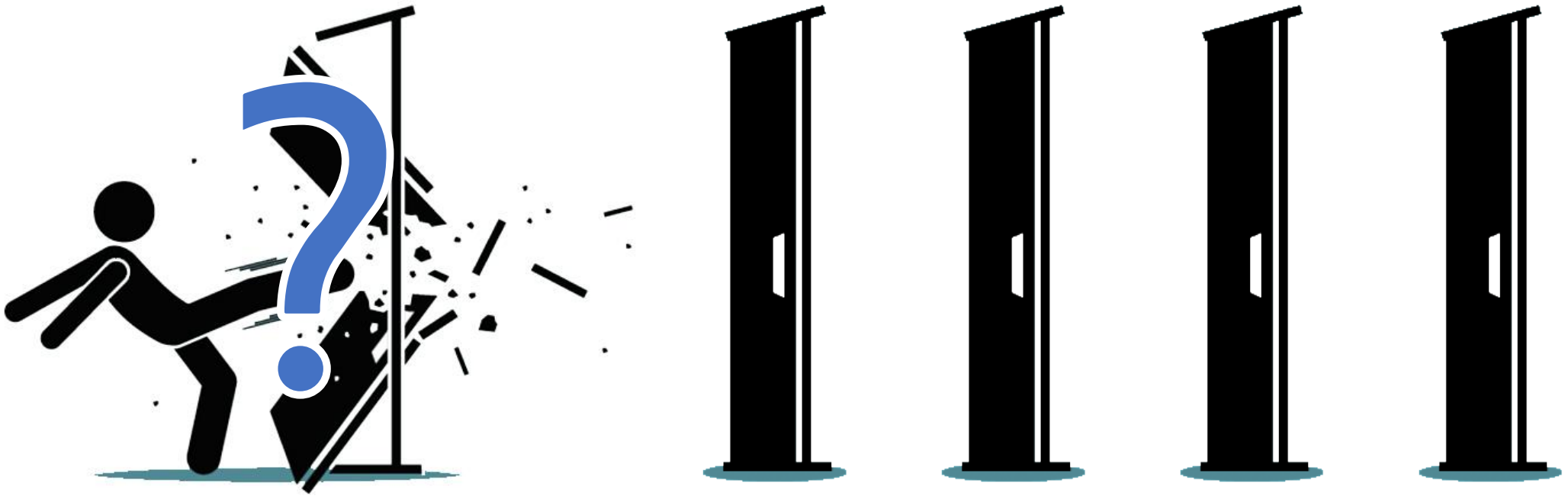
Using information & communication technology for cardiac rehabilitation

2023년 대한재활의학회 춘계학술대회

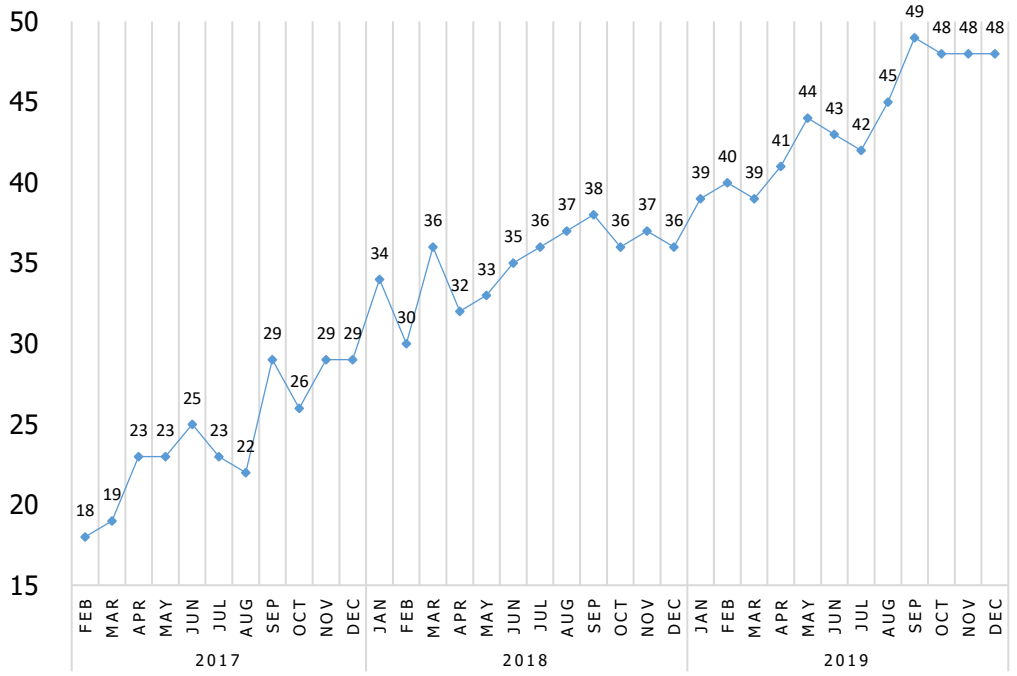
심장재활 활성화 공청회
2023년 4월 22일 11:10~11:30

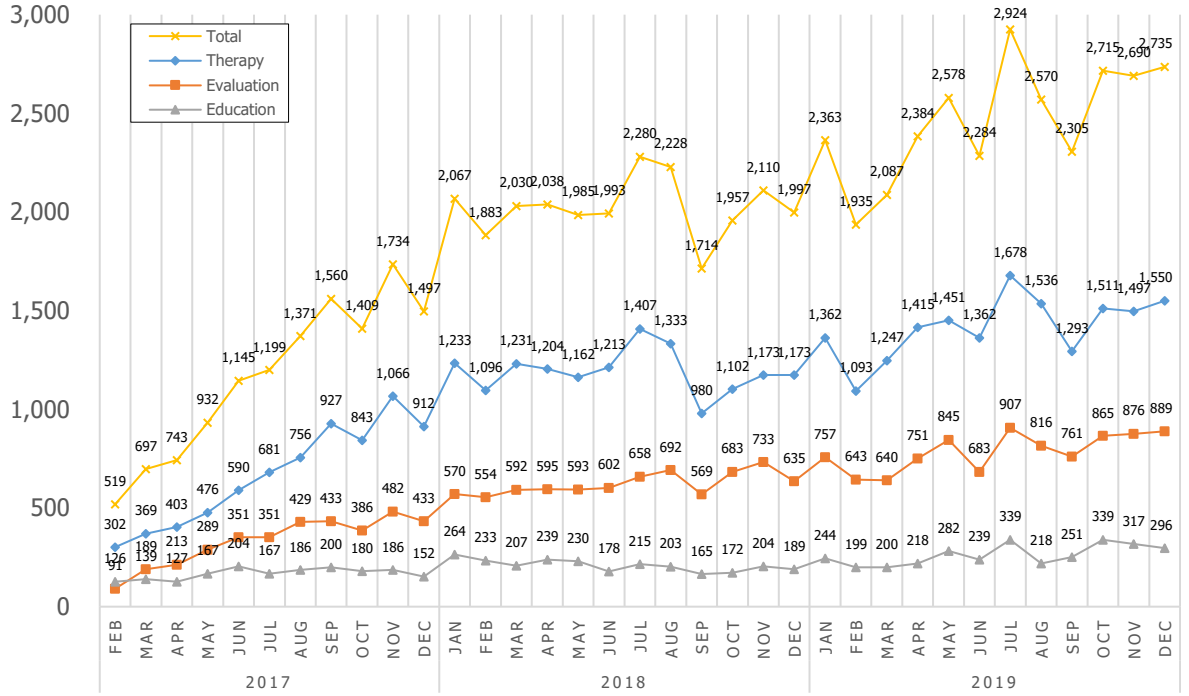
국민건강보험 일산병원 재활의학과 이장우

심장재활 요양급여(2017년 2월)



심장재활 기관 및 처방수 변화





국내 심장재활참여율

- Kim et al. J Korean Med Sci 2020
  - Jul 2017~Jun 2018
  - 1.5% of AMI patients (960/64,982)

- 질병관리청 용역연구(unpublished data)
  - 2017~2019
  - Coronary artery stent or CABG: total 191,840명
  - 심장재활 교육, 평가, 치료: 21,519명(11.22%)
  - 외래 심장재활 평가 혹은 치료: 12,777명(6.66%)

Cardiac Rehabilitation Barrier Scale

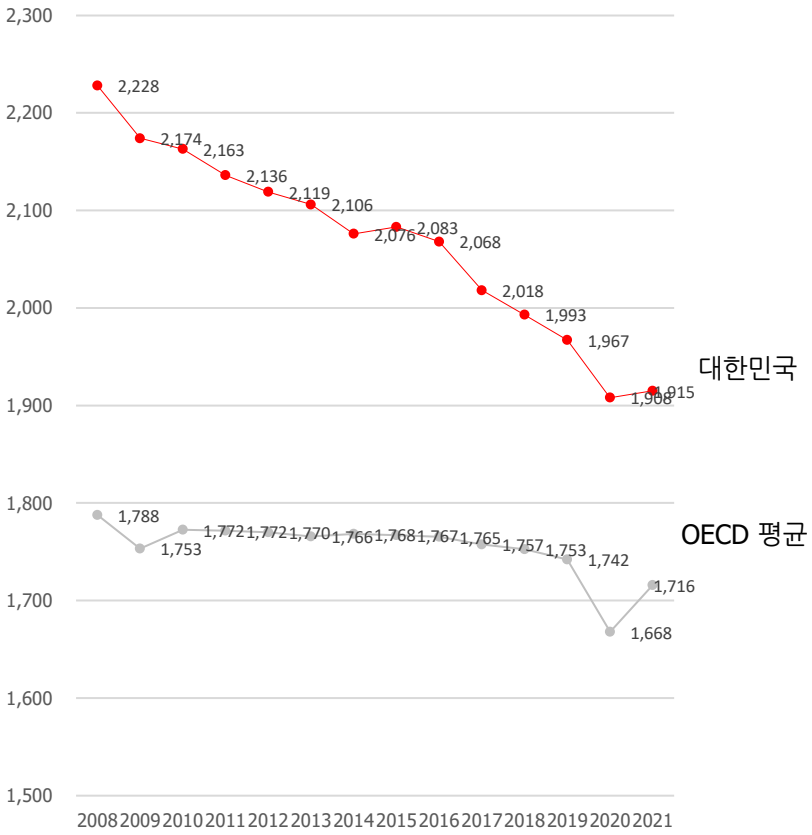
01...I don't need CR
02...I can manage on my own
03...my doctor didn't feel it was necessary
04...my people with heart problems don't go to CR and they are fine
05...I prefer to take care of my health alone
06...I already exercise at home or in my community
07...I didn't know about CR
08...I think I was referred but the rehab program didn't contact me
09...it took too long to get referred and into the program
10...of cost
11...of transportation problems
12...of distance
13...of family responsibilities
14...severe weather
15...of work responsibilities
16...of time constraints
17...travel
18...I don't have the energy
19...I find exercise tiring or painful
20...other health problems prevent me from going
21...I am too old

Shanmugasegaram et al. 2012

심장재활 참여

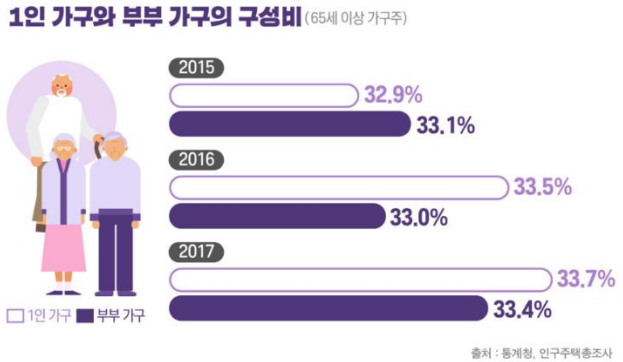
국민건강보험 National Health Insurance Service 일산병원 Ilsan Hospital

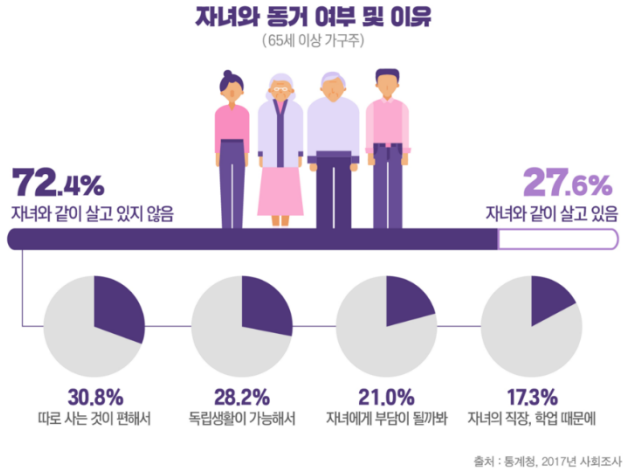
우리나라 연간 근로시간



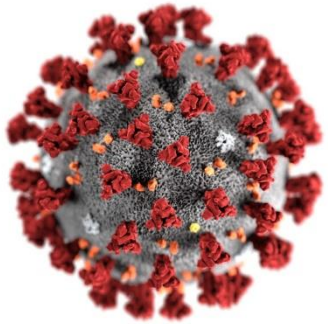
Ref: https://data.oecd.org/emp/hours-worked.htm

노인가구

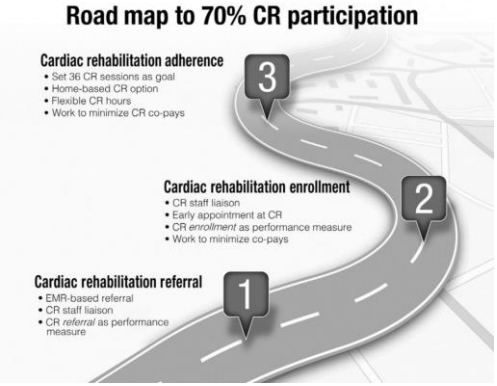




COVID-19



Million Hearts®

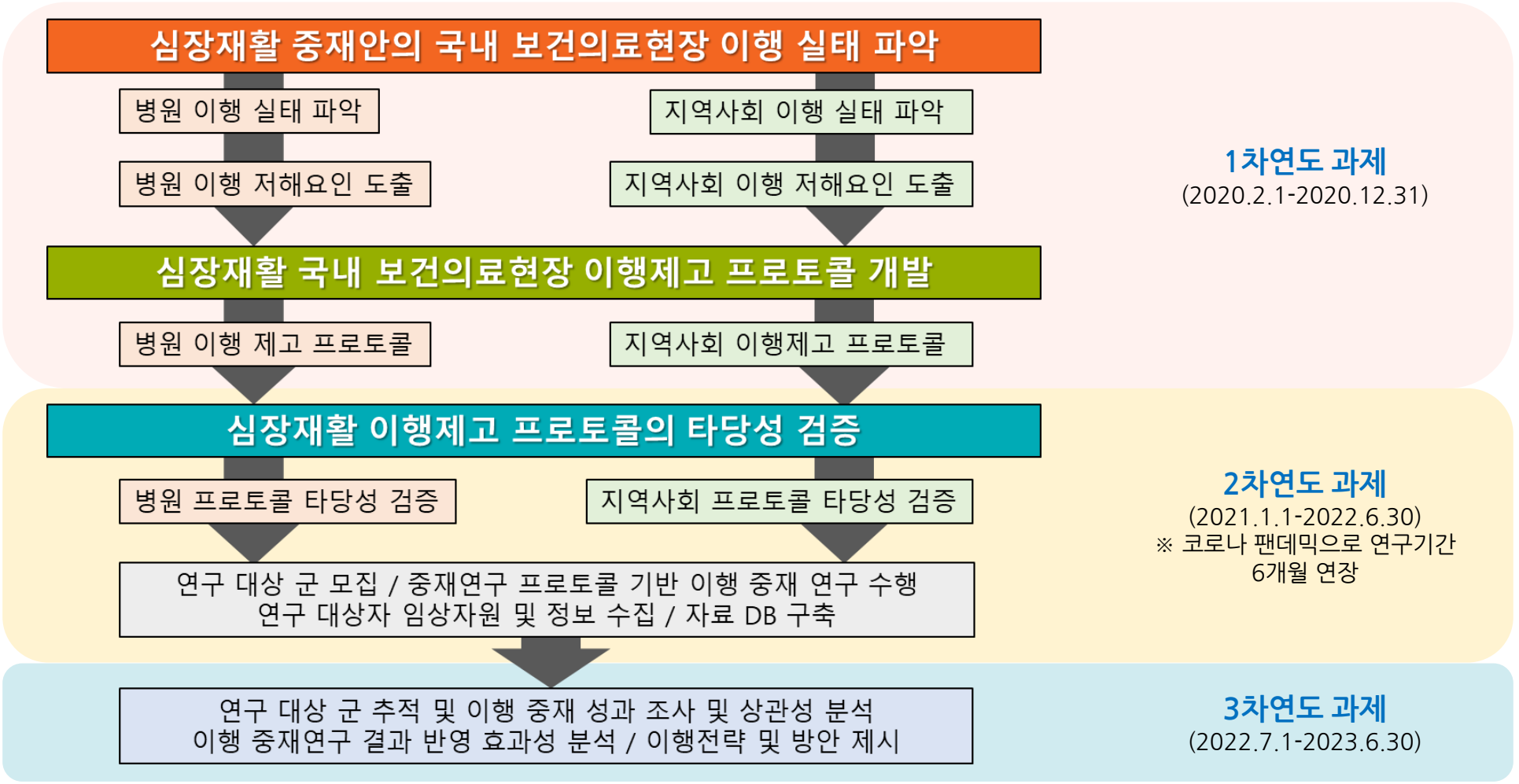


- Reduce the interval between hospital discharge and cardiac rehab program orientation by formalizing enrollment practices.
- Support participation in cardiac rehab through community health workers, home health aides, and visiting nurses.
- Design culturally and linguistically appropriate programs.
- Ensure access to services through transportation options and extended hours.
- Where possible, reduce or eliminate financial burden on cardiac rehab participants.
- Diversify cardiac rehab teams.
  - Research shows that minority physicians are more likely to care for minority, poor, uninsured, and underserved people, compared to white physicians.
- Create web-based or home-based programs in rural areas.
- Develop telemedicine-monitored cardiac rehab programs for people unable to access traditional programs.
- For people unable to attend all 36 sessions in a cardiac rehab facility, conduct baseline assessment in a cardiac rehab clinic followed by a nurse-monitored home exercise program.
- Reward eligible people for completing cardiac rehab programs.
- Reward programs with high completion rates.
- Share best practices and lessons learned, including innovations.

Home-based CR

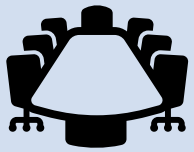
- A reasonable option for CBCR to increase participation in CR
  - AACVPR/AHA/ACC Scientific Statement 2019
  - ESC guideline 2016
- Effects of HBCR compared with CBCR
  - Not inferior in safety, mortality, exercise capacity, risk factor management, and HRQoL
  - Superior in adherence and cost-effectiveness

심장재활의 임상현장 및 지역사회 이행 제고 전략개발 연구



질병관리청 용역연구(2020년~2023년, 계약번호 20200206E03-00)

심장재활 이행 저해 요인 및 제고 전략

	이행 저해 요인	이행 제고 전략
환자 요인 	1) 심장재활 목표 및 필요성에 대한 무지 2) 환자 자기-효능감 부족 (관심 없다. 다니기 귀찮다. 소용이 없다.) 3) 시간이 없다. 직장 및 일 때문에 바쁘다. 4) 병원이 집에서 멀다. 교통이 불편하다. 5) 심장재활 수가, 교통비 등 비용지출 부담 6) 우울증, 심리적 불안감으로 참여 어려움 7) 주변에 안하는 환자 많아 참여 동기 저하 8) 고령 환자 홀로 거동 불편, 동행인 부재	1) 환자/가족을 위한 심층교육 및 자료 제공 2) 심장재활에 대한 자기-효능 교육/상담 3) 참여 가능한 일정, 시간, 횟수 제시 **4) 가정-심장재활 적극 활용(고위험군 제외)** 5) 인센티브 제공, 보험수가 부담금 경감 6) 심리상담 및 심리적 중재 치료 병행 7) 심장재활의 장기 예후 효과에 대한 교육 8) 보호자 설득, 동행 도우미 지원(간병 등급)
의사 및 병원 요인 	1) 심장재활 필요성에 대한 의료진 무지 2) 저조한 심장재활 협진 의뢰율 3) 심장재활에 대한 의료진 일관된 권유 없음 4) 심장재활 외래 등록율 및 참여율 저조 5) 병원-중심 통원 심장재활 예약 및 운영 6) 퇴원 후 외래 방문 시 심장재활 권유 안함. 7) 통원 심장재활 접근성의 문제 8) 가정-기반 심장재활 활용 저조	1) 심장재활 임상진료지침 및 근거논문 제공 2) 자동 의뢰시스템 적용, 코디네이터 활동 3) 전문의, 전공의, 병동간호사 대상 교육 4) 퇴원 시 심장재활 외래 예약 및 필참 권유 5) 환자-중심 통원 심장재활 예약 및 운영 6) 심장내과 외래 방문 시 심장재활 필참 권유 7) 병원 내 동선, 출입로, 주차장 불편 개선 **8) 가정-심장재활 적극 활용(고위험군 제외)**
제도 및 정책적 요인 	1) 심장재활 개설 병원의 부족 2) 심장재활 네트워크의 부재 3) 의료기관 간 신뢰 및 정보 공유 부제 4) 심장재활 설치를 위한 제도적 지원 부재 5) 부담되는 심장재활 건강보험 수가(50%) 6) 직장 복귀로 인한 시간 부족, 통원 심장 재활 참여가 사실 상 불가능한 직장 문화 7) 가정-기반 심장재활 활용 저조 8) 농어촌 지역, 저소득층 지역의 어려움 9) 지역사회-심장재활 운영 기관의 부재	1) 지역 심뇌혈관질환센터 사업, 심장재활 2) 권역-지역 심뇌혈관질환센터 네트워크 3) 심장재활 시행 병원 홍보 및 의뢰 활성화 4) 심장재활 개설 병원 평가 가산점, 인센티브 5) 심장재활 환자 산정특례 적용(부담금 10%) 6) 치료받을 수 있는 권리 강화, 병가 급여 제도, 직장문화 복지제도 개선 **7) 가정-심장재활 프로토콜 및 보험 수가** 8) 공공 의료원, 보건소, 건강관리기관 등 활용 9) 공공 의료원, 보건소, 건강관리기관 등 활용

심장재활 담당 전문의 대상 설문(N=51)

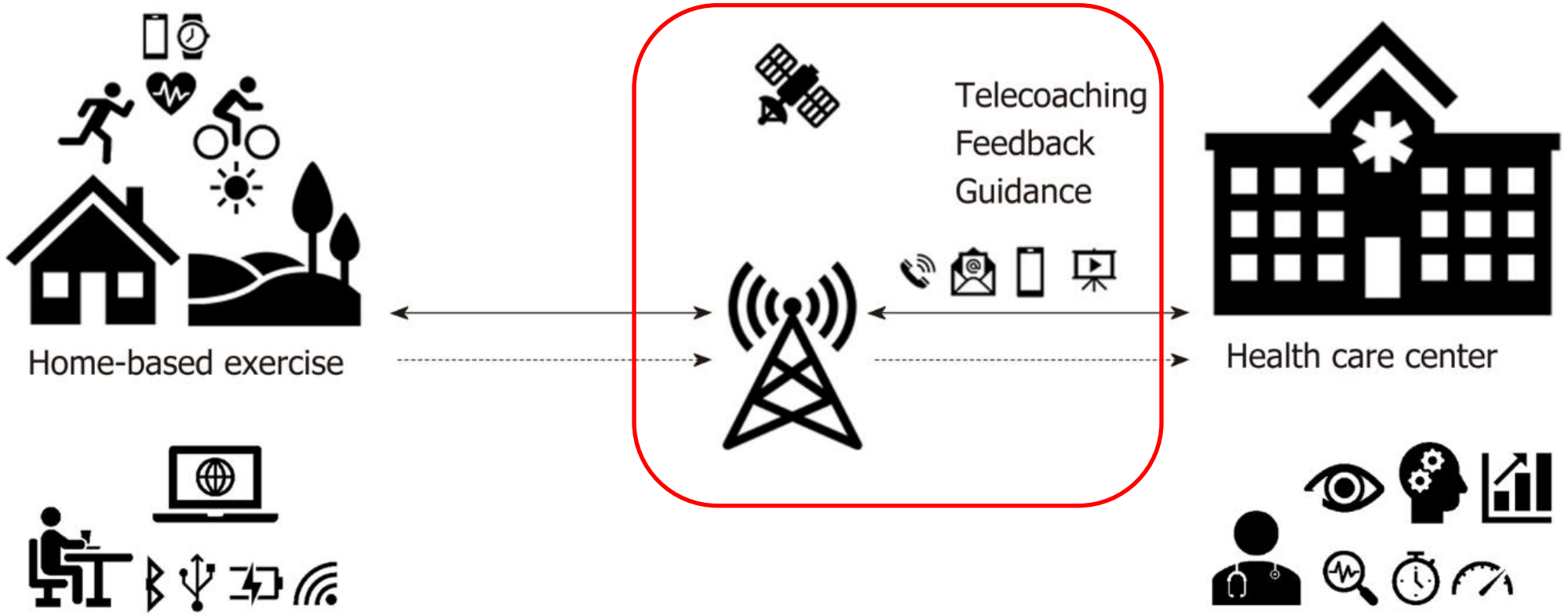
- 통원 심장재활의 대안으로서 가정 심장재활 프로그램을 운영
  - 운영한다 23 (45.1%), 운영하지 않는다 28 (54.9%)

- 가정 심장재활을 운영하지 않는 이유 (복수응답)
  - 수가가 충분하지 않아서 16 (57.1%)
  - 필요한 인력이 부족해서 23 (82.1%)
  - 감시 없이 운동을 하는 것이 위험하다고 생각해서 6 (21.4%)

가정 심장재활 환자들과의 소통 방법

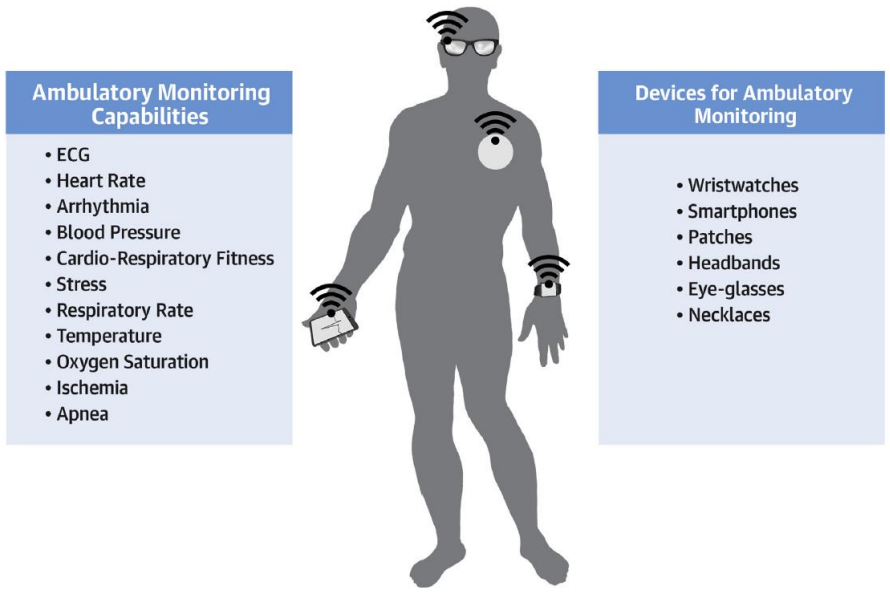
	사용안함	매일	매주몇번	매주한번	매달몇번	매달한번	그저한번	미응답
인터넷 웹페이지	17 (33%)	0	0	0	0	0	0	34 (67%)
이메일	17 (33%)	0	0	0	0	0	0	34 (67%)
통화	12 (24%)	0	0	0	2 (4%)	1 (2%)	2 (4%)	34 (67%)
스마트폰 앱	17 (33%)	0	0	0	0	0	1 (2%)	33 (65%)
문자메시지	13 (25%)	0	0	0	1 (2%)	2 (4%)	1 (2%)	34 (67%)
종이 일지	9 (18%)	4 (8%)	4 (8%)	0	0	1 (2%)	2 (4%)	31 (61%)
방문	11 (22%)	0	0	4 (8%)	0	3 (6%)	1 (2%)	32 (63%)

Information and Communication Technologies

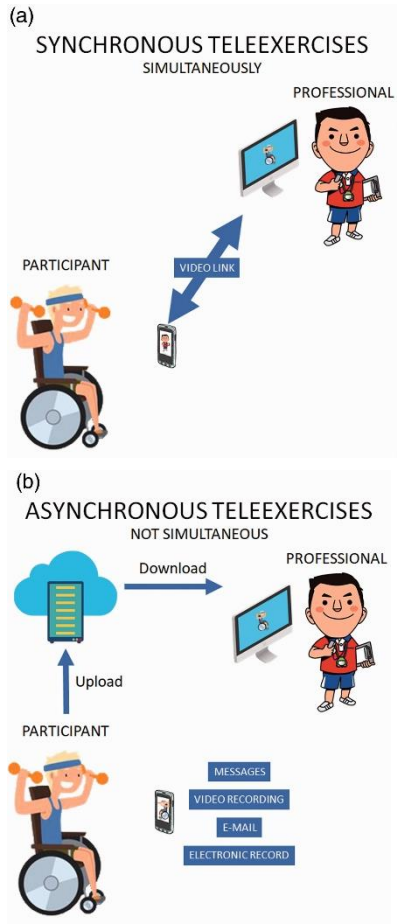


Batalik et al. World J Clin Cases. 2020

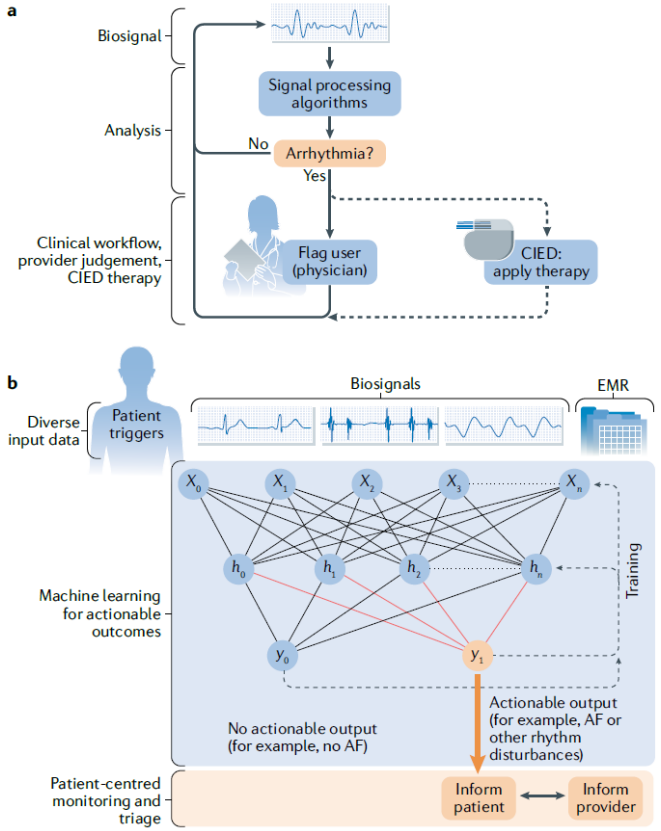
ICT for CR



Sana et al. J Am Coll Cardiol. 2020



Costa et al. J Telemed Telecare. 2021



Krittanawong et al. Nat Rev Cardiol. 2021

HBCR compared with CBCR

Potential Advantages	Potential Disadvantages
Reduced enrollment delays	Lack of reimbursement
Expanded capacity/access	Less intensive exercise training
Individually tailored programs	Less social support
Flexible, convenient scheduling	Less patient accountability
Minimal travel/transportation barriers	Lack of published standards for HBCR
Greater privacy while receiving CR services	Less face-to-face monitoring and communication
Integration with regular home routine	Safety concerns for patients at higher risk

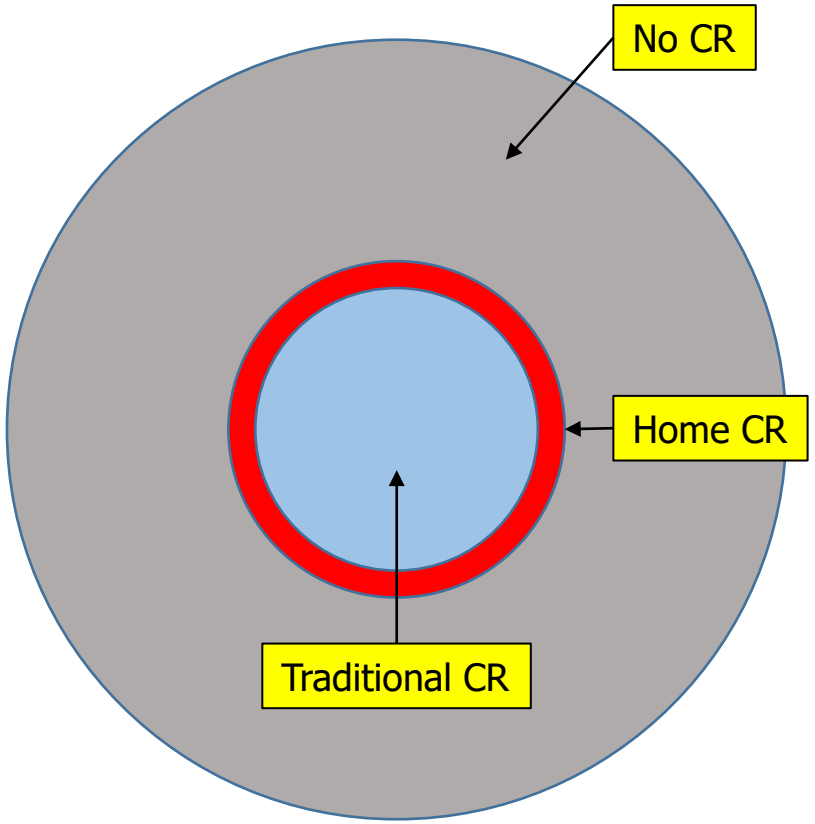
Thomas et al. J Am Coll Cardiol. 2019

Stratification of risk during exercise

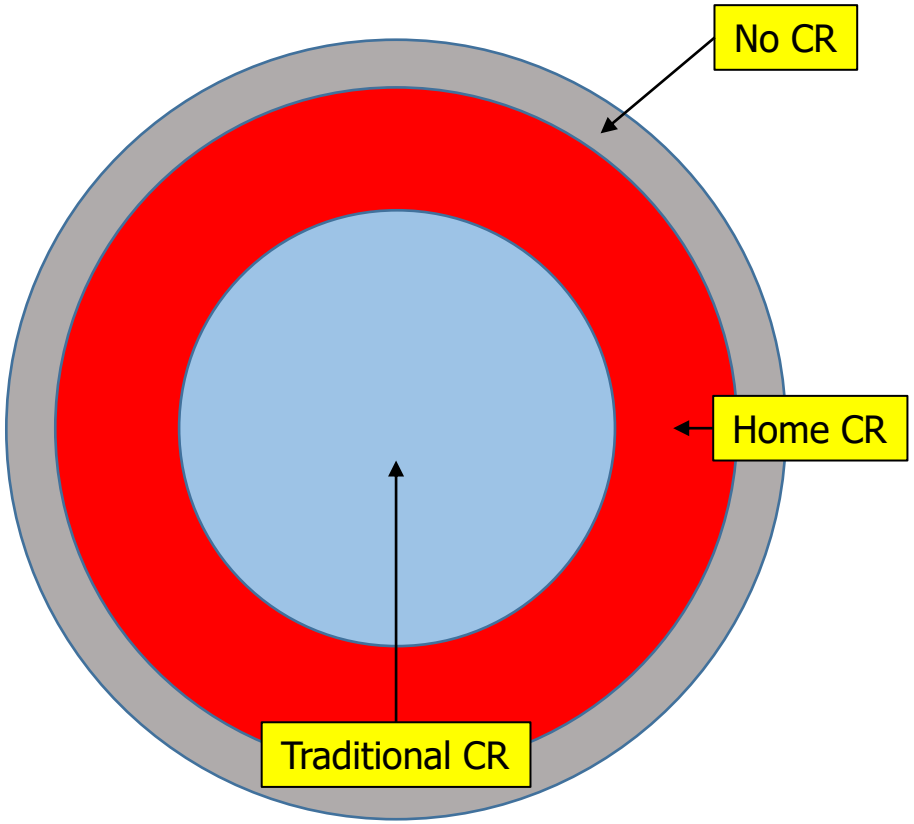
	Lowest	Moderate	High
Exercise testing findings	• Absence of complex ventricular dysrhythmia during exercise testing and recovery • Absence of angina or other significant symptoms (e.g., unusual shortness of breath, light-headedness, or dizziness during exercise testing and recovery) • Presence of normal hemodynamics during exercise testing and recovery (i.e., appropriate increases and decreases in heart rate and systolic blood pressure with increasing workloads and recovery) • Functional capacity ≥7 METs	• Presence of stable angina or other significant symptoms (e.g., unusual shortness of breath, light-headedness, or dizziness occurring only at high levels of exertion [<7 METs]) • Mild to moderate level of silent ischemia during exercise testing or recovery (ST-segment depression <2 mm from baseline) • Functional capacity <5 METs	• Presence of complex ventricular arrhythmias during exercise testing or recovery • Presence of angina or other significant symptoms (shortness of breath, light-headedness, or dizziness at low levels of exertion [≥5 METs] or during recovery) • High level of silent ischemia (ST-segment depression ≥2 mm from baseline) during exercise testing or recovery • Presence of abnormal hemodynamics with exercise testing (i.e., chronotropic incompetence or flat or decreasing systolic BP with increasing workloads) or recovery (i.e., severe postexercise hypotension) • Functional capacity ≤3 METs
Nonexercise testing findings	• Rest ejection fraction ≥50% • Uncomplicated myocardial infarction and/or complete revascularization procedure • Absence of complicated ventricular arrhythmias at rest • Absence of heart failure • Absence of signs or symptoms of postevent or postprocedure ischemia • Absence of clinical depression	• Rest ejection fraction = 35% to 49%	• Left ventricular dysfunction with resting ejection fraction <35% • History of cardiac arrest • Complex dysrhythmias at rest • Complicated myocardial infarction or incomplete revascularization procedure • Presence of heart failure • Presence of signs or symptoms of post-event or post-procedure ischemia • Presence of clinical depression • Implanted cardiac defibrillator

AACVPR. Guidelines for Cardiac Rehabilitation Programs. 6th edi. 2020

Paradigm shift of CR



Current Paradigm



New Paradigm

Phase II CR

Center-based CR

Phase III CR

Home-based CR

TelereCR

국민건강보험 National Health Insurance Service 일산병원 Ilsan Hospital

A controlled trial of cardiac rehabilitation in the home setting using electrocardiographic and voice transtelephonic monitoring

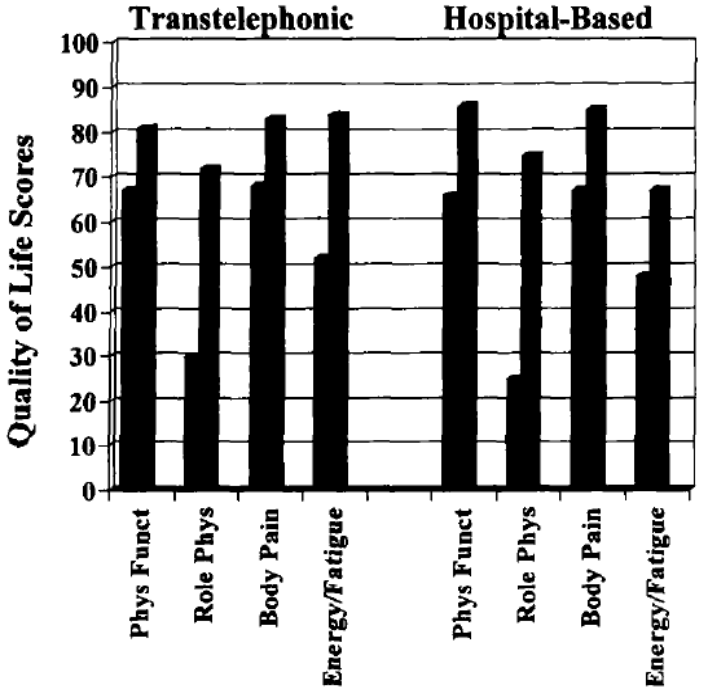
Philip A. Ades, MD, Fredric J. Pashkow, MD, Gerald Fletcher, MD, Ileana L. Pina, MD, Lenore R. Zohman, MD, James R. Nestor, PhD *Burlington, Vt*

Am Heart J 2000; 139: 543-8

TelereCR

- Intervention
  - ScottCare Tele-Rehab System
  - Raytel Cardiac Service
    - Multiple long-distance phone line to monitor up to 8 patients simultaneously
  - Patient kit
    - ECG leads and transmitter unit
    - Headset
    - Voice transmitter
    - Telephone modem
  - During cycle exercise
    - Direct telephone contact with the nurse coordinator and other patient participants
    - 15~20 min, 65% of HRmax → 35~40 min, 85% of Hrmax

- Results



Home-based cardiac telerehabilitation

ESC European Society of Cardiology

European Journal of Preventive Cardiology (2022) **29**, 1017–1043
doi:10.1093/eurjpc/zwab106

FULL RESEARCH PAPER

Effectiveness of home-based cardiac telerehabilitation as an alternative to Phase 2 cardiac rehabilitation of coronary heart disease: a systematic review and meta-analysis

Hadassah Joann Ramachandran [1]*, Ying Jiang[1], Wilson Wai San Tam[1], Tee Joo Yeo[2], and Wenru Wang[1]*

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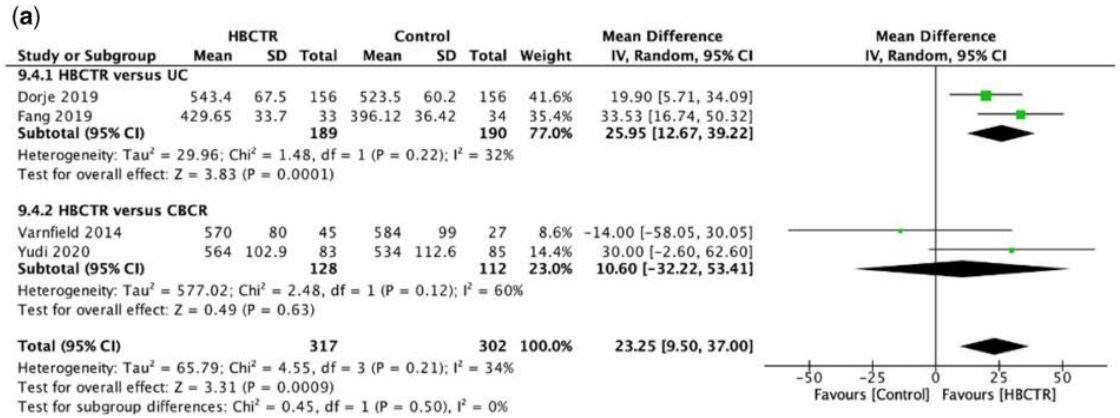
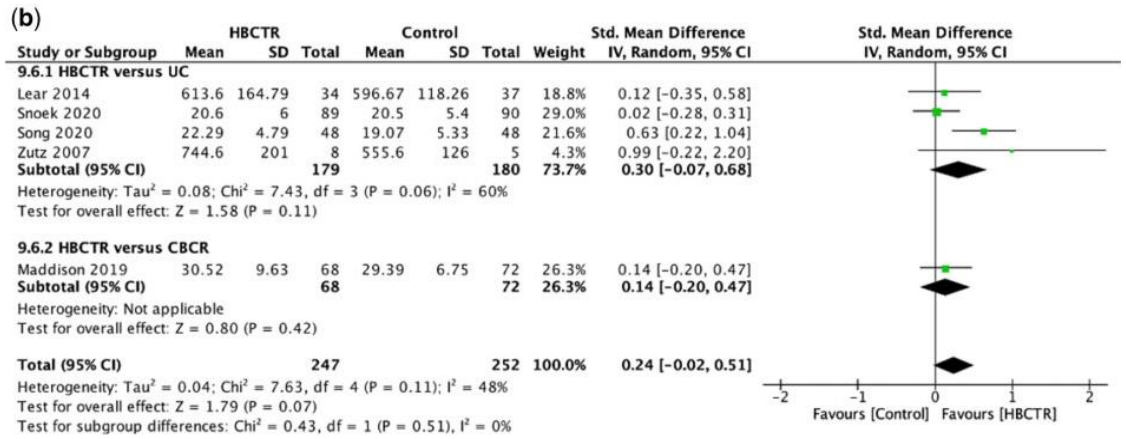
Home-based cardiac telerehabilitation

Study (Total N = 14)	No. of participants	Wearable device	Method of communication	Comparison
Devi et al. 2014 (UK)	95	Accelerometer (Sensewear Pro3)	CR nurse via e-mail or synchronized chat room	Usual care
Dorje et al. 2019 (China)	312	Pedometer, BP and HR monitor (C-health XY-10)	Cardiologist via WeChat	Usual care
Duan et al. 2018 (China)	114	-	Weekly phone calls by nurse	Usual care
Fang et al. 2019 (China)	80	Belt strap with sensor for PA tracing (Ucare RG10)	2 home visit and weekly telephone calls by PT	Usual care
Lear et al. 2014 (Canada)	78	HR monitor (Polar s610i)	Weekly one-on-on web-site chat with nurse, exercise specialist and dietitian/monthly group chat	Usual care
Maddison et al. 2019 (New Zealand)	162	Chest-worn wearable sensor (BioHarness 3)	Physiologist provided individualized coaching on **real-time** platform. SMS 3 times/week	CBCR
Reid et al. 2012 (Canada)	223	Pedometer (Yamax DIGIWALKER)	Exercise specialist via e-mail	Usual care
Snoek et al. 2021 (NED, SUI, DEN, FRA, ESP)	179	HR belt	Telephone interview (4 → 1 time/month)	Usual care
Song et al. 2020 (China)	106	HR belt (Sunto)	Medical staff via text messaging and telephone call, weekly	Usual care
Varnfield et al. 2014 (Australia)	120	Step-counter	Weekly telephone call	CBCR
Wang et al. 2020 (China)	179	-	2 cardiologists and 1 trained nurse via WeChat platform	Usual care
Yu et al. 2020 (China)	1,000	-	App messaging service, weekly	Usual care
Yudi et al. 2020 (Australia)	206	Smartphone's accelerometer	Interactive and personalized feedback (5 times/week)	CBCR
Zutz et al. 2007 (Canada)	15	HR monitor	Weekly one-on-on web-site chat with nurse, exercise specialist and dietitian/monthly ask-an expert group	Usual care

Home-based cardiac telerehabilitation



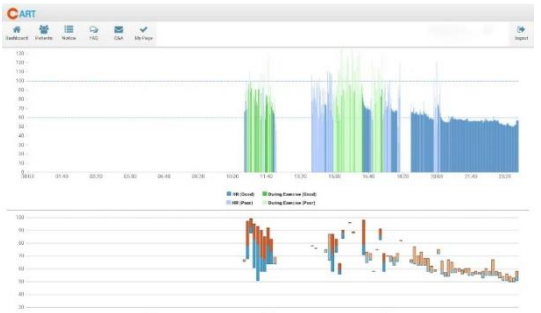
6-min walk test



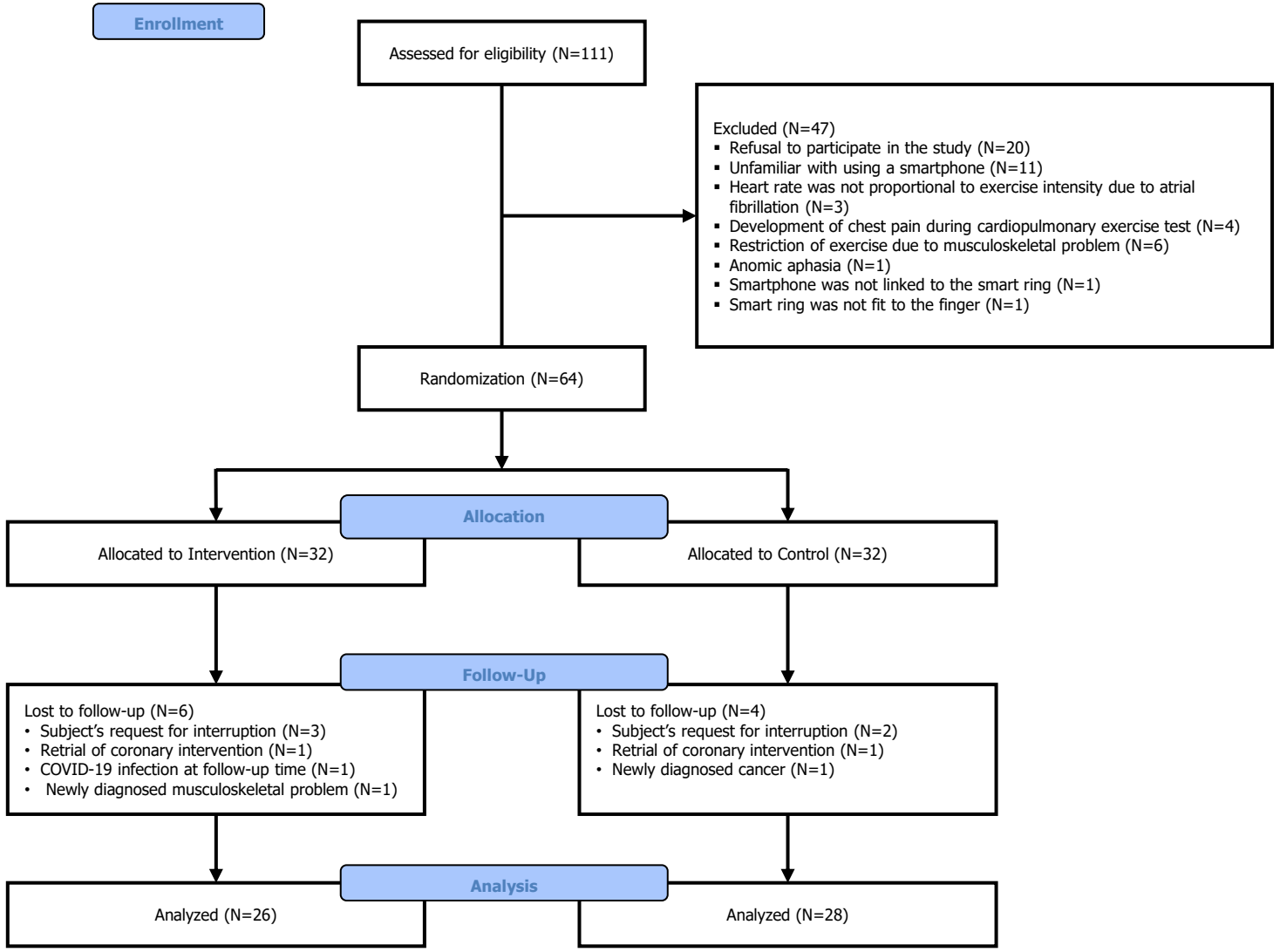
Symptom-limited exercise testing

HBCR using smart ring

- Randomized controlled trial
  - Cardiovascular patients
  - HRR의 60% 이상으로 운동
  - Block randominzation (1:1)
    - **Intervention - 1주일마다 심장재활치료사의 전화상담**
    - **Control - 1회의 교육 이후 observation**
  - 1주일마다 연구자 회의 및 환자 모니터 자료 검토
- Primary outcome
  - 3개월 후 peak VO2



Flow chart


Enrollment
Assessed for eligibility (N=111)
Excluded (N=47)
▪ Refusal to participate in the study (N=20)
▪ Unfamiliar with using a smartphone (N=11)
▪ Heart rate was not proportional to exercise intensity due to atrial fibrillation (N=3)
▪ Development of chest pain during cardiopulmonary exercise test (N=4)
▪ Restriction of exercise due to musculoskeletal problem (N=6)
▪ Anomic aphasia (N=1)
▪ Smartphone was not linked to the smart ring (N=1)
▪ Smart ring was not fit to the finger (N=1)
Randomization (N=64)
Allocation
Allocated to Intervention (N=32)
Allocated to Control (N=32)
Follow-Up
Lost to follow-up (N=6)
• Subject's request for interruption (N=3)
• Retrial of coronary intervention (N=1)
• COVID-19 infection at follow-up time (N=1)
• Newly diagnosed musculoskeletal problem (N=1)
Lost to follow-up (N=4)
• Subject's request for interruption (N=2)
• Retrial of coronary intervention (N=1)
• Newly diagnosed cancer (N=1)
Analysis
Analyzed (N=26)
Analyzed (N=28)

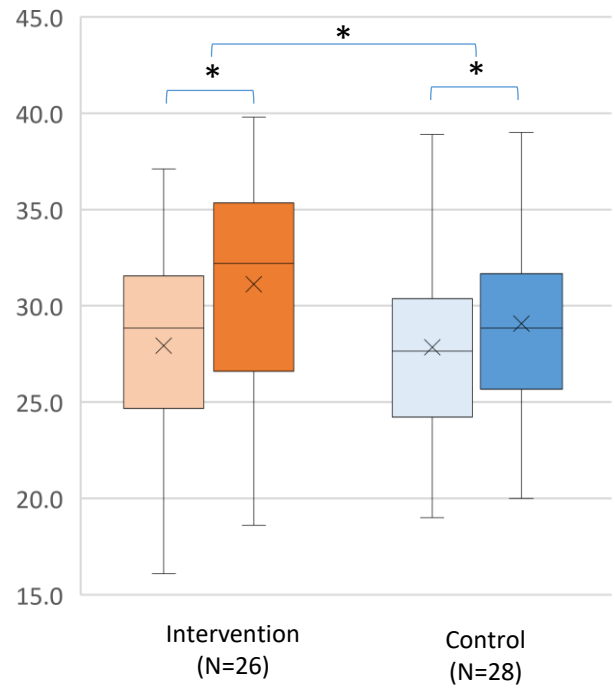
Demographics

	Total (N=64)	Intervention (N=32)	Control (N=32)	*P*
Age (years)	59.8 ± 9.0	59.8 ± 9.9	59.7 ± 8.2	0.967
Male sex	53 (82.8%)	26 (81.3%)	27 (84.4%)	0.740
Diagnosis				0.436
Stable angina	22 (34.4%)	13 (40.6%)	9 (28.1%)	
Unstable angina	9 (14.1%)	4 (12.5%)	5 (15.6%)	
NSTEMI	18 (28.1%)	10 (31.3%)	8 (25.0%)	
STEMI	15 (23.4%)	5 (15.6%)	10 (31.3%)	
Peak VO_2 (mL/kg/min)	27.9 ± 5.5	27.9 ± 5.8	27.9 ± 5.4	0.979
RER	1.08 ± 0.07	1.08 ± 0.07	1.08 ± 0.07	0.930
HRrest (beat/min)	69.3 ± 9.4	69.6 ± 9.0	69.0 ± 9.9	0.803
HRmax (beat/min)	148.8 ± 17.9	151.1 ± 18.5	146.6 ± 17.4	0.327
HRmax%	93.0 ± 10.8	94.3 ± 10.3	91.6 ± 11.3	0.318

Results

	Intervention (N=26)			Control (N=28)		
	Baseline	3 months	*P*	Baseline	3 months	*P*
Cardiopulmonary exercise test						
Peak VO_2 (mL/kg/min)	27.9 ± 5.1	31.1 ± 5.6	<0.001	27.8 ± 5.4	29.1 ± 5.5	0.025
RER	1.07 ± 0.07	1.08 ± 0.07	0.227	1.08 ± 0.07	1.07 ± 0.07	0.163
HRrest (beat/min)	69.9 ± 9.0	68.6 ± 9.0	0.446	69.2 ± 10.1	68.6 ± 10.3	0.727
HRmax (beat/min)	151.7 ± 17.4	153.7 ± 16.8	0.477	147.1 ± 16.5	148.8 ± 19.2	0.327
HRmax%	94.9 ± 9.0	96.2 ± 9.0	0.473	91.6 ± 11.4	92.6 ± 12.3	0.370
KASI	64.9 ± 13.0	67.0 ± 11.1	0.069	65.4 ± 11.5	64.3 ± 12.4	0.524
PHQ-9	2.6 ± 3.0	2.5 ± 2.8	0.272	3.0 ± 3.6	2.9 ± 5.2	0.958
EQ-5D-5L	0.872 ± 0.040	0.862 ± 0.044	0.860	0.880 ± 0.029	0.880 ± 0.049	0.970
EQ_VAS	74.7 ± 12.9	78.2 ± 10.8	0.034	77.5 ± 11.4	75.5 ± 13.1	0.434

Peak VO2



* P < 0.05

Summary

- 진정한 의미의 HBCR을 위해서는 적절한 technology가 뒷받침되어야 한다 (technology-driven CR).
- 현재의 기술로도 충분히 비대면 심장재활이 가능하다.
  - 기기의 문제가 아니라 현재의 기술을 어떻게 활용하느냐의 문제
  - 제도적 뒷받침(법적인 문제 및 의료수가)이 필요하다.
- 안전한 심장재활을 위해서는 심폐운동부하 검사가 선행되어야 한다.
- 비대면 심장재활을 위해서는 CBCR이 의미 없는 것이 아니라 적절한 CBCR이 support 되어야 한다.
- ICT에서 Information보다 Communication이 더 중요
- 비대면 심장재활과 비대면 진료 혹은 원격진료와는 다른 개념이다.
  - 어차피 심장재활에 필요한 모니터링을 원격으로 하는 것