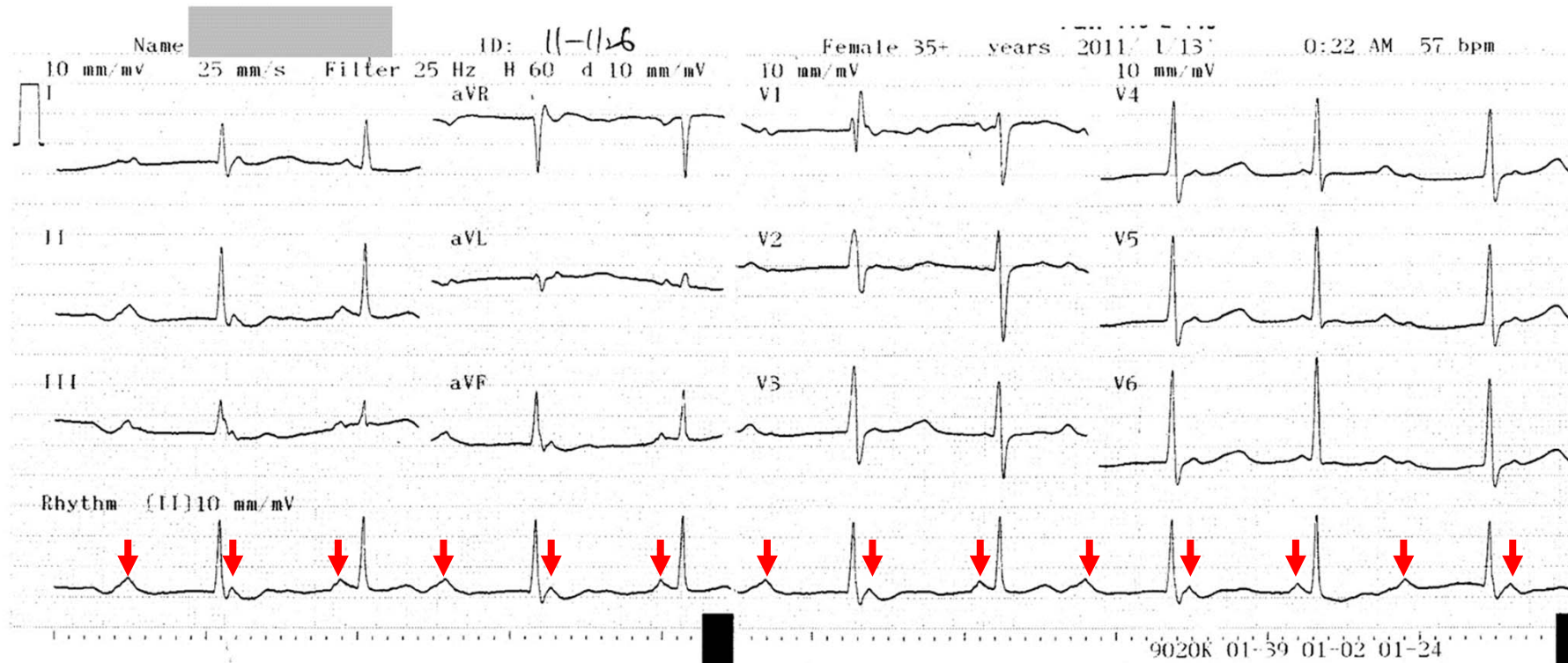
Background

- Survival rate of the in-hospital cardiac arrest patients is 10-20%.^{1,2)}
- Some of the in-hospital cardiac arrests are caused by careless medical practice.³⁾ We may call such kind of cardiac arrests, which are avoidable by giving medical attentions, as iatrogenic preventable cardiac arrest.
- It is difficult to know the exact incidence and causes of iatrogenic preventable in-hospital cardiac arrests.





Background



- 68-yr-old female, 2nd degree AV block
- CPR was performed two times for polymorphic VT.



1st Hospital

진료소견

내원 당시 VS 200/130 - 105 - 20 - (32.9°C) 및 EKG에서
 2~3초간 VT 지다가서 시행한 EKG에서 V4-6 기서 ST depress
 & Twave inversion 보였습니다.
 이후 brain CT 검사 동안 2번 pulseless VT 있어 defib
 시행하였고, 이후 바로 ROSC 돌아왔습니다.
 Proper evaluation & Mx 위해 전담하러 교진선처 바랍니다. 검사실
 amiodarone 150mg 20 // 1. 1. 12. (SDW 500 + amiodarone 900mg)

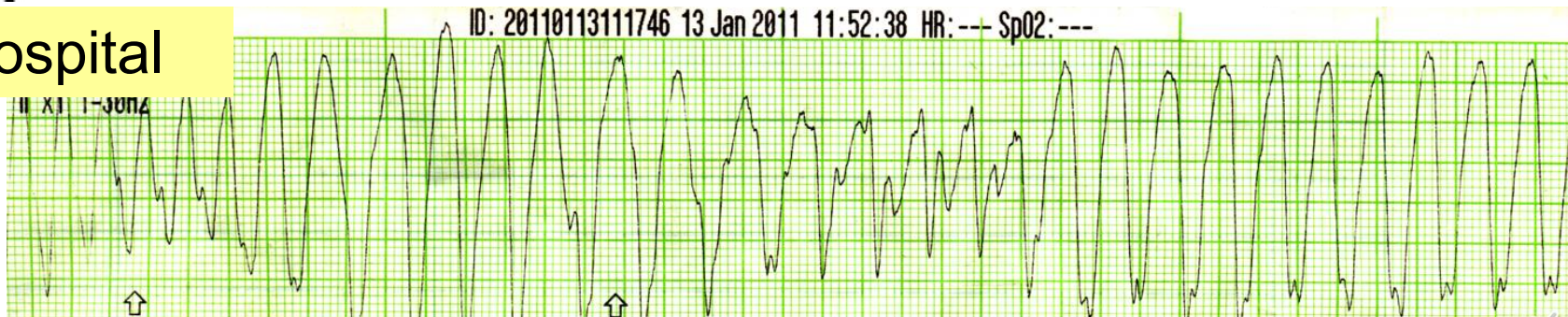
2nd Hospital

환자 상태 및 진료소견

Physicians' careless medical practice, which results in cardiac arrest, may be common than expected.

5% 500+ Codarone 40

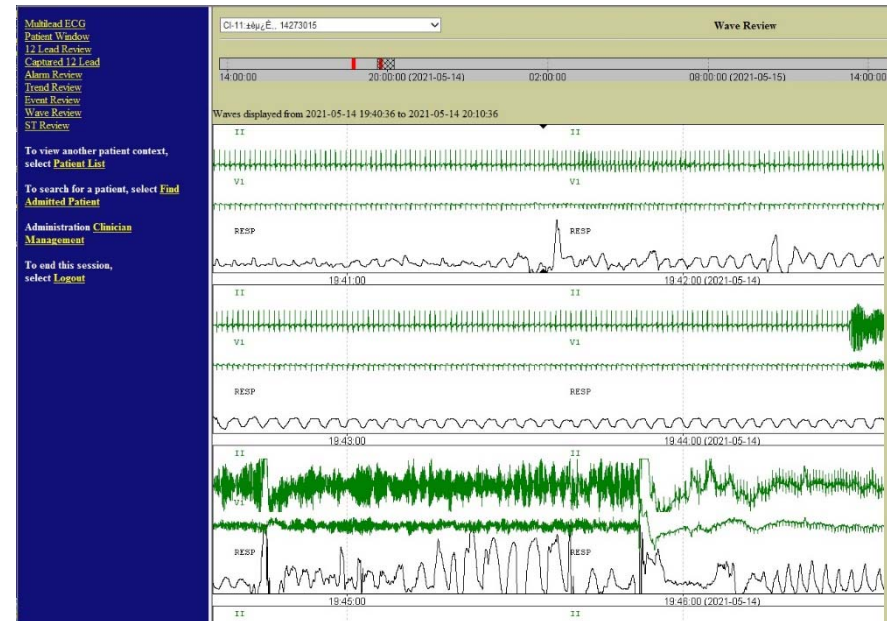
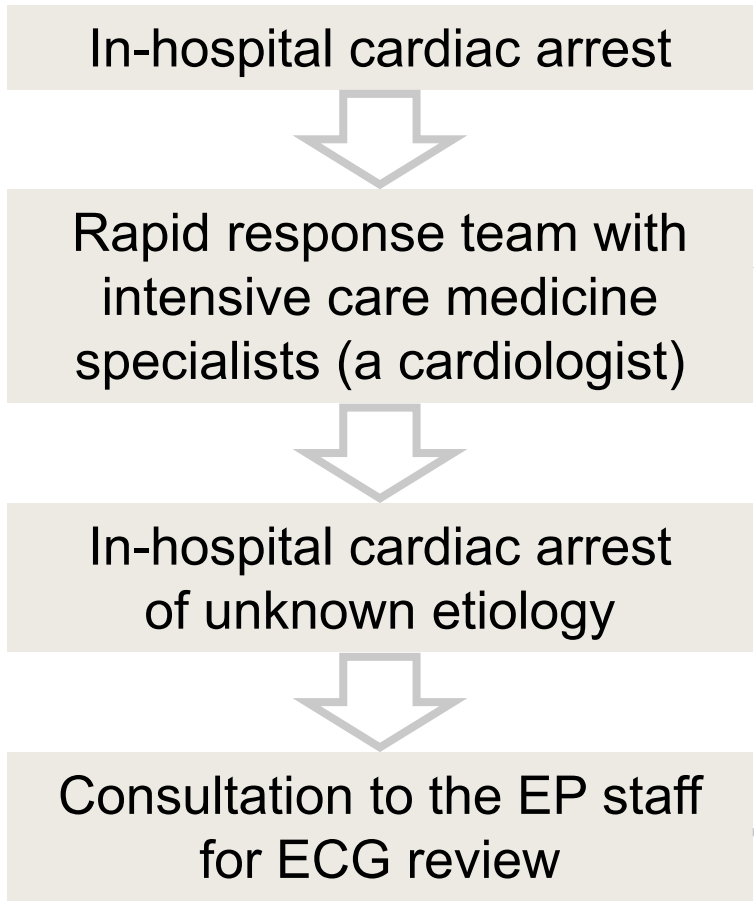
3rd Hospital



Amiodarone 900 mg/day, CPR over 20 times for 3 days



Background



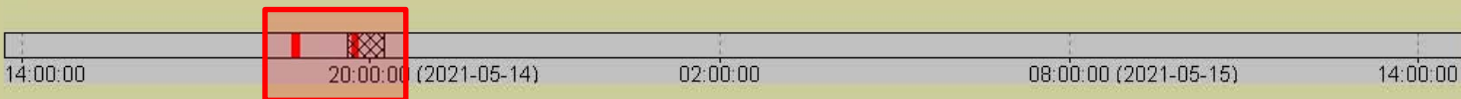
Retrospective ECG analysis up to 96 hr
TraceMasterVue ECG management system (PHILIPS)



- Multilead ECG
- Patient Window
- 12 Lead Review
- Captured 12 Lead
- Alarm Review
- Trend Review
- Event Review
- Wave Review
- ST Review

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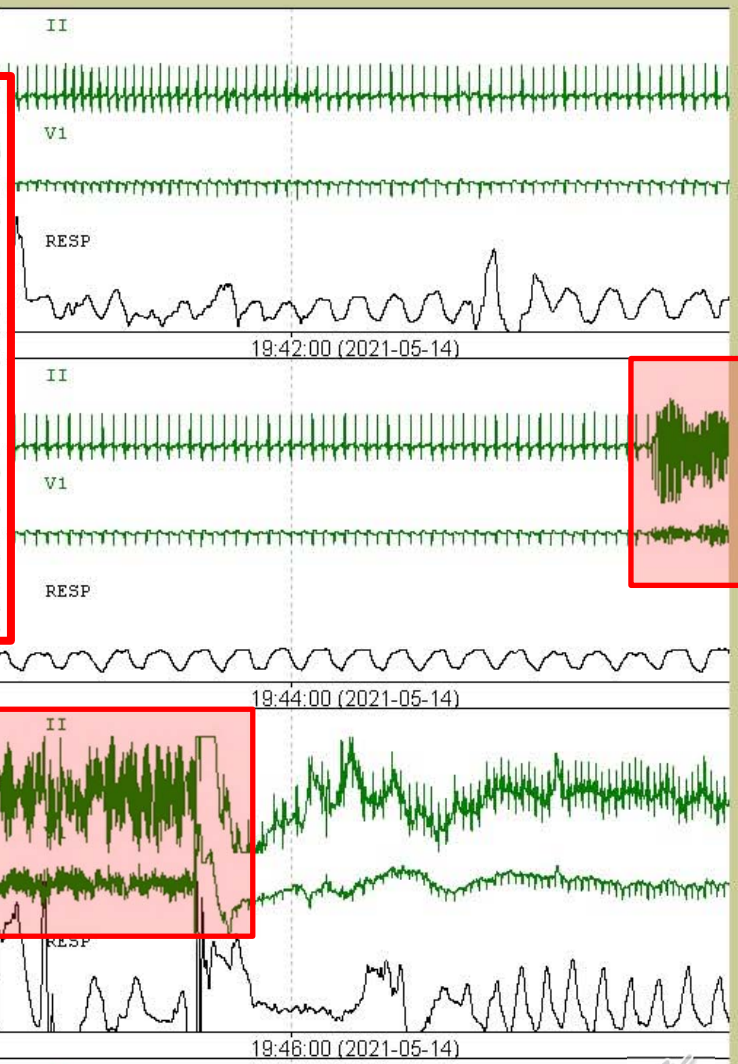
Wave Review



Waves displayed from 2021-05-14 19:40:36 to 2021-05-14 20:10:36

To view another patient context:

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TraceMasterVue ECG management system (PHILIPS)





Study purpose

Annual number of in-hospital cardiac arrest (n =2,304)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
54	164	183	193	267	267	228	265	282	265	136

2010-09-01 – 2010-12-31
(Data of 6 months)

2020-01-01 – 2020-08-31
(Data of 6 months)

- We performed a retrospective study to know the crude incidence and common causes of iatrogenic and preventable in-hospital cardiac arrests related with physicians' careless medical decisions or procedures.



Methods

- Medical records of in-hospital cardiac arrest patients (from 01-Sep-2010 to 31-Aug-2020, Dong-A University hospital) were reviewed.
- Exclusion criteria: not-iatrogenic or not-preventable
 - 1) Irresistible cardiac arrest due to underlying disease
 - 2) Iatrogenic but not-preventable cardiac arrest caused by complications accompanying normal diagnosis or treatment process





Methods

- Inclusion criteria: iatrogenic & preventable
 - 1) When specific medical treatment or procedure, which was performed by mistake, induced cardiac arrest
 - 2) When specific medical treatment or procedure, which might potentially cause cardiac arrest, was performed without appropriate medical precaution/prevention and induced cardiac arrest
 - 3) When cardiac arrest seemed to be avoidable if such medical treatment or procedure were not performed or appropriate precaution/prevention were performed

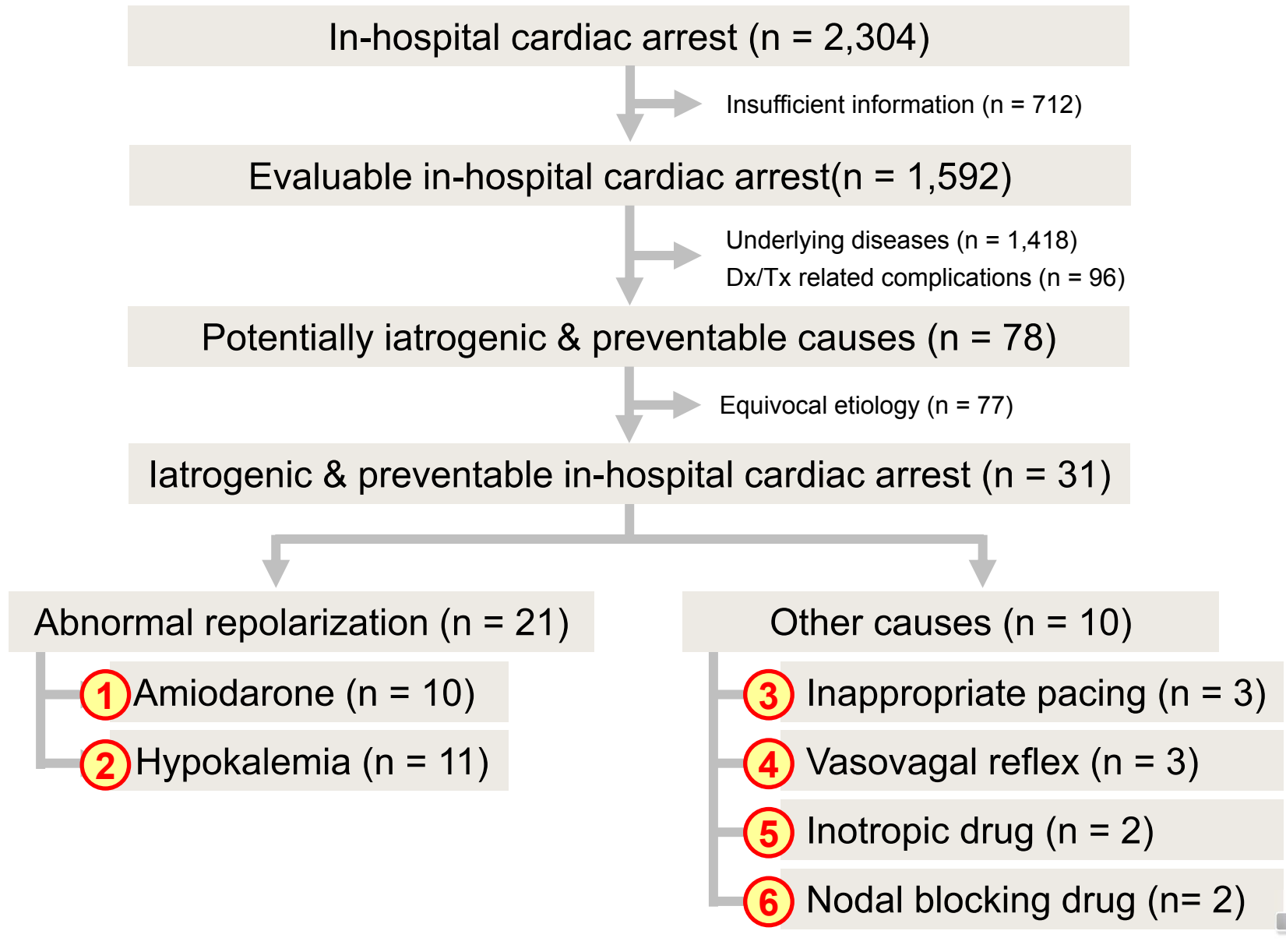




Methods

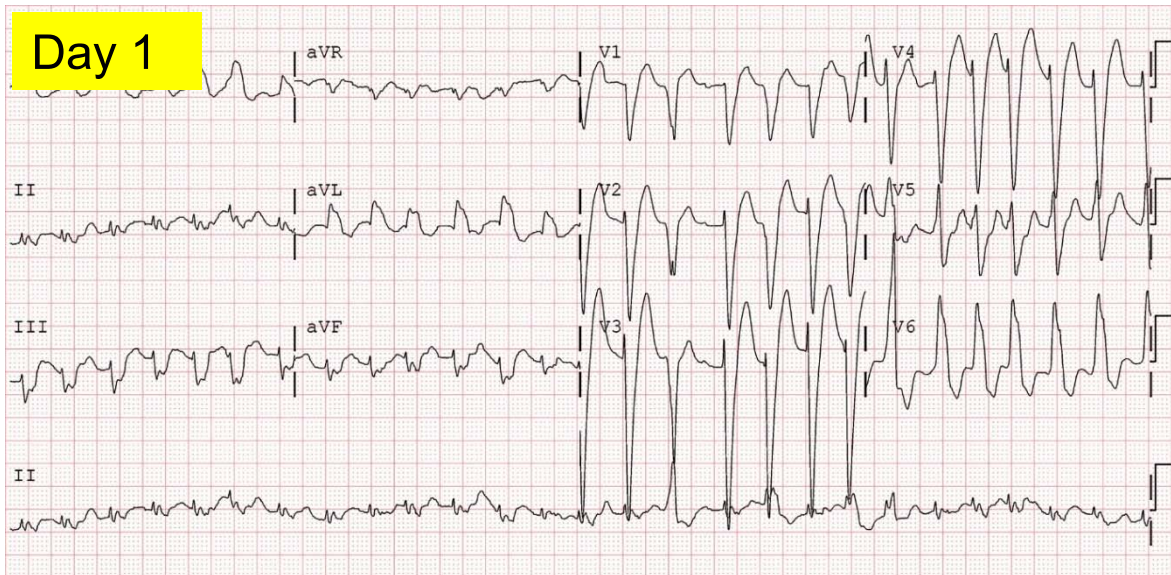
- Insufficient information: lack of medical records or evaluations to know the etiology
- Equivocal etiology: different diagnosis on the causes of cardiac arrest between the EP staff and intensive care medicine specialists







Etiology-1 (Amiodarone)

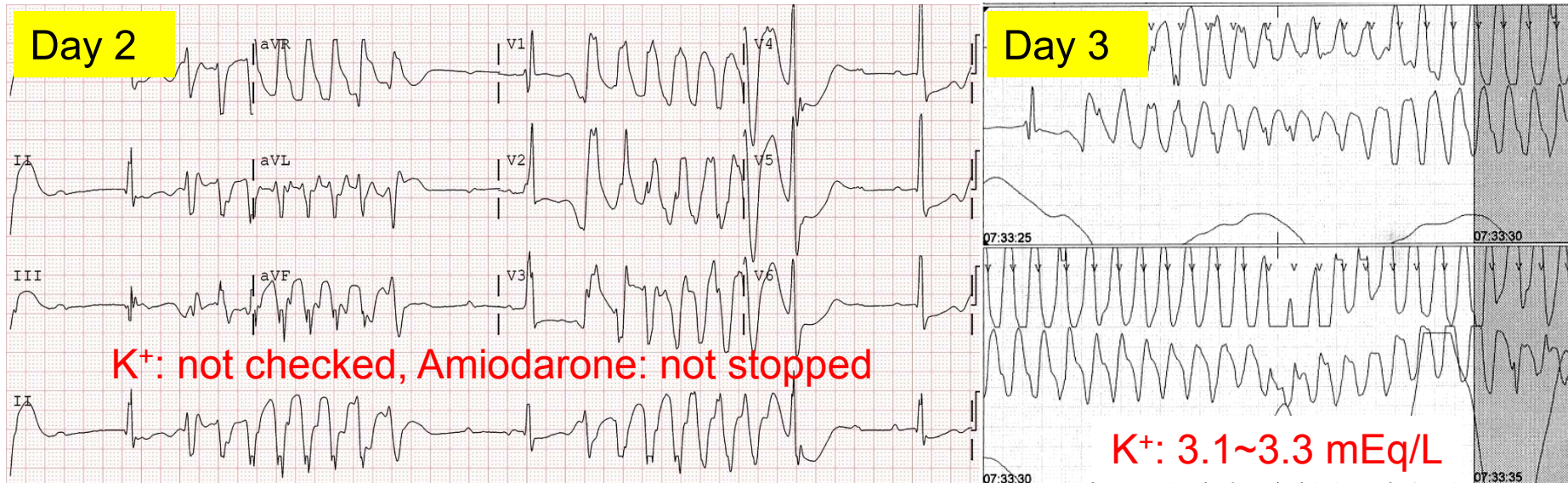


- 80-yo-female with admitted for HFrEF with AF (EF 25-29%).
- Amiodarone 900 mg/day was infused for rate or rhythm control.





Etiology-1 (Amiodarone)



- Although R on T phenomenon was documented on 12-lead ECG, high dose amiodarone was continuously infused and electrolytes levels were not checked until polymorphic VT occurs.





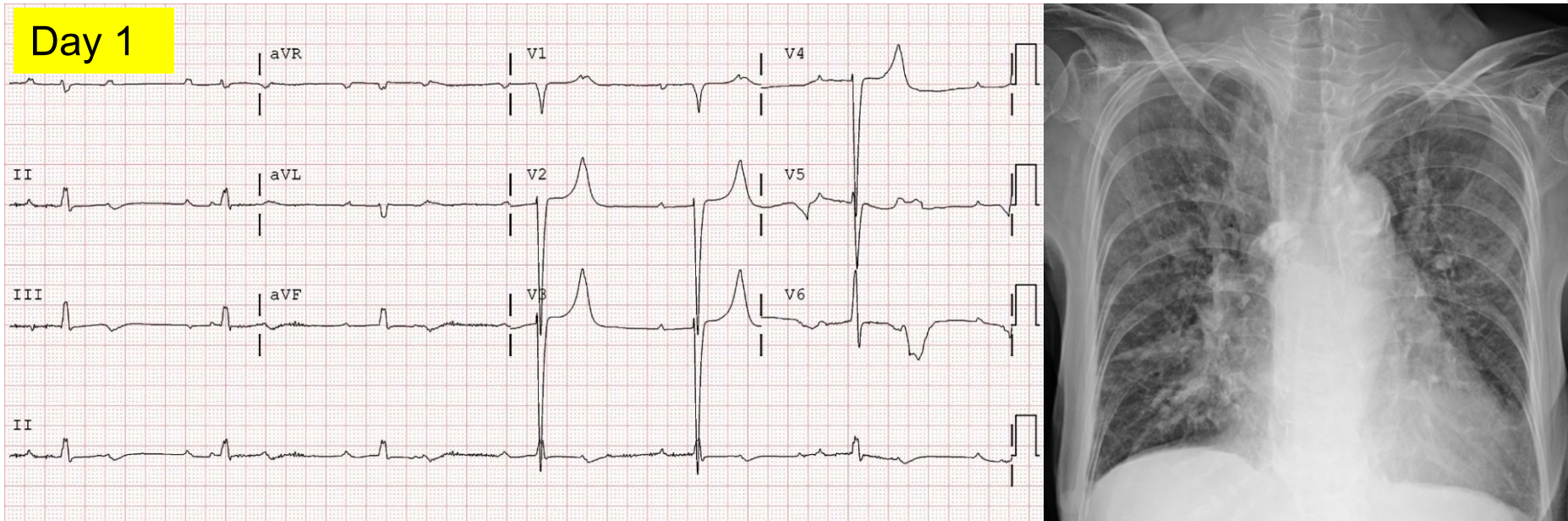
No.	Sex	Age	Mechanism	Arrhythmia	Cardiac diseases	Provocative factors	
1	F	71	QT prolongation	TdP-VT	HFrEF (27%), AF	Amiodarone (300 mg/d), DC version	K+: 3.9 mEq/L
2	M	78	QT prolongation	TdP-VT	HFrEF (33%), AF	Amiodarone (400 mg/d), ciprofloxacin	K+: 4.6 mEq/L
3	M	76	QT prolongation	TdP-VT	HFrEF (32%), AF	Amiodarone (300 mg/d)	K+: 3.4 mEq/L
4	F	80	QT prolongation	TdP-VT	HFrEF (27%), AF, WPW	Amiodarone (300 mg/d)	K+: 3.7 mEq/L
5	M	70	QT prolongation	TdP-VT	HFrEF (17%), AF	Amiodarone (900 mg/d), diltiazem	K+: 3.6 mEq/L
6	F	80	QT prolongation	TdP-VT	HFrEF (23%), AF	Amiodarone (900 mg/d)	K+: 3.3 mEq/L
7	F	89	QT prolongation	TdP-VT	HFrEF (33%), AF	Amiodarone (900 mg/d)	K+: 2.4 mEq/L
8	F	60	QT prolongation	TdP-VT	HFpEF (63%), AF, CAD	Amiodarone (400 mg/d), carvedilol	K+: 3.9 mEq/L
9	F	34	QT prolongation	TdP-VT	HFpEF (52%), AF, MVR	Amiodarone (300 mg/d), DC version	K+: 4.9 mEq/L
10	F	68	QT prolongation	TdP-VT	CAVB with TdP-VT **	Amiodarone (900 mg/d)	K+: 3.2 mEq/L

- Mean age was 71 ± 15 years and female patients were 7 (70%)
- Amiodarone administration dose was 560 ± 295 (range: 300~900) mg/day.
- Among the 10 patients, 9 had CHF (ejection fraction: $34 \pm 14\%$) with AF.
- Among the 10 patients, 8 had significant hypokalemia (< 4.0 mEq/L) at the day of cardiac arrest.



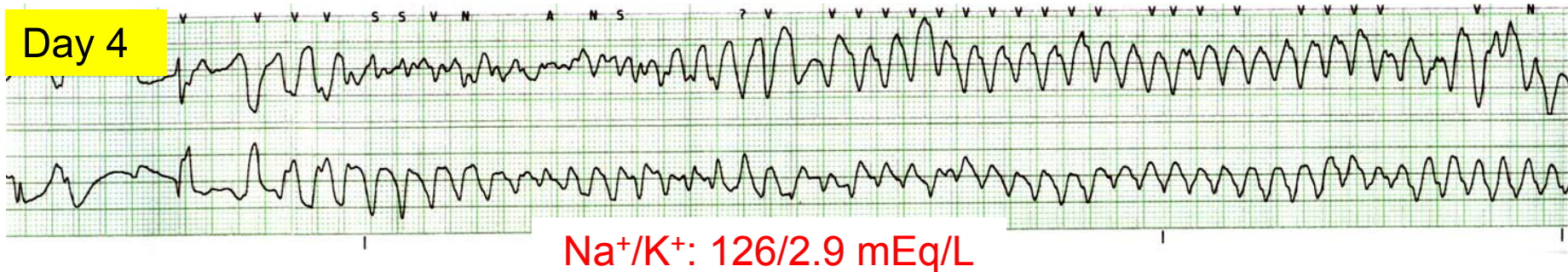
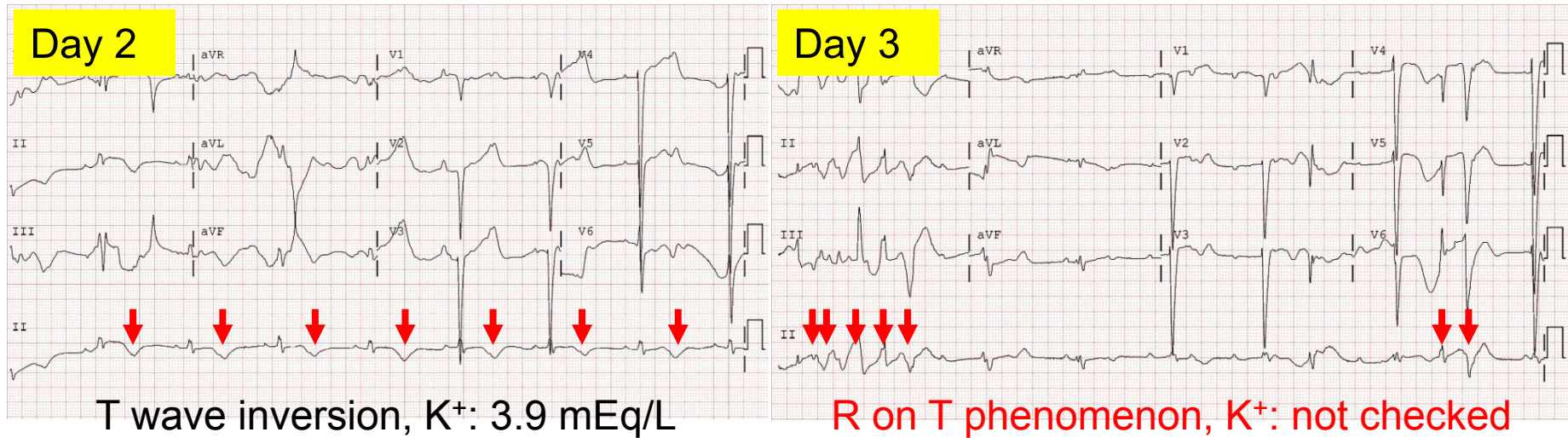


Etiology-2 (Hypokalemia)



- 81-yo-female, long standing complete AV block, HFpEF
- Furosemide 240 mg/day #3 was infused for decongestion.





- Although R on T phenomenon was documented on 12-lead ECG, high dose furosemide was continuously infused and electrolytes levels were not checked until polymorphic VT occurs.





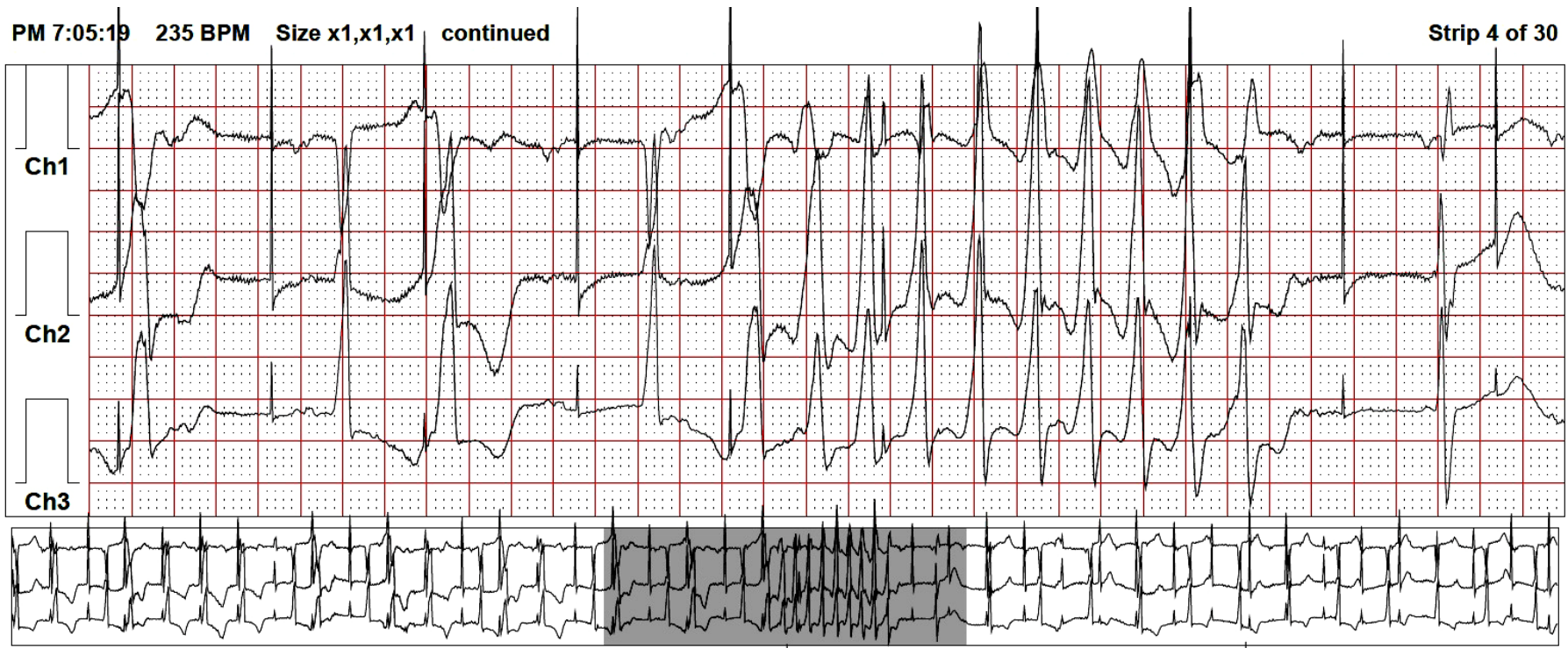
No.	Sex	Age	Mechanism	Arrhythmia	Cardiac diseases	Provocative factors	
1	F	61	QT prolongation	TdP-VT	None	K+: 3.4 mEq/L	Moxifloxacin
2	M	67	QT prolongation	TdP-VT	AF	K+: 2.7 mEq/L	AF-SVR < 40 bpm
3	F	76	QT prolongation	TdP-VT	AF	K+: 3.4 mEq/L	Amiodarone 900 mg/d*
4	F	56	QT prolongation	TdP-VT	HFmEF (43%)	K+: 2.9 mEq/L	Moxifloxacin
5	F	61	QT prolongation	TdP-VT	HFrEF (27%), AF	K+: 3.5 mEq/L	AF-SVR < 40 bpm
6	F	71	QT prolongation	TdP-VT	HFrEF (36%), AF	K+: 2.7 mEq/L	AF-SVR < 40 bpm
7	F	56	QT prolongation	TdP-VT	HFpEF (62%), AF	K+: 1.9 mEq/L,	Adrenal tumor
8	F	64	QT prolongation	TdP-VT	HFmEF (42%), Post-AVR	K+: 2.8 mEq/L	
9	M	61	QT prolongation	TdP-VT	HFmEF (43%), Post-AVR	K+: 2.9 mEq/L	
10	F	69	QT prolongation	TdP-VT	HFrEF (37%), CAVB	K+: 3.3 mEq/L	Myocarditis
11	F	80	QT prolongation	TdP-VT	HFpEF (56%), CAVB	K+: 2.9 mEq/L	

- Mean age was 66 ± 8 years and female patients were 9 (82%).
- Hypokalemia was induced by high diuretic therapy in 8 patients and malnutrition in 3 patients.
- Among the 11 patients, 8 had CHF (ejection fraction: $42 \pm 12\%$).
- K⁺ concentration was 2.9 ± 0.5 mEq/L (range: 1.9-3.5 mEq/L) at the day of cardiac arrest .





Etiology-3 (Inappropriate pacing)

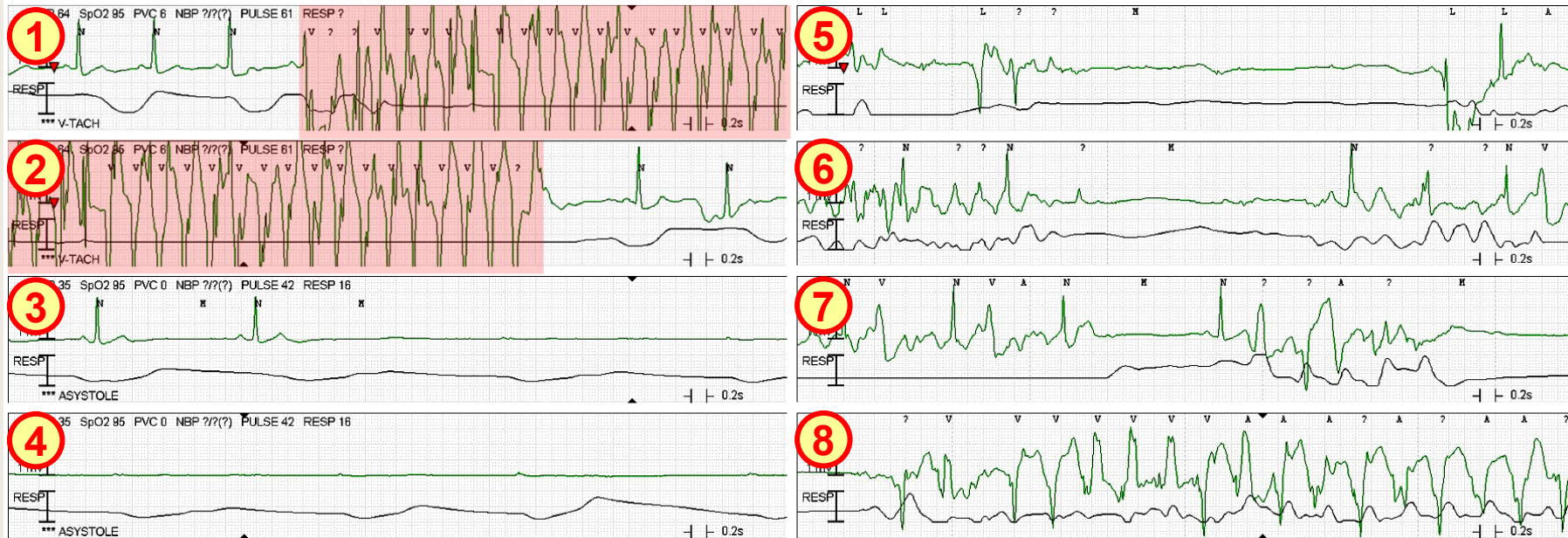


- 79-yo-female, Post-CABG state, cardiac arrest (x 6) for a week
- R on T pacing by the epicardial pacemaker induced polymorphic VT.





Etiology-4 (Vasovagal reflex)

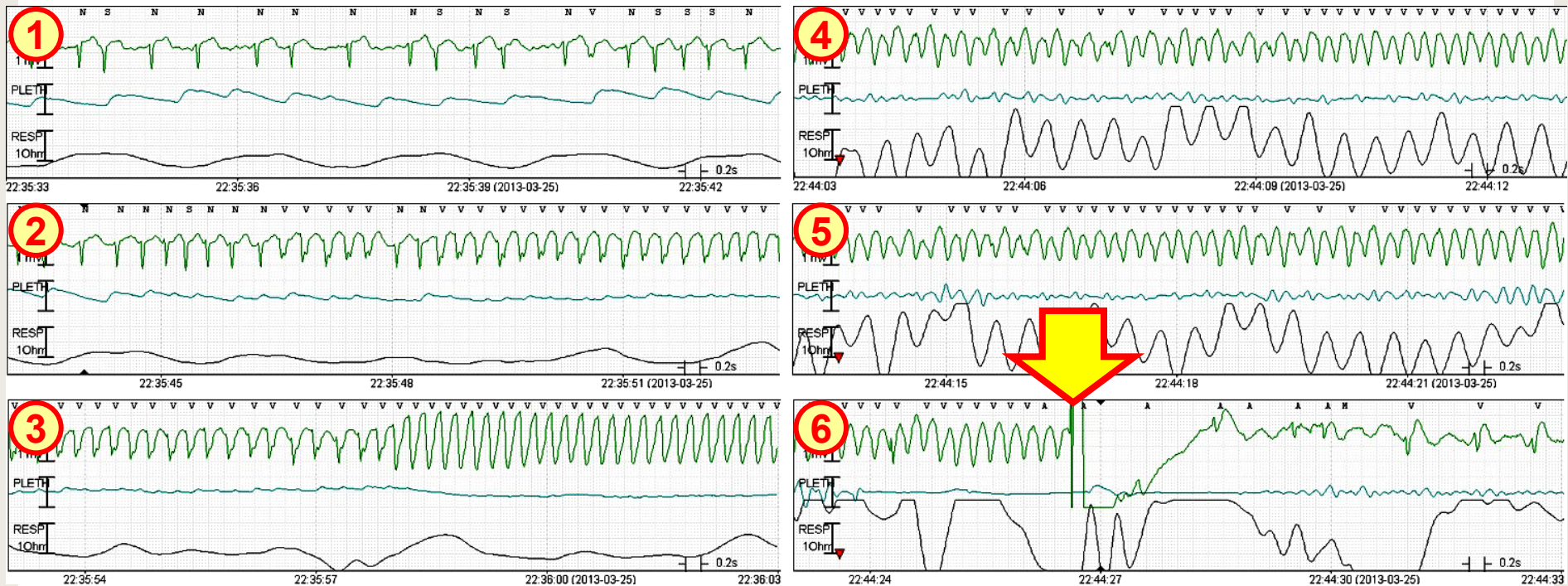


- 80-yo-female, C-spine fracture, cardiac arrest (x 7) for two weeks
- Prolonged asystole was induced by endotracheal suction or position change.





Etiology-5 (Inotropic drug)

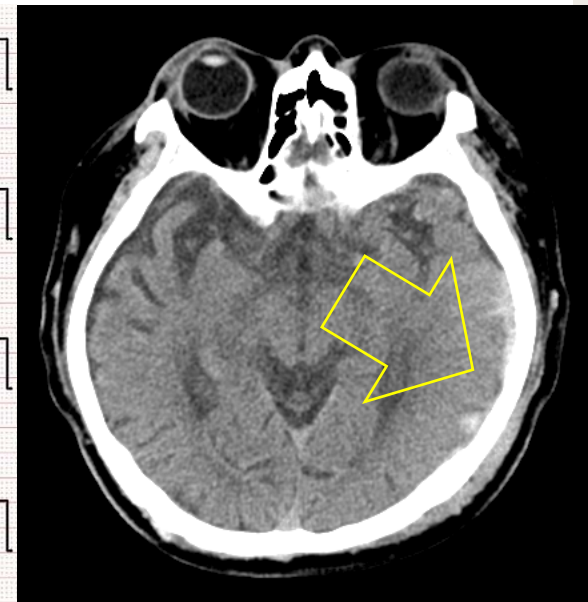
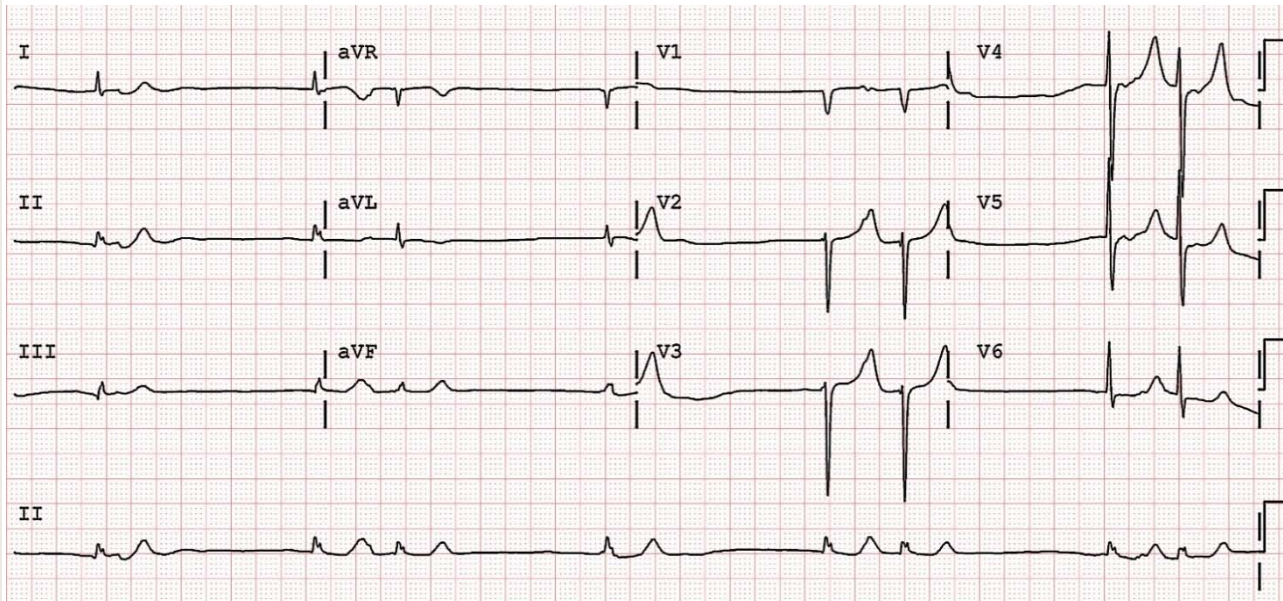


- 70-yo-female, admitted for endoscopic examination
- Epinephrine, which was prepared for endoscopic hemostasis, was accidentally injected intravenously.









Etiology-6 (nodal blocking drug)






- 68-YO-male, syncope with cerebral contusion, junctional escape
- Bisoprolol 2.5 mg/day was administered for atrial fibrillation.



회신일자	2020-11-06  01:13	회신의사	
회신내용	<p>Comments:</p> <p><u>개인 약제중 concor 에 의한 서맥 발현 가능성이 높습니다.</u></p> <p>개인 약제는 모두 중단하고 출혈 위험이 없다면 astrix 100mg qd만 유지하고 경과 관찰하기 바랍니다.</p> <p>2-3일 경과 후에도 맥박 회복 없으면 재협진 바랍니다.</p>		
			Recommended to stop bisoprolol for bradycardia

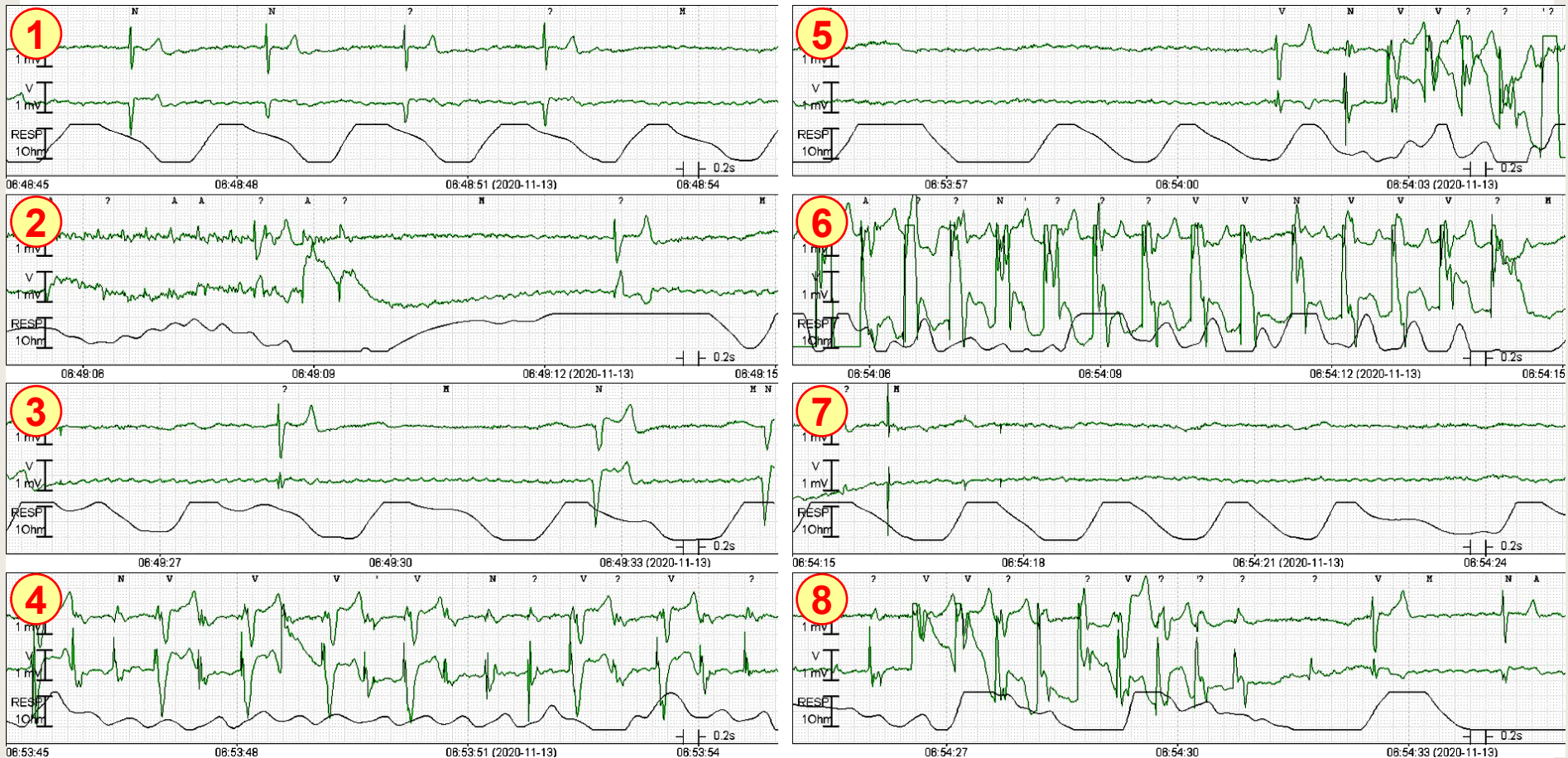
회신일자	2020-11-08  15:37	회신의사	
회신내용	<p>Comments: 혈압 조절 위해</p> <p><u>adalat 33mg bid 로 유지해보기 바랍니다.</u></p> <p>매일 오전에 심전도 검사하고 재협진 바랍니다.</p>		
			Recommended to add nifedipine for BP control

회신일자	2020-11-12  15:29	회신의사	
회신내용	<p>Comments: 다음의 약제 투약을 추천합니다.</p> <p>1. PO adalat 66mg bid</p> <p>2. PO nebilet 5mg bid</p> <p>3. PO herben 90mg bid</p>		
			Recommended to add high dose nebivolol and diltiazem simultaneously for BP control





Etiology-6 (nodal blocking drug)



- Prolonged asystole which required chest compression for over 10 min occurred after bisoprolol 5 mg and diltiazem 90 mg administration.





Results

No.	Sex	Age	Mechanism	Arrhythmia	Cardiac diseases	Provocative factors
1	F	79	Inappropriate pacing	TdP-VT	Post-CABG state	R-on-T pacing
2	M	82	Inappropriate pacing	TdP-VT	Pacing-CMP	Pacing withdrawal
3	F	76	Inappropriate pacing	TdP-VT	AF	Low pacing rate, flecainide
4	M	36	Vasovagal reflex	Asystole	None	Endotracheal suction etc.
5	F	80	Vasovagal reflex	Asystole	None	Endotracheal suction etc.
6	F	52	Vasovagal reflex	Asystole	None	Endotracheal suction etc.
7	M	72	Inotropic agent	SMMVT	SiCMP, AF	Epinephrine volus injection
8	F	70	Inotropic agent	AF aberration → VF	AF	Epinephrine volus injection
9	M	68	Nodal blocking agent	Asystole	AF	Nebivolol & diltiazem
10	F	55	Nodal blocking agent	Preexcited AF → VF	WPW-SD with AF	Digitalis & propranolol

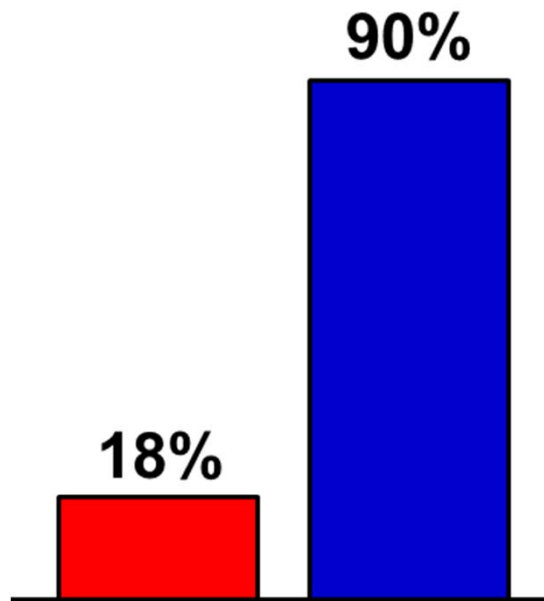
- Other causes of preventable and iatrogenic cardiac arrest were heterogenous.
- They were largely grouped into pacing problem, inappropriate medication, vasovagal reflex.
- Vasovagal reflex induced asystole was induced only in patients with neurologic problem.



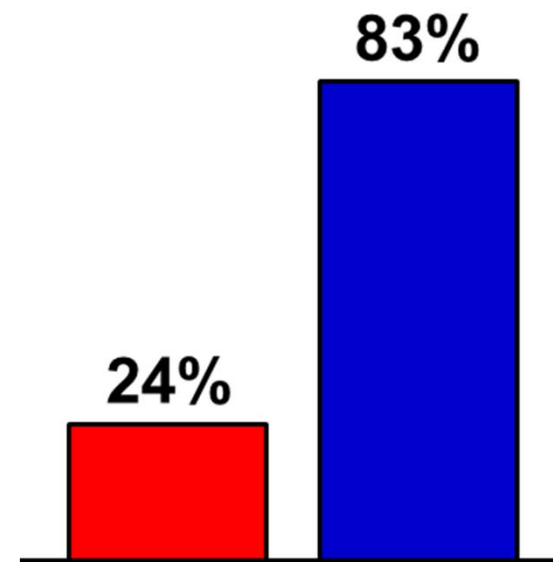




Results

VT/VF arrest



Survival discharge



-  Not-iatrogenic or not-preventable In-hospital cardiac arrest
-  Iatrogenic & preventable In-hospital cardiac arrest





Summary

- Among the 2,304 in-hospital cardiac arrest patients, 31(1.3%) had iatrogenic and preventable causes of cardiac arrest.
- The most common cause of iatrogenic and preventable in-hospital cardiac arrest was abnormal repolarization which was induced by amiodarone therapy or diuretic therapy induced hypokalemia, or both.
- Pacing problem, inappropriate medication, and vaso-vagal reflex were miscellaneous causes of iatrogenic and preventable cardiac arrest.





Summary

- Prognosis of in-hospital cardiac arrest with iatrogenic and preventable was better than cardiac arrest with other causes because the most common presenting rhythm was polymorphic VT.





Limitation

- Definition of iatrogenic preventable in-hospital cardiac arrest was not established yet.
- The study data cannot reflect the true incidence and causes of iatrogenic preventable in-hospital cardiac arrest.





Conclusion

- About 2/3 of the iatrogenic and preventable in-hospital cardiac arrest was caused by abnormal repolarization.
- Appropriate education for the physicians and nurses may reduce the risk of iatrogenic and preventable in-hospital cardiac arrest.



Iatrogenic and Preventable Causes of In-hospital Cardiac Arrest



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