Journal reading

Conventional and chest-compression-only cardiopulmonary resuscitation by bystanders for children who have out-of-hospital cardiac arrests: a prospective, nationwide, population-based cohort study

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Intrduction

- CPR by bystanders improves survival after OHCA but most do not receive any CPR from bystanders
- AHA now recommends CPR with chest compression only for people with OHCA of presumed cardiac origin
- Survival rates in adults are similar after conventional CPR or compression-only CPR
- Compression- only CPR is easier to teach, learn, and remember

- Most children with OHCA do not receive CPR
- Many paediatric OHCA are of respiratory rather than cardiac cause
- Animal studies suggest that conventional CPR is better for cardiac arrests of respiratory cause -> compression-only CPR is not recommended for children

The Three Questions

- Any type of CPR would have favourable neurological outcome after paediatric OHCA compared with no CPR?
- Conventional CPR would be better than CPR with chest compression only in cardiac arrests with presumed non-cardiac causes?
- Both CPR technique would have similar outcomes after OHCA with presumed cardiac causes?

Methods - Study Design

- The All-Japan Utstein registry of the Fire and Disaster Management Agency (FDMA) is a prospective, nationwide, population-based registry system of OHCA in adults and children, with Utstein-style data collection

- Inclusion:
  children aged ≤ 17 y/o with an OHCA, treated by EMS personnel and transported to medical institutions from Jan 1, 2005 to Dec 31, 2007
- Exclusion: arrests occurred after the arrival of EMS or witness status was not documented

- The cause of arrest: presumed cardiac
  Except evidence of external causes (trauma, hanging, drowning, drug overdose, asphyxia), respiratory diseases, cerebrovascular diseases, malignant tumours, or any other non-cardiac cause
- Cause of OHCA: the physicians/the EMS personnel
- Approved by the ethics committee of Kyoto University Graduate School of Medicine

Study Setting

- Japan: about 378000 km^2 including both urban and rural communities
- The population of Japan: about 127 million in 2005, and 21.3 million people $\leq$ 18 years of age
- 807 fire stations with dispatch centres in 2007
- EMS were provided by the municipal governments 24 h every day

- All providers did CPR according to the Japanese CPR guidelines (AHA 2000/ILCOR 2005)
- DNR orders are not allowed out of hospital
- Most patients were sent to hospital except those with decapitation, incineration, decomposition, rigor mortis, or dependent cyanosis
- Conventional CPR were performed mainly by local fire departments and compression-only CPR: not been taught during the study period

Data Collection & Quality Control

- Data included: data for sex, age, cause, bystander's witness status, first documented cardiac rhythm, presence and type of CPR by bystander, and intubation and administration of epinephrine by EMS personnel
- Outcome data included: ROSC before hospital arrival, 1-month survival, and neurological status 1 month after the event

- The time from collapse to first resuscitation attempt by the bystander -> by interview
- Times of receipt of call by EMS, vehicle arrival at the scene, contact with patients, initiation of CPR, defibrillation by emergency staff, and arrival at hospital -> recorded with the clock used by each EMS system

Study endpoints

- The primary endpoint: favourable neurological outcome 1 month after cardiac arrest, (Glasgow-Pittsburgh cerebral performance category 1 (good performance) or 2 (moderate disability))
- The other categories: 3 (severe cerebral disability), 4 (vegetative state), and 5 (death): unfavourable neurological outcome
- Secondary outcome: measures ROSC before hospital arrival and 1-month survival

Statistical Analysis

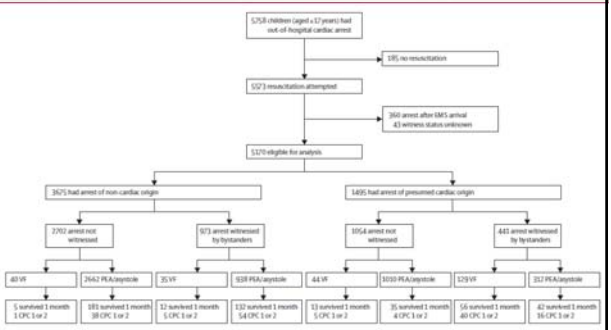
- An estimate of the number of victims -> previous studies of OHCA in children in the USA and 2 large epidemiological studies in adults in Japan
- The minimum sample size: 400 victims for each group (2-sided α value of 0.05 and a β error of 0.20)
- 4 groups: non-cardiac or cardiac arrest/infants aged <1 year or children aged 1–17 years

- Multivariable logistic regression analysis: CPR by bystanders to favourable neurological outcome/no CPR, and conventional CPR/compression-only CPR
- ORs and their 95% CIs: calculated with adjustment for potential confounding factors including sex, age, cause of arrest, witness status, first documented rhythm, time from call to CPR by EMS, and time from call to hospital arrival
- All tests: 2-tailed, and p values <0.05 -> significant

Incidence

- The mean yearly population-based incidence of all cases was 8.0/100 000 person-years (65.9/100000 person-years for infants <1 year)
- Presumed cardiac cause: 2.3/100000 person-years (22.6/100000 person-years for infants)
- Noncardiac cause: 5.7/100000 person-years (43.3/100 000 person-years for infants)

Results



- Overall 1-month survival: 9.2% (476/5170)
- Favourable neurological 1-month survival: 3.2% (163/5170)
- 973 (26%) arrests of a non-cardiac causes and 441 (29%) of cardiac causes were witnessed by bystanders
- Neurological status at 1 month was not documented for 23 (<1%)

- 2439 (47%) children received CPR by bystanders, (1551 (30%) with conventional CPR and 888 (17%) with chest compression-only CPR)
- 2719 (53%) children did not receive any CPR
- Data for type of CPR by bystander were not available for 12 (<1%) children

	Total (n=5158)	No CPR (n=2719)	Any bystander CPR (n=2439)	p value*
Age (years)	5·1 (6·2)	5·3 (6·3)	4·9 (6·1)	0·031
<1 year of age	2082 (40·4%)	1087 (40·0%)	995 (40·8%)	0·10
Boys	3149 (61·1%)	1656 (60·9%)	1493 (61·2%)	0·82
Type of origin				<0·0001
Cardiac	1494 (29·0%)	709 (26·1%)	785 (32·2%)	–
Non-cardiac	3664 (71·0%)	2010 (73·9%)	1654 (67·8%)	–
Type of bystander-witness status				0·0001
No witness	3750 (72·7%)	1910 (70·2%)	1840 (75·4%)	–
Family members	845 (16·4%)	480 (17·7%)	365 (15·0%)	–
Others	563 (10·9%)	329 (12·1%)	234 (9·6%)	–
First documented rhythm				<0·0001
VF/pulseless VT	247 (4·8%)	99 (3·6%)	148 (6·1%)	–
PEA	948 (18·4%)	525 (19·3%)	423 (17·3%)	–
Asystole	3963 (76·8%)	2095 (77·1%)	1868 (76·6%)	–
Call to CPR time by EMS personnel (min)†	9·1 (5·8)	9·5 (6·9)	8·7 (4·2)	<0·0001
Call to defibrillation time by EMS personnel (min)‡	11·0 (6·4)	11·3 (7·4)	10·8 (5·9)	0·57
Call to hospital arrival (min)§	27·0 (10·0)	27·1 (10·3)	26·9 (9·8)	0·62

Data are number of patients (%) or mean (SD). Data for type of CPR by bystander were not available for 12 (<1%) children. CPR=cardiopulmonary resuscitation. VF=ventricular fibrillation. VT=ventricular tachycardia. PEA=pulseless electrical activity. EMS=emergency medical service. *p value calculated for any bystander CPR versus no CPR. †Time recorded for 5125 cases (2695 in the no CPR group and 2430 in the any CPR group). ‡Time calculated for cases with VF as first documented rhythm. §Time recorded for 5134 cases (2704 in the no CPR group and 2430 in the any CPR group).

Table 1: Characteristics of the study participants who had out-of-hospital cardiac arrests

	Adjusted OR (95% CI)	p value
Boys (vs girls)	0·81 (0·57–1·15)	0·24
Age 1–17 years (vs age 0–<1 years)	1·60 (1·07–2·36)	0·022
Cardiac (vs non-cardiac)	0·75 (0·50–1·12)	0·16
VF (vs non-VF)	6·21 (3·93–9·80)	<0·0001
Type of bystander-witnessed status (vs no witness)		
Family	5·21 (3·44–7·90)	<0·0001
Others	6·43 (4·08–10·12)	<0·0001
Any bystander-initiated CPR (vs no CPR)	2·59 (1·81–3·71)	<0·0001
Call to CPR by EMS (for one increment of minute)	0·91 (0·86–0·97)	0·0021
Call to hospital arrival (for one increment of minute)	0·99 (0·96–1·02)	0·66

OR=odds ratio. VF=ventricular fibrillation. CPR=cardiopulmonary resuscitation. EMS=emergency medical service.

Table 2: Contributing factors to neurologically favourable 1-month survival after out-of-hospital cardiac arrests in children

	No CPR (n=2719)	Bystander CPR (n=2439)	p value*	Compression-only CPR (n=888)	Conventional CPR (n=1551)	p value†
Non-cardiac origin						
Total	2010	1654		599	1055	
Age (years)	5·8 (6·5)	4·9 (6·0)	<0·0001	5·8 (6·5)	4·4 (5·6)	<0·0001
<1 year of age	717 (35·7%)	650 (39·3%)	0·024	219 (36·6%)	431 (40·9%)	0·086
Boys	1242 (61·8%)	1021 (61·7%)	0·97	358 (59·8%)	663 (62·8%)	0·22
Type of cause			<0·0001			0·031
External causes	1085 (54·0%)	734 (44·4%)		267 (44·6%)	467 (44·3%)	
Respiratory diseases	196 (9·8%)	182 (11·0%)		71 (11·9%)	111 (10·5%)	
Cerebrovascular diseases	44 (2·2%)	43 (2·6%)		17 (2·8%)	26 (2·5%)	
Malignant tumours	18 (0·9%)	9 (0·5%)		8 (1·3%)	1 (0·1%)	
Others	667 (33·2%)	686 (41·5%)		236 (39·4%)	450 (42·7%)	
Type of bystander-witness status			<0·0001			0·013
No witness	1398 (69·6%)	1299 (78·5%)		464 (77·5%)	835 (79·1%)	
Family members	335 (16·7%)	236 (14·3%)		79 (13·2%)	157 (14·9%)	
Others	277 (13·8%)	119 (7·2%)		56 (9·3%)	63 (6·0%)	
First documented rhythm			0·12			0·64
VF/pulseless VT	36 (1·8%)	38 (2·3%)		11 (1·8%)	27 (2·6%)	
PEA	417 (20·7%)	303 (18·3%)		110 (18·4%)	193 (18·3%)	
Asystole	1557 (77·5%)	1313 (79·4%)		478 (79·8%)	835 (79·1%)	
Call to CPR by EMS personnel‡	9·9 (7·5)	8·8 (4·5)	<0·0001	8·5 (3·8)	9·0 (4·9)	0·025
Call to shock by EMS personnel§	13·7 (13·1)	13·4 (7·9)	0·92	12·9 (5·4)	13·7 (9·5)	0·82
Call to hospital arrival¶	27·1 (10·5)	27·0 (9·9)	0·77	26·9 (9·9)	27·0 (9·9)	0·93
Cardiac origin						
Total	709	785		289	496	
Age (years)	3·7 (5·7)	5·0 (6·3)	<0·0001	5·3 (6·7)	4·7 (6·0)	0·19
<1 year of age	370 (52·2%)	345 (43·9%)	0·015	131 (45·3%)	214 (43·1%)	0·55
Boys	414 (58·4%)	472 (60·1%)	0·50	169 (58·5%)	303 (61·1%)	0·47

	No CPR (n=2719)	Bystander CPR (n=2439)	Bystander CPR vs no CPR*	Compression-only CPR (n=888)	Conventional CPR (n=1551)	Conventional CPR vs compression-only CPR*
Non-cardiac origin						
Total	2010	1654		599	1055	
Age 1–17 years	1293	1004		380	624	
ROSC before hospital arrival	60 (4·6%)	82 (8·2%)	1·97 (1·35–2·87)	20 (5·3%)	62 (9·9%)	2·17 (1·24–3·82)
1-month survival	89 (6·9%)	133 (13·2%)	2·09 (1·55–2·83)	34 (8·9%)	99 (15·9%)	1·89 (1·23–2·91)
Neurologically favourable 1-month survival	20 (1·5%)	51 (5·1%)	4·17 (2·37–7·32)	6 (1·6%)	45 (7·2%)	5·54 (2·52–16·99)
Age 0–<1 years	717	650		219	431	
ROSC before hospital arrival	30 (4·2%)	23 (3·5%)	0·92 (0·32–2·71)	9 (4·1%)	14 (3·2%)	NA
1-month survival	56 (7·8%)	51 (7·8%)	1·08 (0·71–1·65)	17 (7·8%)	34 (7·9%)	NA
Neurologically intact 1-month survival	14 (2·0%)	13 (2·0%)	1·19 (0·54–2·61)	2 (0·9%)	11 (2·6%)	NA
Cardiac origin						
Total	709	785		289	496	
Age 1–17 years	339	440		158	282	
ROSC before hospital arrival	24 (7·1%)	52 (11·8%)	1·49 (0·84–2·64)	18 (11·4%)	34 (12·1%)	1·07 (0·53–2·15)
1-month survival	36 (10·6%)	71 (16·1%)	1·41 (0·86–2·30)	26 (16·5%)	45 (16·0%)	0·96 (0·52–1·75)
Neurologically favourable 1-month survival	14 (4·1%)	42 (9·5%)	2·21 (1·08–4·54)	14 (8·9%)	28 (9·9%)	1·20 (0·55–2·66)
Age 0–<1 years	370	345		131	214	
ROSC before hospital arrival	8 (2·2%)	8 (2·3%)	1·01 (0·36–2·86)	2 (1·5%)	6 (2·8%)	NA
1-month survival	17 (4·6%)	22 (6·4%)	1·28 (0·64–2·56)	7 (5·3%)	15 (7·0%)	NA
Neurologically intact 1-month survival	5 (1·4%)	4 (1·2%)	0·93 (0·20–4·32)	1 (0·8%)	3 (1·4%)	NA

Data are number of patients (%), unless otherwise indicated. Data for type of CPR by bystander were not available for 12 (<1%) children. CPR=cardiopulmonary resuscitation. ROSC=return of spontaneous circulation. NA=not analysed. *Adjusted odds ratio (95% CI).

Table 4: Age-stratified outcomes after paediatric out-of-hospital cardiac arrests of non-cardiac and cardiac origins by type of bystander CPR

Discussion

- Bystander CPR: higher survival rates and better survival with favourable neurological outcome than no CPR
- For children with OHCA of non-cardiac causes: conventional CPR -> higher frequency of favourable neurological outcome than compression-only CPR or no CPR
- For OHCA of cardiac causes, both CPR -> higher rate of favourable neurological outcome than no CPR, and both CPR -> similarly effective

- Data: consistent with findings from animal studies
- After a Vf cardiac arrest, any types of CPR -> effective
- Cardiac arrests caused by acute asphyxia, conventional CPR -> more effective
- Conventional CPR -> most important for cardiac arrests after trauma, hanging, drowning, drug overdose, and acute respiratory compromise

- Like previous study for adults with OHCA in Tokyo and Osaka, any types of CPR -> effective for children who have arrests of cardiac cause
- Compression-only CPR bystanders: more likely not received any CPR training (30% vs 14%) and less likely to have medical training (22% *vs* 49%) than those of conventional CPR
- Other studies: both types of CPR better than no CPR, but similar after either conventional or compression-only CPR

- Compression-only CPR: may apply to children with OHCA of cardiac causes
- In infants, outcomes were poor in both types of CPR (presumably sudden infant death syndrome, dead for a long time before EMS's arrival, and acute asphyxia was main cause)
- Compression-only CPR: NOT promising for infants
- Focus: prevention of OHCA

- Compression-only CPR: better than no CPR and easier to learn, remember, and undertake
- Double CPR training strategy: compression-only CPR training for most people and conventional CPR training for those who are most likely to witness children who have cardiac arrests with non-cardiac causes

Limitations

- Conventional CPR: taught during this study, and might have been better trained (no data for the quality of bystander CPR)
- Neurological status: 1 month after the arrest were assesed only, longer follow-up was needed
- The category of presumed cardiac arrest: diagnosis by exclusion
- Data integrity, validity, and ascertainment bias are inevitable

Thanks for your attention