대한부정맥학회
Korean Heart Rhythm Society

Multi-Day ECG Recording System

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Monitoring of Arrhythmia

Monitoring of Arrhythmia

Ambulatory ECG

- ✓ Ambulatory ECG (AECG) is used to evaluate symptoms such as syncope, dizziness, chest pain, palpitations, or shortness of breath, which may correlate with intermittent cardiac arrhythmias.
- ✓ AECG is used to evaluate patient's response to anti-arrhythmic therapy and to assess prognosis in specific clinical contexts.
- ✓ Noninvasive, easy to use, relatively inexpensive

Holter monitoring

- ✓ Ability to record and document continuous 3- to 12-lead ECG signal simultaneously with a variety of other biological signals during normal daily activities.

Disadvantage

- ✓ Frequent noncompliance with symptom logs and event markers
- ✓ Frequent electrode detachments
- ✓ Signal quality issues due to skin adherence artifacts, wire entanglements, and occasional skin dermatitis caused by electrode gels
- ✓ Absence of real-time data analysis

Duration of Recording

Duration of recording	Type
< 1 min	External event recorder Smartphone-based recorder
24–48 hr	Standard Holter recorder Mobile cardiac telemetry
3–7 days	Patch/Vest/Belt recorder Mobile cardiac telemetry Event loop recorder
1–4 weeks	Patch/Vest/Belt recorder Mobile cardiac telemetry External loop recorder
<36 months	Implantable loop recorder

Heart Rhythm 2017;14:e55–e96

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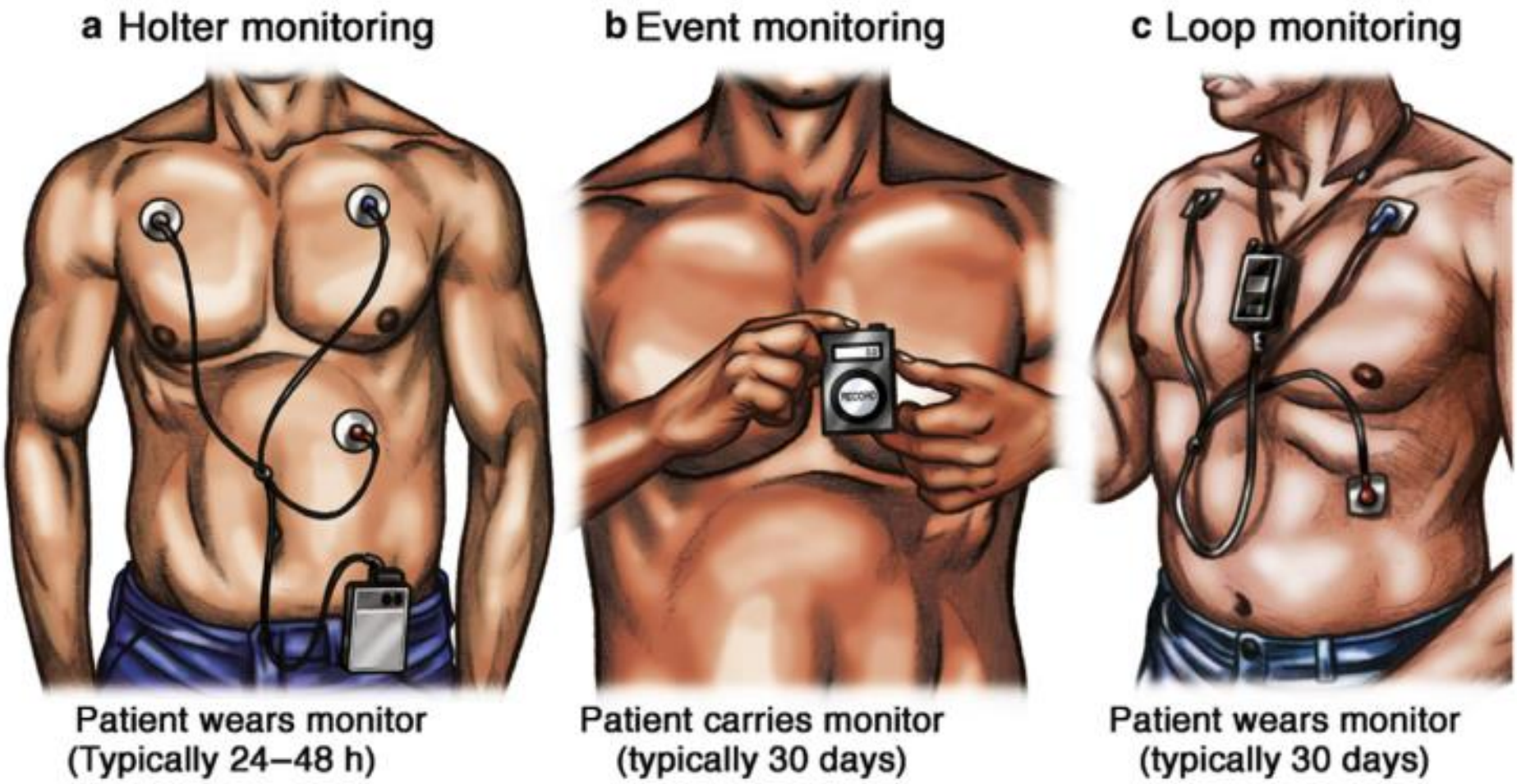
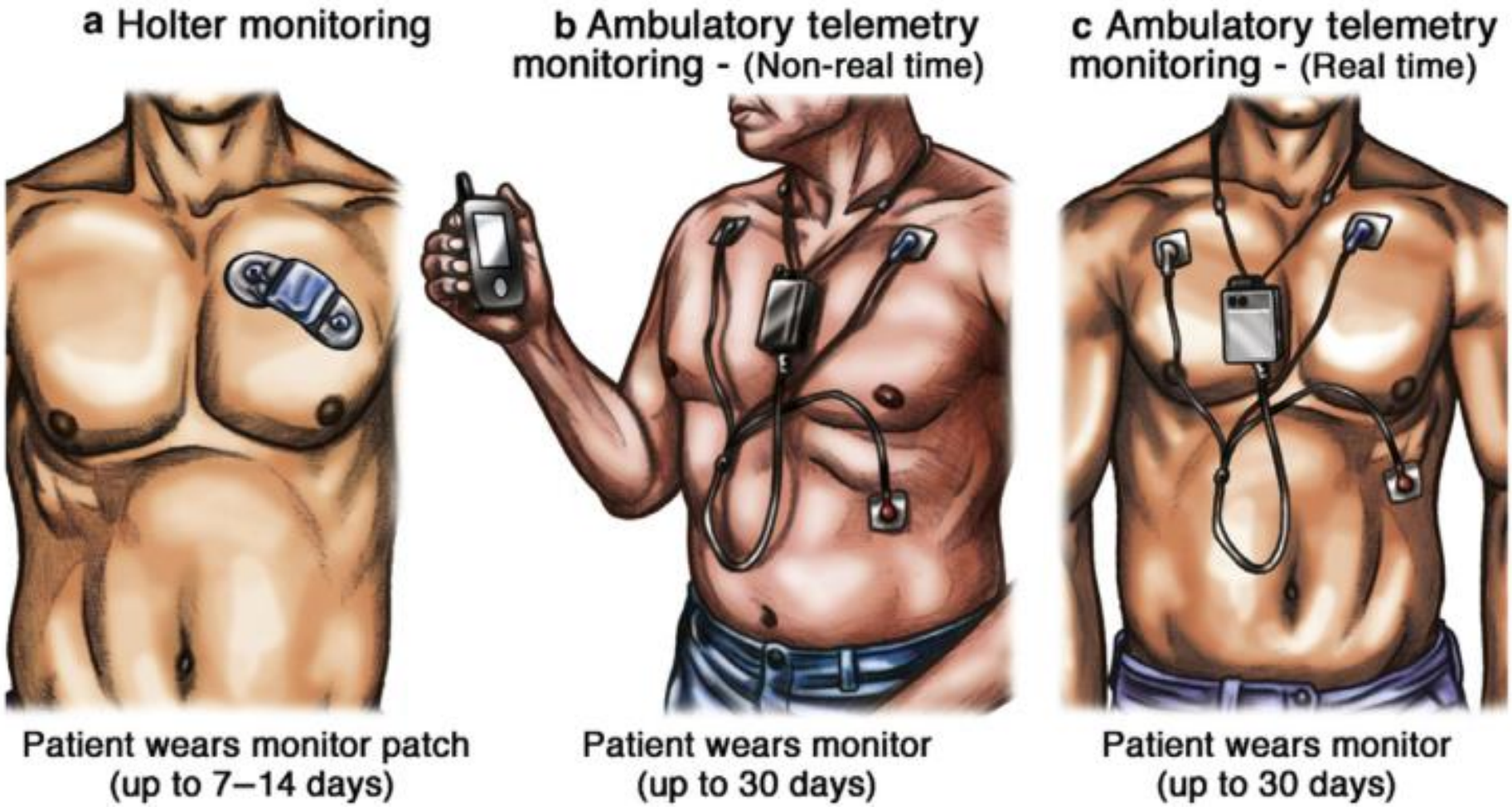
Multi-day Monitoring

First generation External Ambulatory Monitoring



J Am Coll Cardiol 2011;58:1741–9

Second generation External Ambulatory Monitoring



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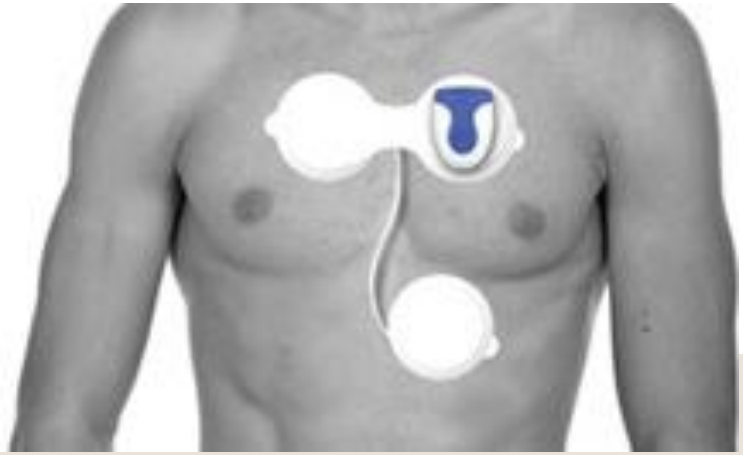
Patch ECG monitor



Patch ECG monitor

- ✓ Long-term recording of 14 days or longer
- ✓ Excellent patient acceptance

Disadvantage

- ✓ Records a limited ECG from closely spaced electrodes with lower voltage amplitudes
- ✓ Lacking localization ability of arrhythmia origin
- ✓ Inconsistent optimal ECG signal quality due to varying body types

Event recorders

Event recorders

- ✓ Records only selected ECG segments of fixed duration after an event is detected by the patient
- ✓ Immediate alarm generation upon the event detection
- ✓ Well-tolerated by the patient

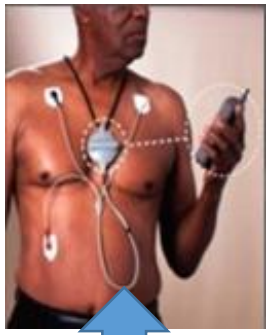
Disadvantage

- ✓ Single-lead devices → Unknown origin of arrhythmias
- ✓ No capability to continuously document cardiac rhythm
- ✓ Diagnostic yield of event recorders is highly dependent on patient's ability to recognize correct symptom

Mobile Cardiac Telemetry (MCT)

✓Outpatient

Patient indicates symptoms on PDA. Abnormal ECG transmitted automatically.



PDA stores ECG data and symptom status. Wireless transmission capability provided.

Monitor center receives, reviews and transmits data to physician. Pre-determined "urgency" criteria determine timing of physician alerts.

Physician receives and acts upon data as medically appropriate

✓Hospital-Based

Clinical Indication of AECG

Diagnosis of arrhythmia

- ✓ Unexplained syncope and dizziness
- ✓ Cardiac palpitation
- ✓ Chest pain or dyspnea thought to be associated with arrhythmias
- ✓ Cryptogenic stroke evaluation
- ✓ Pediatric monitoring

Clinical Indication of AECG

Prognosis and risk stratification

- ✓ Ischemic heart disease and postinfarction
- ✓ Non-ischemic DCM
- ✓ HCM
- ✓ Arrhythmogenic RV Cardiomyopathy
- ✓ WPW syndrome
- ✓ Inherited arrhythmic diseases
- ✓ Athletes and pre-competition screening

Clinical Indication of AECG

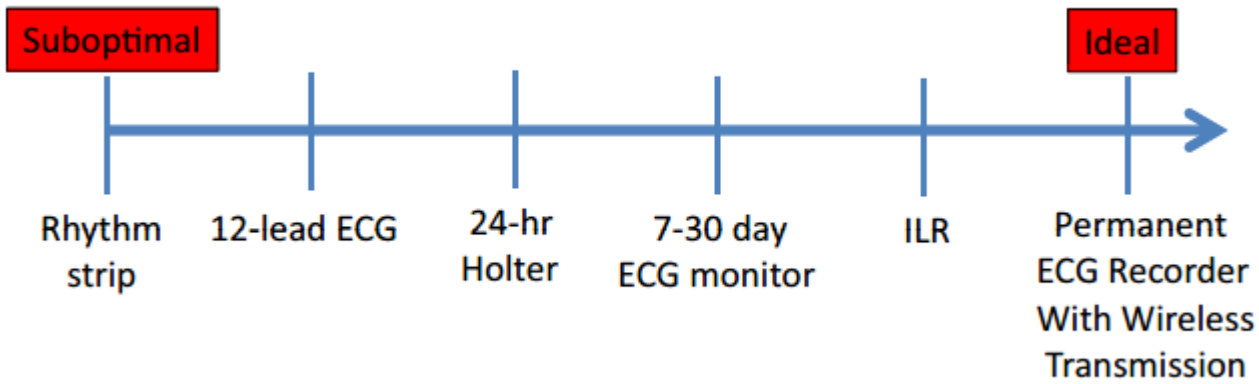
- ✓ ST segment analysis
- ✓ Heart rate variability
- ✓ Signal-averaged ECG
- ✓ Obstructive sleep apnea
- ✓ The effect and safety of treatment (medication or catheter ablation)

Selection of Appropriate Technologies

Consideration about…

- ✓ Symptom frequency
- ✓ Patient acceptance
- ✓ Degree of automaticity
- ✓ Cost-effectiveness
- ✓ The overall patient clinical condition
- ✓ The probability of life-threatening arrhythmia

Diagnostic yield of AECG



Duration of recording	Type of recorder	Palpitations (%)	Syncope (%)	Cryptogenic stroke (%)
<60 s	Event recorder	50–60	Not applicable	Not applicable
24–48 hr	Standard Holter	10–15	1–5	1–5
3–7 days	Patch/Vest/Belt Recorder/MCT/ELR	50–70	5–10	5–10 (?)
1–4 weeks	ELR/Patch/Vest/Belt Recorder/MCT	70–85	15–25	10–15 (?)
≤36 months	ILR	80–90	30–50	15–20 (?)

MCT, mobile cardiac telemetry; ELR, external loop recorder; ILR, implantable loop recorder.

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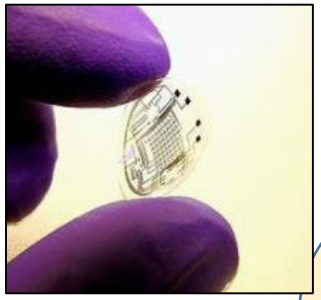
Modern AECG Device

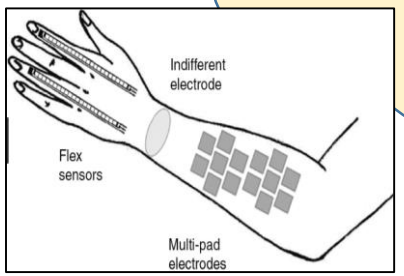


Microelectronic circuits

Bluetooth 5.0

Networking technology
Smart Bluetooth

- ✓ Light and inconspicuous
- ✓ Automatic arrhythmia detection
- ✓ Wireless transmission of data in real time



Multiple biological signal sensors

Artificial intelligence

Circulation 2012;126:806–814.
Circulation 2009; 120:S177–S184.
JACC 2011;58:1741–1749.

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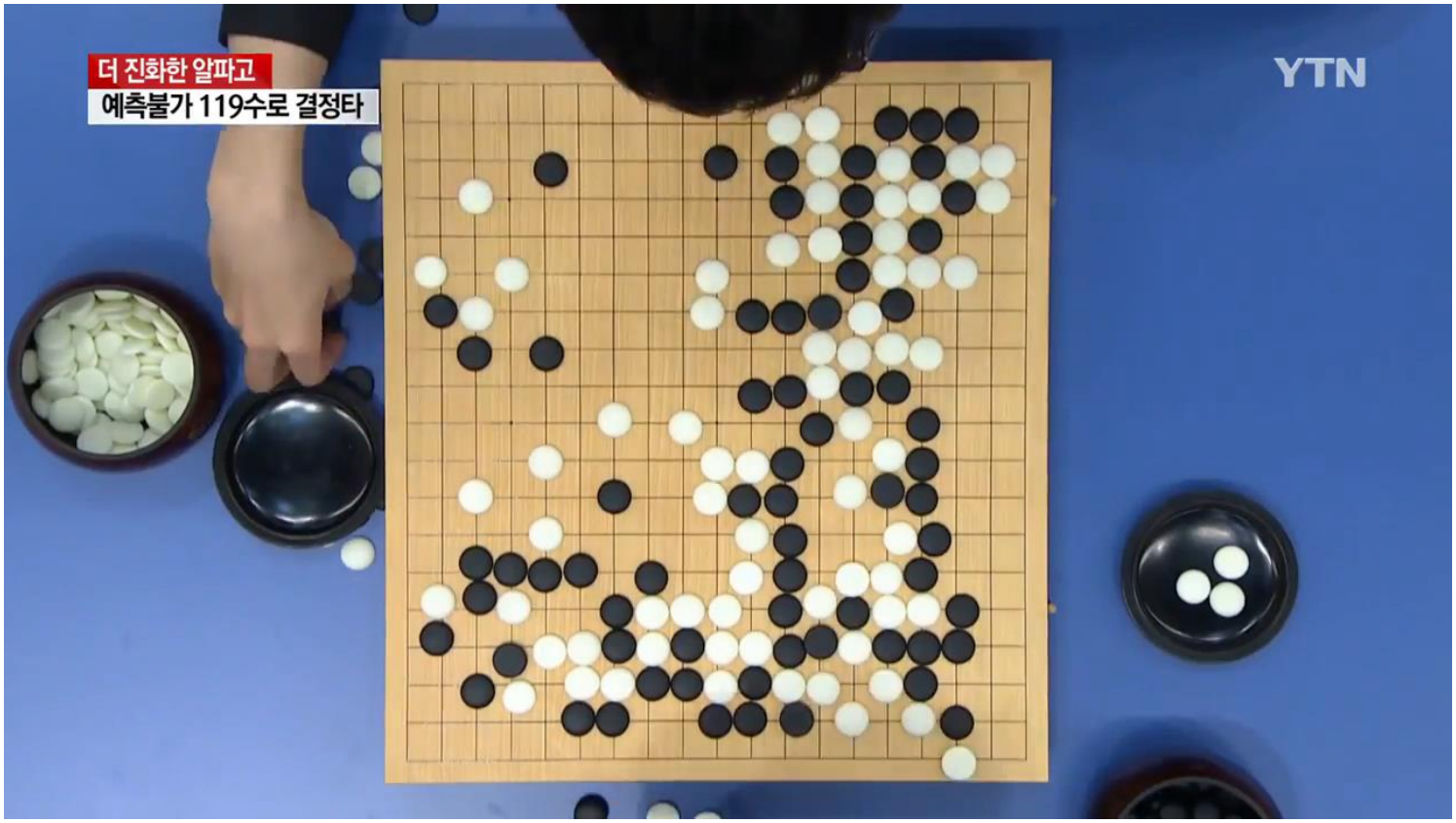
Future needs

✓ **Data burden**



Take Home Message

- ✓ AECG is commonly used in a variety of clinical contexts, for a variety of clinical purposes, and involves a variety of clinical personnel.

- ✓ There needs to be an understanding of the strengths and limitations of the AECG, and also of the specifically implemented technique, in order to optimize the impact that these results have on patient care.

Thank you for Listening