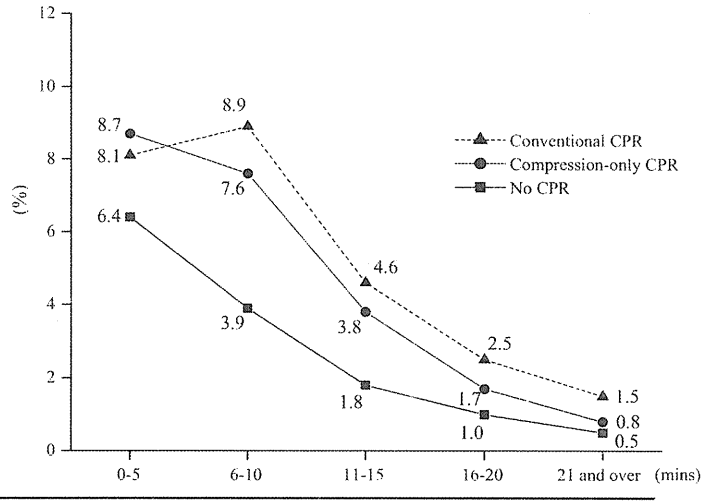

Conventional CPR	1.04 (0.80-1.36)	2.17 (1.84-2.55)	1.98 (1.53-2.56)	2.04 (1.19-3.50)	2.11 (1.02-4.38)
Compression-only CPR	1.16 (0.92-1.46)	1.81 (1.54-2.13)	1.62 (1.25-2.10)	1.27 (0.73-2.20)	1.40 (0.64-3.24)
No CPR	Reference	Reference	Reference	Reference	Reference

Fig. 4. Neurologically favourable 1-month survival by type of bystander-initiated CPR and "Bystander CPR interval" (the time interval from collapse to the initiation of treatments by EMS). Values in figure are expressed as percentage of neurologically favourable 1-month survival by type of bystander-initiated CPR. Values in table indicate adjusted odds ratio (95% confidence interval) of conventional CPR and compression-only CPR referring to no CPR. Odds ratios and 95% confidential intervals are adjusted for gender, age, bystander-witnessed status, first recorded rhythm, advanced airway management, intravenous fluid, epinephrine, time interval from collapse to the initiation of CPR by EMS, time interval from collapse to hospital arrival and the period with 15:2 versus 30:2 CPR guideline. EMS denotes emergency medical service; CPR, cardiopulmonary resuscitation.

confirms that both compression-only CPR and conventional CPR similarly improve outcomes from OHCAs compared with no CPR when the bystander CPR interval is <15 min, and extends these findings to the era of 30:2 compressions-to-ventilations ratio.

These epidemiological observations are quite relevant for bystander CPR training and recommendations. Our findings indicate that conventional CPR is superior for prolonged OHCAs, nearly 20% of all OHCAs. However, the absolute survival is low regardless of type of CPR among this group. Even among the >55 000 witnessed OHCAs over 3 years in an entire large country, <20 additional patients survived with a favourable neurological outcome following conventional CPR compared with compression-only CPR. Importantly, compression-only CPR is easier to teach, learn, remember and perform.[13,29,30] Not surprisingly, bystander CPR increased after compression-only CPR was recommended as an 'acceptable' alternative to conventional CPR, and most of the increase in bystander-initiated CPR was due to increases in compression-only CPR. Therefore, we conclude that these data support the recommendations of the AHA and the Japan Circulation Society that bystanders should provide compression-only CPR for adult-witnessed sudden collapse OHCA.[13,31] In addition, we believe that bystanders, such as medical personnel, EMS providers or lifeguards, who have a relatively high chance to encounter cardiac arrests should be encouraged to provide conventional CPR for OHCAs that are prolonged or that are not witnessed.

This study evaluated the time-dependent effectiveness of type of bystander CPR and observed that conventional CPR with rescue breathing was more effective than compression-only CPR for OHCA of >15 min duration. Why is rescue breathing for prolonged cardiac arrests necessary? In cardiac arrests of short duration, active gasping during CPR and the pulmonary oxygen reservoir can provide adequate oxygenation and ventilation with chest compressions alone, despite no rescue breathing.[32,33] However, these mechanisms may be inadequate during prolonged CPR.[34,35] Although the absolute number of survivors after OHCA of prolonged duration was very low, irrespective of type of bystander CPR, and the incremental benefit of rescue breathing might be small, the addition of rescue breathing improved outcomes from prolonged OHCA.

In addition, the present data showed the effectiveness of compression-only CPR in the era with 30:2 compression-to-ventilation CPR. Although a study of animal models showed that compression-only CPR had better outcomes than conventional CPR with 30:2 compressions-to-ventilations,[36] no clinical study evaluated the effectiveness of compression-only CPR under the new guideline. Indeed, experts had opined[13,17] that the previous observation[4–9] that bystander-initiated compression-only CPR and conventional CPR were similarly effective were observations during the pre-30:2 era. This study showing the effectiveness in the 30:2 CPR era strengthens the evidence that compression-only CPR is a reasonable approach, and could thereby encourage communities to promote dissemination of compression-only CPR.[13,31]

This study has some inherent limitations. First, there were no data regarding the quality of bystander CPR. Because none of these bystanders was actually taught in a course to provide compression-only CPR, bystanders who provided rescue breathing might have been better trained and might have provided more effective chest compressions. If so, this observational study may have inadvertently underestimated the relative value of compression-only CPR. Unfortunately, our data cannot explicitly address this potential bias. Second, our data do not address potential variability in post-arrest care (haemodynamic support, induced hypothermia and coronary interventional therapies).[37] Third, the increasing prevalence of compression-only CPR might overestimate its effectiveness as outcome has been improving gradually during the study period. Fourth, there might be unmeasured confounding factors that might have influenced the association between type of bystander CPR and outcomes. Fifth, as with all epidemiological studies, data integrity, validity and ascertainment bias are potential limitations. The use of uniform data collection based on Utstein-style guidelines for reporting cardiac arrest, large sample size and a population-based design to cover all known adult

OHCA in Japan was intended to minimise these potential sources of biases.

4. Conclusions

This nationwide population-based observational study indicates that conventional CPR with rescue breathing had incremental benefit compared with either no CPR or compression-only CPR for very prolonged witnessed OHCAs of cardiac origin, but the absolute survival was low, regardless of type of CPR. Present data also demonstrated that compression-only CPR was as effective as conventional CPR for most adult-witnessed OHCA of cardiac origin.

Conflict of interest statement

There are no conflicts of interest to declare.

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