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Review

Comparison of paediatric basic life support guidelines endorsed by member councils of Resuscitation Council of Asia

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Abstract

Background: Paediatric cardiac arrest outcomes, especially for infants, remain poor. Due to different training, resource differences, and historical reasons, paediatric cardiac arrest algorithms for various Asia countries vary. While there has been a common basic life support algorithm for adults by the Resuscitation Council of Asia (RCA), there is no common RCA algorithm for paediatric life support.

We aimed to review published paediatric life support guidelines from different Asian resuscitation councils.

Methods: Pubmed and Google Scholar search were performed for published paediatric basic and advanced life support guidelines from January 2015 to June 2023. Paediatric representatives from the Resuscitation Council of Asia were sought and contacted to provide input from September 2022 till June 2023.

Results: While most of the components of published paediatric life support algorithms of Asian countries are similar, there are notable variations in terms of age criteria for recommended use of adult basic life support algorithms in the paediatric population less than 18 years old, recommended paediatric chest compression depth targets, ventilation rates post-advanced airway intra-arrest, and first defibrillation dose for shockable rhythms in paediatric cardiac arrest.

Conclusion: This was an overview and mapping of published Asian paediatric resuscitation algorithms. It highlights similarities across paediatric life support guidelines in Asian countries. There were some differences in components of paediatric life support which highlight important knowledge gaps in paediatric resuscitation science. The minor differences in the paediatric life support guidelines endorsed by the member councils may provide a framework for prioritising resuscitation research and highlight knowledge gaps in paediatric resuscitation.

Keywords: Cardiopulmonary resuscitation, Life support care, Pediatrics, Practice guidelines as topic

Introduction

There are important differences in the infant, child, adolescent and adult anatomy and physiology that would influence the management of cardiopulmonary arrest.[1–7] Paediatric cardiac arrest outcomes, especially for infants, remain generally poor.[1–3] The paediatric life support taskforce of the International Liaison Committee on Resuscitation (ILCOR) regularly reviews and updates available scientific evidence to make treatment recommendations on paediatric life support.[1] These treatment recommendations based on expert consensus and scientific literature are reviewed by resuscitation councils worldwide for their resuscitation guidelines.[2–8]

Asia represents a large and diverse region with significant variations in their resources, paediatric resuscitation training, and historical influence that might potentially result in differences in their approach to paediatric life support. Resuscitation Council of Asia (RCA) was founded on July 17th, 2005.[9] Member resuscitation councils include Japan Resuscitation Council (JRC), Korean Association of Cardiopulmonary Resuscitation (KACPR), National Resuscitation

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Council, Taiwan (NRCT), Philippine Heart Association (PHA) Cardiopulmonary Resuscitation (CPR) Council, Resuscitation Council of Hong Kong (RCHK), Singapore Resuscitation and First Aid Council (SRFAC), and Thai Resuscitation Council (TRC). While there had been a common RCA basic life support algorithm for adults, there has not been a common RCA algorithm for paediatric life support.[9,10].

The aim of this paper is to provide a descriptive review of published paediatric basic and advanced life support recommendations by resuscitation council members of RCA. This would allow a broad overview and mapping of published paediatric life support guidelines across Asian resuscitation councils and describe the concordance and differences in their paediatric life support guidelines. This, in turn, may provide a platform for prioritisation and further review of knowledge gaps in paediatric resuscitation in Asia.

Methods

PubMed, Medline, and Google Scholar search were performed for published paediatric basic and advanced life support guidelines of member councils of RCA from January 2015 to June 2023. Paediatric representatives from countries of member councils of RCA were contacted to provide input from September 2022 until July 2023.

In this study, we reported the frequencies of concordant life support guidelines using proportions and percentages. As this was a purely descriptive study, no statistical analyses performed.

If the paediatric life support guidelines were similar in terms of action and sequence, but the phrasing may not be, they were aligned if deemed appropriate, after review by representatives from countries of the resuscitation councils and other international members of the writing group. Consensus by the members of the writing group would be obtained if there were disagreements.

When appropriate, published texts were be referred to for rationale, values, and preferences in selected paediatric life support guidelines for comparison of the paediatric life support guidelines. If these were not available or if further clarifications were needed, the Asian resuscitation council members of the guideline writing group (specifically Japan, South Korea, and Singapore) were be contacted for their input.

In addition, the Appraisal of guidelines for research and evaluation (AGREE) II instrument was used for assessing quality of the four guidelines.[11] At least two independent appraisers without conflict of interests (who were not a member of the writing group of the appraised life support manuscript guidelines) evaluated the paeditric life support guidelines using the AGREE II instrument. The six domains were scored on a scale of one to seven. Domains which were considered to be of high quality if they were >70%.[11] The overall assessment required the user to make a judgment as to the quality of the guideline, taking into account the criteria considered in the assessment process and if the user would recommend use of the guideline. An average of the scores were used for the overall assessment of the guidelines and percentage of appraisers were described if they recommended the guidelines, with modifications, or did not recommend the guidelines.

As this was a comparison of paediatric life support guidelines and no patients or personal data involved, we did not apply for ethics board approval.

Results

There are three RCA member councils; namely Japan Resuscitation Council (JRC), Korean Association of Cardiopulmonary Resuscitation (KACPR), and Singapore Resuscitation and First Aid Council (SRFAC), which had their own published paediatric life support guidelines with their own evidence-based guideline development and independent review process (Table 1). The rest of the four member councils of RCA endorse American Heart Association paediatric life support guidelines (Table 1).

A summary review of the latest selected basic and advanced paediatric life support guidelines of these resuscitation councils were reported in Tables 2 and 3, respectively.[3,5–8] The previous guidelines for basic and advanced paediatric life support guidelines were reported in Supplementary Tables S1 and S2, respectively.[12–17]

The concordance of the paediatric life support guidelines endorsed or developed by the RCA resuscitation councils, and how this varied from their previous published guidelines, were reported in Table 4. While some paediatric life support guidelines became more concordant, others paradoxically became more varied in the latest paediatric life support guidelines.

Paediatric basic life support

There are minor variations in the consideration for the use of adult basic life support algorithms in the paediatric population less than 18 years-old (Tables 2 and 4). These range from using age-cut-offs such as 8-years-old (South Korea), more than 12 years-old (Singapore), to the use of pubertal signs (Japan, Philippines, Hong Kong, Taiwan, and Thailand). Pragmatic considerations for using 12-years-old as a unique cut-off in Singapore for considering adult life support algorithm included arbitrarily using educational levels expected for pubertal adolescents to facilitate training and identification. There were also concerns on the potential difficulty in rapidly identifying pubertal signs during cardiac arrests (Table 2).

Paediatric dispatch-assisted cardiopulmonary resuscitation (DA-CPR) instructions are mentioned as part of the in the paediatric life support guidelines 2020/2021 for Japan, South Korea, and Singapore. These countries have established Emergency Medical Service (EMS) systems that could routinely provide these (Tables 1 and 2).

All resuscitation member councils' initial approach to paediatric cardiac arrest is to start chest compressions first ("C-A-B"), similar to the paediatric basic life support guidelines from American Heart Association (AHA).

The paediatric chest compression depth targets varied amongst the four paediatric life support guidelines from JRC (Japan), KACPR (South Korea), SRFAC (Singapore), and AHA (which were endorsed by resuscitation councils of Hong Kong, Philippines, Taiwan, and Thailand). In general, the paediatric chest compression depth targets recommendations from the non-AHA resuscitation councils are shallower than those recommended AHA's (Tables 2 and 4).

As long as there is only one rescuer (layperson or healthcare worker), the ventilation-compression ratio for the all the RCA resuscitation member councils is uniformly 30:2. However, three of the member councils, specifically JRC (Japan), KACPR (South Korea), and SRFAC (Singapore), advocate a universal 30:2 for laypeople (whether single or multiple rescuers) to simplify CPR instructions for laypeople.

While the management of severe but conscious foreign body airway obstruction (FBAO) for infants is uniformly the same, the child

Table 1 – Characteristics of paediatric life support guidelines and resources available among member councils of Resuscitation Council of Asia.

Member council of RCA	Has local pediatric basic life support guidelines with guideline development and review process	Endorse external resuscitation pediatric basic life support guidelines (specify)	Has local pediatric advanced life support guidelines with guideline development and review process	Endorse external pediatric advanced life support guidelines (specify)	Community pediatric basic life support courses use local guidelines (predominantly)	Pediatric DA-CPR instructions are part of EMS activation systems	EMS system(s) are/is pediatric-enabled	Pediatric advanced life support courses use local guidelines (predominantly)
JRC, Japan	+	-	+	-	+	Yes/Most	Yes/Most	+
KACPR, Korea	+	-	+	-	+	Yes/Most	Yes/Most	+
PHA CPR Council, Philippines	-	AHA	-	AHA	-	No/Limited	No/ Limited to certain areas	-
NRCT, Taiwan	-	AHA	-	AHA	-	Yes/Most	Yes/Most	-
RCHK, Hong Kong	-	AHA	-	AHA	-	No/Limited	No/ Limited to certain areas	-
SRFAC, Singapore	+	-	+	-	+	Yes/Most	Yes/Most	+
TRC, Thailand	-	AHA	-	AHA	-	No/Limited	No/ Limited to certain areas	-

Legend: +, present; -, absent; AHA, American Heart Association; CPR; cardiopulmonary resuscitation; DA-CPR, Dispatcher-assisted cardiopulmonary resuscitation; EMS, Emergency Medical Services; JRC, Japan Resuscitation Council; KACPR, Korean Association of Cardiopulmonary Resuscitation; NRCT, National Resuscitation Council of Taiwan; PHA – Philippine Heart Association; RCHK, Resuscitation Council of Hong Kong; SRFAC, Singapore Resuscitation and First Aid Council; TRC, Thailand Resuscitation Council.

Table 2 – Comparison of selected paediatric basic life support guidelines among member councils of Resuscitation Council of Asia.

Paediatric Basic Life Support Guidelines (2020/2021)	**AHA 2020[3] (Hong Kong, Philippines, Taiwan, Thailand)**	**JRC 2020 (Japan)[5]**	**SRFAC (Singapore) 2021[6]**	**KACPR (Korea) 2020[7]**
Age definitions and inclusion	Pediatric algorithms are used until signs of puberty.	Pediatric algorithms are used until signs of puberty.	Pediatric algorithms used till age of 12 years-old	Pediatric algorithms are used in children younger than 8 years-old.
Changes from previous guidelines in 2015/2016	Nil change	Nil change	Previous cut-off was 8 years old.	Nil change
Values and preferences	No new evidence	No new evidence	Cut-off of 12 years was arbitrary. Considerations: - Age at which pubertal signs are likely. Issues of assessment of pubertal status during a cardiac arrest event. - Ground application as "secondary or high school" children are > 12 years old; ease of application and teaching (previously 8 years old).	No new evidence
Provision of dispatch-assisted paediatric basic life support via EMS activation	No specific mention or recommendations	Specific mention	Specific mention	Specific mention
Changes from previous guidelines in 2015/2016	Nil prior mention	Nil change	Nil prior mention	Nil prior mention
Values and preferences	Nil mention	Improved outcomes demonstrated in studies.[48–55,57] Has an established EMS system with pediatric dispatcher-assisted CPR instructions available.	Improved outcomes demonstrated in studies. [48–55,57] Has an established EMS system with pediatric dispatcher-assisted CPR instructions available.	Improved outcomes demonstrated in studies. [48–55,57] Has an established EMS system with pediatric dispatcher-assisted CPR instructions available.
Sequence	**C-A-B**			
Chest compression	Relative: At least 1/3 AP chest diameter Absolute: Infants: ~4cm Child: ~5cm Adolescents with pubertal signs/adults: 5 to 6 cm	Relative: Approximately 1/3 AP chest diameter Absolute: Infants: ~4cm Child: ~5cm Adolescents with pubertal signs/adults: Approximately 5 cm, <6cm	Relative: Approximately 1/3 AP chest diameter Absolute: Infants: 3 to 4 cm Child 1–12 years: 4 to 5 cm Adolescents > 12 years /adults: 4 to 6 cm	Relative: At least 1/3 AP chest diameter Absolute: Infants: ~4cm Child < 8 years: 4 to 5 cm 8 years or more/adults: Approximately 5 cm, <6cm
Changes from previous guidelines in 2015/2016	Nil changes	Nil changes	Relative: changed from "at least" to "approximately"	Nil changes
Values and preferences	Based on AHA evidence review 2020 which included a scoping review.[25–27] Nil change from 2015 guidelines.	Based on JRC evidence review Nil change from 2015 guidelines. Observational study (N = 66 from CT, 10 from autopsy) demonstrating one-third of anteroposterior chest diameter as optimal chest compression target for children between 1 and 8 years old.[20]	Local paediatric radiological study (N = 592) suggesting current AHA absolute chest compression depth recommendations (approximately 4 cm for infants and approximately 5 cm for children) may risk over-compression in the local population especially for infants.[21]	Based on KACPR evidence review 2020 Nil change from 2015 guidelines. Three local radiological studies N = 442, N = 349, N = 203) which suggest that ~ 4 cm and ~ 5 cm were too deep in infants and children respectively.[22–24]

Table 2 (continued)

Paediatric Basic Life Support Guidelines (2020/2021)	AHA 2020[3] (Hong Kong, Philippines, Taiwan, Thailand)	JRC 2020 (Japan)[5]	SRFAC (Singapore) 2021[6]	KACPR (Korea) 2020[7]
			2 large adult North American studies observed that the optimal compression depth associated with peak survival and favourable neurological outcomes were at 4.7 cm and 4.56 cm, respectively.[58,59] These were less than that recommended for children above 1 year old (~5cm). SRFAC changed the age cut-off from 8- to 12 years-old as cut-off for considering the use of adult chest compression algorithms (chest compression depth target of 4–6 cm).	
Chest compression: ventilation ratio	Layperson: – 1 rescuer: 30:2 – 2 rescuers: 15:2 Healthcare worker: – 1-rescuer- 30:2 – 2 or more rescuers: 15:2 Adolescents with pubertal signs- 30:2	Layperson: – 30:2 Healthcare worker: – 1-rescuer- 30:2 – 2 or more rescuers: 15:2 Adolescents with pubertal signs- 30:2	Layperson: – 30:2 Healthcare worker: – 1-rescuer- 30:2 – 2 or more rescuers: 15:2 >12 years old: 30:2	Layperson: – 1 rescuer: 30:2 – 2 rescuers: 15:2 Healthcare worker: – 1-rescuer- 30:2 – 2 or more rescuers: 15:2 ≥8 years old: 30:2
Changes from previous guidelines in 2015/2016	Nil change	Nil change	Nil change	Nil change
Values and preferences	No new evidence or considerations to inform change	No new evidence or considerations to inform change	No new evidence or considerations to inform change	No new evidence or considerations to inform change
Chest compression rate	**100–120/min**			
Changes from previous guidelines in 2015/2016	Nil change	Nil change	Nil change	Nil change
Values and preferences	No new evidence or considerations to inform change	No new evidence or considerations to inform change	No new evidence or considerations to inform change	No new evidence or considerations to inform change
AED use: age-group	Infants and children < 8 years: attenuation pads 8 years or more: standard pads	Infants and children < 1st grade: attenuation pads 1st grade (school child) or more: standard pads	Neonates: Manual defibrillation only. AEDs not recommended. Infants (except neonates): Manual defib preferred but if not immediately available, use AED with energy attenuation modes. If not available, use standard pads. <8 years old: use AED with energy attenuation modes. If not available, use standard pads. 8 years or more: standard pads	Infants manual defib preferred but if not immediately available, use AED with energy attenuation modes. If not available, use standard pads. 8 years or more: standard pads Manual defib 1st 2 J/kg, subsequent ≥ 4–10 J/kg
Changes from old guidelines	Nil change	Nil change	Nil change	Nil change
Values and preferences	No new evidence or considerations to inform change	No new evidence or considerations to inform change. 1st grade school (usually above 7 years old): to allow familiarity and use for AEDs	No new evidence or considerations to inform change	No new evidence or considerations to inform change

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Table 2 (continued)

Paediatric Basic Life Support Guidelines (2020/2021)	AHA 2020[3] (Hong Kong, Philippines, Taiwan, Thailand)	JRC 2020 (Japan)[5]	SRFAC (Singapore) 2021[6]	KACPR (Korea) 2020[7]
Ventilation rates in respiratory failure with perfusing rhythms	Infants and children: 1 breath every 2 to 3 s or 20–30 breaths/min.	Infants and children: 1 breath every 3 to 5 s or 12–20/min. Pubertal adolescents: 1 breath every 5 s or 12 breaths/min	Infants: 1 breath every 2 s or 30 breaths/min Child: 1 breath every 3 s or 20 breaths/min Adolescents (>12 years-old): 1 breath every 5 s or 12 breaths/min	Infants and children: 1 breath every 3 to 5 s or 12–20/min. Child $\geq$ 8 years old: 1 breath every 5 s or 12 breaths/min
Changes from previous guidelines in 2015/2016	No specific mention	Nil change	Infants and children: 1 breath every 3 s or 20 breaths/min Child > 8 years old: 1 breath every 5 s or 12 breaths/min	Nil change
Values and preferences	AHA considered a small observational study on ventilation rates in paediatric cardiac arrest and extrapolated this to paediatric patients with a perfusing rhythm but required had respiratory insufficiency.[28]	Based on JRC evidence review Nil change from 2015 guidelines. Insufficient new evidence to change guidelines	SRFAC considered a small observational study on ventilation rates in paediatric cardiac arrest and extrapolated this to paediatric patients with a perfusing rhythm but required had respiratory insufficiency.[29]	Based on KACPR evidence review Nil change from 2015 guidelines. Insufficient new evidence to change guidelines.
Foreign body airway obstruction (severe, conscious)	Infants: Combination of 5 back blows and 5 chest thrusts Head down Children/Adults: Abdominal thrusts	Infants: Combination of 5 back blows and 5 chest thrusts Head down Children: a few back blows or chest thrust. The order does not matter. Adult: Back blows, if ineffective, abdominal thrusts	Infants: A few back blows or chest thrust. The order does not matter. Head down Children and adults: Abdominal thrusts	Infants: Combination of 5 back blows and 5 chest thrusts Head down Children < 8 years old: back blows Children $\geq$ 8 years old (adult algorithm): Back blows, if ineffective, abdominal thrusts
Changes from previous guidelines in 2015/2016	Not mentioned in 2015 guidelines	Nil change	Nil change	Not mentioned in 2015 guidelines
Values and preferences	Based on AHA evidence review 2020.	No new evidence or considerations to inform change. Evidence for potential harm using abdominal thrusts.[41–47]	No new evidence or considerations to inform change.	Based on AHA evidence review 2020. Evidence for potential harm using abdominal thrusts.[41–47]
Foreign body airway obstruction (Unconscious) - All age groups	Start chest compressions as per cardiac arrest algorithm	Start chest compressions as per cardiac arrest algorithm	Start chest compressions as per cardiac arrest algorithm	Start chest compressions as per cardiac arrest algorithm

Legend: ~ - approximately; /min – per minute; AED - automated external defibrillators; AHA – American Heart Association; cm- centimeter; AP – anterior-posterior; C-A-B – circulation-airway-breathing; cm – centimeter, CPR - cardiopulmonary resuscitation; DA-CPR – Dispatch-assisted cardiopulmonary resuscitation; J/kg – joules per kilogram, JRC - Japan Resuscitation Council; KACPR - Korean Association of Cardiopulmonary Resuscitation; min, minute; N – number; RCA – Resuscitation Council of Asia; s – seconds; SRFAC - Singapore Resuscitation and First Aid Council.

Table 3 – Table of selected Paediatric Advanced Life Support Guidelines in 2020/2021 by member councils of Resuscitation Council of Asia.

Advanced Paediatric Life Support Guidelines (2020/2021)	AHA 2020[3] (Hong Kong, Philippines, Taiwan, Thailand)	JRC 2020 (Japan)[5]	SRFAC (Singapore) 2021[6]	KACPR (Korea) 2020[8]
Age group inclusion	<18 years	<18 years	<18 years	<18 years
Specific mention in considerations of overlaps on use of adult compared to paediatric advanced life support algorithms	-	Adult advanced life support algorithms can be used in adolescents < 18-years-old if pubertal signs are present, or in high school grade 2 students or older	Adult advanced life support algorithms can be used in adolescents 16 to 18 years-old in non-paediatric healthcare settings	-
Changes from previous guidelines in 2015/2016	Nil	Nil	Nil	Nil
Values and preferences	-	Allows for high performance life support to be optimized in adolescents for which evidence is limited/equipoised on either algorithms being used	Allows for high performance life support to be optimized in adolescents for which evidence is limited/equipoised on either algorithms being used	-
Airway management of children during cardiac arrest in the out-of-hospital setting.	Bag-mask ventilation is reasonable, compared with advanced airway interventions (SGA and ETI) in the pre-hospital setting.	Bag-mask ventilation is reasonable, compared with advanced airway interventions (SGA and ETI) in the pre-hospital setting.	Effective bag-valve-mask is emphasised over advanced airway placement (SGA and ETI) in the pre-hospital setting.	Effective bag-valve-mask is emphasised over advanced airway placement (SGA and ETI) in the pre-hospital setting.
Changes from previous guidelines in 2015/2016	Nil significant change	Nil significant change	Bag-mask ventilation is reasonable, compared with advanced airway interventions (SGA and ETI) in the pre-hospital setting	Bag-mask ventilation is reasonable, compared with advanced airway interventions (SGA and ETI) in the pre-hospital setting.
Values and preferences	Based on AHA evidence review; including an updated systematic review and meta-analysis considered.[60]	Based on JRC evidence review; including an updated systematic review and meta-analysis considered.[60]	Based on SRFAC evidence review; including an updated systematic review and meta-analysis considered.[60]	Based on KACPR evidence review; including an updated systematic review and meta-analysis considered.[60]
Ventilation rates post-advanced airway placement during cardiac arrest	BVM- 15:2 SGA/ETI – 20–30/min	BVM – 15:2 SGA/ETI: All ages 10 ventilations/min	BVM – 15:2 SGA/ETI – Infants: 30/min Child 1-12yrs: 20/min Adolescents > 12yrs: 10–12/min	BVM – 15:2 (if 2-rescuers) SGA/ETI: All ages 10 ventilations/min
Changes from previous guidelines in 2015/2016	Previously, intra-arrest post advanced airway: 10/min	Nil change	Previously, intra-arrest post advanced airway: 10/min	Nil change
Values and preferences	Small paediatric study (N = 47) demonstrating improved outcomes (especially for infants) when high ventilation rates (30 breaths/min in infants, 25 breaths/min in older children) were associated with improved outcomes.[29]	Small study (N = 47) demonstrating improved outcomes (especially for infants) when high ventilation rates (30 breaths/min in infants, 25 breaths/min in older children) were associated with improved outcomes.[29] Small single institution study. Insuffi-	Small paediatric study (N = 47) demonstrating improved outcomes (especially for infants) when high ventilation rates (30 breaths/min in infants, 25 breaths/min in older children) were associated with improved outcomes.[29]	Small study (N = 47) demonstrating improved outcomes (especially for infants) when high ventilation rates (30 breaths/min in infants, 25 breaths/min in older children) were associated with improved outcomes.[29] Small single institution study. Insuffi-

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Table 3 (continued)

Advanced Paediatric Life Support Guidelines (2020/2021)	AHA 2020[3] (Hong Kong, Philippines, Taiwan, Thailand)	JRC 2020 (Japan)[5]	SRFAC (Singapore) 2021[6]	KACPR (Korea) 2020[8]
	Changed recommendations for ventilation rates intra-arrest for paediatrics to 20–30/min after advanced airway placement.	cient evidence to change prior 2015 recommendations.	2 adult retrospective observational studies did not demonstrate improved clinical outcomes using ventilation rates of 10/min intra-arrest.[61, 62] Ventilation rates at 20–30/min would be considered hyperventilation in older children and teenagers with concerns on hyperventilating patients during cardiac arrest after advanced airway placement. Decision was to arbitrary use low normal age-appropriate ventilation rates that are easy to follow: Infants: 30/min (1 per 2 seconds) Children 1–12 years: 20/min (1 per 3 seconds) Teenagers > 12 years: 10/min (1 per 5 seconds)	cient evidence to change prior 2015 recommendations.
Non-shockable cardiac arrest rhythms				
1st dose Epinephrine (adrenaline) administration timing and subsequent dosing interval	IV/IO Epinephrine (adrenaline) as soon as possible and then every 3 to 5 minutes	IV/IO Epinephrine (adrenaline) as soon as possible and then every 3 to 5 minutes	IV/IO Epinephrine (adrenaline) as soon as possible and then every 3 to 5 minutes	IV/IO Epinephrine (adrenaline) as soon as possible and then every 3 to 5 minutes
Changes from previous guidelines in 2015/2016	Nil change	Nil change	Nil change	Nil change
Values and preferences	Based on AHA evidence. [63–67] No new evidence to suggest change required.	Based on JRC evidence review.[63–67] No new evidence to suggest change required.	Based on SRFAC evidence review;[63–67] including an updated systematic review and meta-analysis considered.[36] No new evidence to suggest change required.	Based on KACPR evidence review.[63–67] No new evidence to suggest change.
Role of ETT epinephrine (adrenaline)	ETT (10X IV/IO dose) only if IO/IV delayed and ETT already in place	Not mentioned	ETT (10X IV/IO dose) only if IO/IV delayed and ETT already in place	ETT (10X IV/IO dose) only if IO/IV delayed and ETT already in place
Changes from previous guidelines in 2015/2016	Nil	Nil	Nil	Nil
Values and preferences	While it may not be as effective as IV/IO, emphasis is on administering epinephrine (adrenaline) as early as possible	Nil mention	While it may not be as effective as IV/IO, emphasis is on administering epinephrine (adrenaline) as early as possible	While it may not be as effective as IV/IO, emphasis is on administering epinephrine (adrenaline) as early as possible

Table 3 (continued)				
Advanced Paediatric Life Support Guidelines (2020/ 2021)	**AHA 2020[3] (Hong Kong, Philippines, Taiwan, Thailand)**	**JRC 2020 (Japan)[5]**	**SRFAC (Singapore) 2021[6]**	**KACPR (Korea) 2020[8]**
Shockable cardiac arrest rhythms				
1st Defibrillation energy dose	2–4 J/kg	4 J/kg	2–4 J/kg	2 J/kg
Changes from previous guidelines in 2015/2016	No change	No change	Previously 4 J/kg	Previously 2–4 J/kg
Values and preferences	Based on AHA evidence, including an observational study that showed improved survival to hospital discharge in paediatric in-hospital cardiac arrest using 2 Joules/kilogram as first defibrillation dose for initial pulseless ventricular arrhythmia.[32] No new evidence to suggest change required.	Based on JRC evidence, including an observational study that showed improved survival to hospital discharge in paediatric in-hospital cardiac arrest using 2 Joules/kilogram as first defibrillation dose for initial pulseless ventricular arrhythmia.[32] There were significant limitations in the external validity of this single centre IHCA study to change current recommendation.	Based on JRC evidence, including an observational study that showed improved survival to hospital discharge in paediatric in-hospital cardiac arrest using 2 Joules/kilogram as first defibrillation dose for initial pulseless ventricular arrhythmia.[32] There were significant limitations in the external validity of this single centre IHCA study but in IHCA patients, a lower initial dose with a range of 2–4 J/kg can be considered. Units that have been trained to use 4 J/kg for the initial defibrillation can continue this practice.	Based on JRC evidence, including an observational study that showed improved survival to hospital discharge in paediatric in-hospital cardiac arrest using 2 Joules/kilogram as first defibrillation dose for initial pulseless ventricular arrhythmia.[32] No new evidence to suggest change required.
Subsequent defibrillation doses	4–10 J/kg	4 J/kg	≥4-10 J/kg (max adult dose) Prescriptive dosing given 2nd to 5th defibrillation: 4 J/kg >6th defib: increase up to 10 J/kg or max adult dose of 200 J biphasic and 360 J monophasic	≥4-10 J/kg (max adult dose)
Changes from previous guidelines in 2015/2016	No change	No change	No change	No change
Values and preferences	-	Limited evidence to suggest change	Emphasis on optimizing conditions/ resuscitation and look for reversible elements and not just increasing energy dose.	-
1st dose Epinephrine (adrenaline) administration timing and subsequent dosing interval	After 2nd defibrillation and every 3 to 5 minutes	No specific mention on timing of 1st dose and every 3 to 5 minutes	After 2nd defibrillation and every other defibrillation (approximately every 3 to 5 minutes)	After 1st defibrillation and every 3 to 5 minutes
Changes from previous guidelines in 2015/2016	No change	No change	No change	No change
Values and preferences	Limited/no evidence updates to suggest change	Limited/no evidence updates to suggest change	Limited/no evidence updates to suggest change	Limited/no evidence updates to suggest change

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Table 3 (continued)

Advanced Paediatric Life Support Guidelines (2020/2021)	AHA 2020[3] (Hong Kong, Philippines, Taiwan, Thailand)	JRC 2020 (Japan)[5]	SRFAC (Singapore) 2021[6]	KACPR (Korea) 2020[8]
1st dose Amiodarone administration timing and subsequent dosing interval	After 3rd defibrillation No mention of subsequent dosing interval with up to a maximum of 3 doses of 5 mg/kg. 1st and subsequent maximum single dosing not specified.	After 3rd defibrillation No mention of subsequent dosing interval up to a maximum of 3 doses. 1st and subsequent maximum single dosing not specified.	After 3rd defibrillation Subsequent doses given every other defibrillation, alternating with epinephrine (adrenaline) (up to maximum of 3 doses) in a CPR, shock-drug cycle in refractory shockable rhythms. 1st and subsequent maximum single dosing not specified.	After 3rd defibrillation No mention of subsequent dosing interval 1st and subsequent maximum dosing of 300 mg per dose.
Changes from previous guidelines in 2015/2016	No change	No change	No change	No change
Values and preferences	Limited/no evidence updates to suggest change	Limited/no evidence updates to suggest change	Limited/no evidence updates to suggest change	Limited/no evidence updates to suggest change
Lignocaine administration and dosing	Alternative to amiodarone – loading dose of 1 mg/kg bolus followed by infusion 20–50 mcg/kg/min	Alternative to amiodarone at 1–1.5 mg/kg bolus, no mention on repeat or infusion	Alternative to amiodarone – loading dose of 1 mg/kg bolus followed by infusion 20–50 mcg/kg/min	Alternative to amiodarone – loading dose of 1 mg/kg bolus followed by infusion 20–50 mcg/kg/min
Changes from previous guidelines in 2015/2016	No change from previous guidelines	No change from previous guidelines	No change from previous guidelines	No change from previous guidelines
Values and preferences	Based on AHA evidence review; including an updated systematic review and meta-analysis considered.[65] Insufficient evidence to change prior 2015 recommendations.	Based on JRC evidence review; including an updated systematic review and meta-analysis considered.[65] Insufficient evidence to change prior 2015 recommendations.	Based on SRFAC evidence review; including an updated systematic review and meta-analysis considered.[65] Insufficient evidence to change prior 2015 recommendations.	Based on KACPR evidence review; including an updated systematic review and meta-analysis considered.[65] Insufficient evidence to change prior 2015 recommendations.
Tachyarrhythmias with perfusing rhythms				
Supraventricular tachycardia (SVT), stable Adenosine	2 doses mentioned. 1st dose 0.1 mg/kg (max 6 mg) 2nd dose 0.2 mg/kg (max 12 mg per dose)	Number of doses not specific. 0.1–0.3 mg/kg (Uses Adenosine triphosphate, ATP, instead)	2 doses mentioned. 1st dose 0.1 mg/kg (max 6 mg) 2nd dose 0.2 mg/kg (max 12 mg per dose)	2 doses mentioned. 1st dose 0.1 mg/kg (max 6 mg) 2nd dose 0.2 mg/kg (max 12 mg per dose)
Changes from previous guidelines in 2015/2016	No change from previous guidelines	No change from previous guidelines	No change from previous guidelines	No change from previous guidelines
Values and preference	Based on old algorithm. No mention on increasing dose in refractory but stable SVT.	Based on old algorithm. No mention on increasing dose in refractory but stable SVT. No new paediatric evidence to change current approach. Limited availability of adenosine in Japan. Both adenosine and adenosine triphosphate were shown to be effective in pharmacological cardioversion of supraventricular	Based on old algorithm. No mention on increasing dose in refractory but stable SVT.	Based on old algorithm. No mention on increasing dose in refractory but stable SVT.

Table 3 (continued)

Advanced Paediatric Life Support Guidelines (2020/2021)	AHA 2020[3] (Hong Kong, Philippines, Taiwan, Thailand)	JRC 2020 (Japan)[5]	SRFAC (Singapore) 2021[6]	KACPR (Korea) 2020[8]
		tachyarrhythmias. Higher doses may be required for adenosine triphosphate when compared to adenosine.[68–71]		
Electric cardioversion in unstable supraventricular tachycardias	Initial synchronized cardioversion 0.5–1 J/kg (max adult); subsequent doses up to 2 J/kg	Initial synchronized cardioversion 0.5–1 J/kg (max adult); subsequent doses up to 2 J/kg	Initial synchronized cardioversion 0.5–1 J/kg (max adult); subsequent doses up to 2 J/kg	Initial synchronized cardioversion 0.5–1 J/kg (max adult); subsequent doses up to 2 J/kg
Changes from previous guidelines in 2015/2016	No change from previous guidelines	No change from previous guidelines	No change from previous guidelines	No change from previous guidelines
Values and preferences	Limited/no evidence updates to suggest change	Limited/no evidence updates to suggest change	Limited/no evidence updates to suggest change	Limited/no evidence updates to suggest change

Legend: 1st, first; 2nd – second; 3rd – third; 5th – fifth; 6th – sixth; AHA – American Heart Association; cm- centimeter; BVM – bag-valve-mask; CPR- cardiopulmonary resuscitation; DA-CPR – Dispatch-assisted cardiopulmonary resuscitation; ETI – endotracheal intubation, ETT – endotracheal tube; J – joules; J/kg – joules per kilogram, IV/IO – intravenous or intra-osseous; JRC - Japan Resuscitation Council; KACPR - Korean Association of Cardiopulmonary Resuscitation; max – maximum; mcg/kg/min – microgram per kilogram per minute; mg – milligram; mg/kg, milligram per kilogram; RCA – Resuscitation Council of Asia; SGA – supraglottic airway; SRFAC Singapore Resuscitation and First Aid Council; Supraventricular tachycardia – SVT; X- times.

and adult (which may be relevant in adolescents <18 years-old) FBAO algorithms are different for JRC (Japan) and KACPR (South Korea) (Tables 2 and 4).

Paediatric advanced life support

The age-group definitions for the use of infant and children advanced life support algorithms were similar (Tables 3 and 4). However, JRC (Japan) and SRFAC (Singapore) considered the use of adult life support in older adolescents using academic years or age as more healthcare workers are generally more familiar with adult resuscitation.

Ventilation rates during cardiac arrest after advanced airway placement (endotracheal intubation or supraglottic airway insertion) varied amongst the four paediatric life support guidelines. JRC (Japan) and KACPR (South Korea) maintained their 2015/2016 guideline (10ventilationsperminuteforallages), while SRFAC (Singapore) specified age-group specific low-normal ventilation rates of 30 ventilations per minute in infants, 20 ventilations per minute in children, and 10 ventilations per minute in adolescents older than 12-years-old (Table 3 and 4).

While there was full concordance on the timing of the first dose of epinephrine (adrenaline) in paediatric cardiac arrests with non-shockable rhythms, for shockable rhythms, this varied from after the first shock (KACPR, South Korea), after the second shock (AHA and SRFAC, Singapore), to not having a specified timing (JRC, Japan).

AHA and SRFAC (Singapore) recommend that initial defibrillation dose for shockable rhythms in paediatric cardiac arrest to be in the range of 2 to 4 J/kg. JRC (Japan) and KACPR (South Korea) retained their 2015/2016 guideline of 4 J/kg and 2 J/kg, respectively (Table 3).

The AGREE II instrument was used to compare the quality of the four paediatric life support guidelines (Supplementary Table S3). AHA paediatric life support guidelines had consistently scored >70% for all six domains and had the highest overall assessment scores. All three Asian paediatric life support guidelines did not achieve >70% for domain three (rigour of development) due to unspecified methodology for the evidence review. JRC (Japan) did not score >70% in domain six (editorial independence) as it was not published in a peer-reviewed journal. All four guidelines scored >70% overall and were all recommended for use.

Discussion

This comparison and review of concordance of paediatric life support guidelines of member councils of RCA, is the first to review how paediatric life support guidelines changed from their last iteration and the values and preferences of the member councils were reflected in these changes.

It raises important questions about whether member councils in Asia should follow a common guideline or advocate that individual resuscitation councils should tailor their guidelines to their local needs. It would be important to consider resources, pre-existing training, cost to change training and time to achieve high performance life support; especially if the updated paediatric evidence to suggest change in the life support guidelines may also be limited.

Most of the variations between the four paediatric life support guidelines could be, at least in part, be due to member councils' interpretation of evidence and treatment recommendations which were

Table 4 – Concordance of selected paediatric basic life support guidelines among member councils of Resuscitation Council of Asia.

Paediatric Basic Life Support

Age group basic life support definitions 2020/ 2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Age group basic life support definitions 2015/ 2016	Proportion of member councils (%)	RCA member councils	Overall concordance
Infants: ≤1-year-old	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%	Infants: ≤1-year-old	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%
Child: >1- to 8-years-old	**1/7 (14.3%)***	KACPR (South Korea)	71.4%	Child: >1- to 8-years-old	**2/7 (28.6%)***	KACPR (South Korea), SRFAC (Singapore)	71.4%
Child: >1- to 12-years-old	**1/7 (14.3%)***	SRFAC (Singapore)		Child: >1- to 12-years-old	**0/7 (0.0%) ***	-	
Child: no pubertal signs	5/7 (71.4%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], JRC (Japan)		Child: no pubertal signs	5/7 (71.4%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], JRC (Japan)	
Paediatric DA-CPR 2020/ 2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Paediatric DA-CPR 2015/ 2016	Proportion of member councils (%)	RCA member councils	Overall concordance
DA-CPR included in guidelines	**3/7 (42.9%)***	KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	**57.1%**[#]	DA-CPR included in guidelines	**2/7 (28.6%)***	JRC (Japan), KACPR (South Korea)	**71.4%**[#]
DA-CPR not mentioned in guidelines	**4/7 (57.1%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)]		DA-CPR not mentioned in guidelines	**5/7 (71.4%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], SRFAC (Singapore)	
Paediatric chest compression depth 2020/ 2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Paediatric chest compression depth 2015/ 2016	Proportion of member councils (%)	RCA member councils	Overall concordance
Approximately one-third chest depth	**2/7 (28.6%)***	JRC (Japan), SRFAC (Singapore)	**71.4%**[#]	Approximately one-third chest depth	**1/7 (14.3%)***	JRC (Japan)	**85.7%**[#]
At least one-third chest depth	**5/7 (71.4%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea)		At least one-third chest depth	**6/7 (85.7%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), SRFAC (Singapore)	
Infant algorithm: 3 to 4 cm	1/7 (14.3%)	SRFAC (Singapore)	71.4%	Infant algorithm: 3 to 4 cm	1/7 (14.3%)	SRFAC (Singapore)	71.4%
Infant algorithm: Approximately 4 cm	5/7 (71.4%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea)		Infant algorithm: Approximately 4 cm	5/7 (71.4%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea)	
Infant algorithm: no specific depth	1/7 (14.3%)	JRC (Japan)		Infant algorithm: no specific depth	1/7 (14.3%)	JRC (Japan)	
Child algorithm: 4 to 5 cm	2/7 (28.6%)	KACPR (South Korea), SRFAC (Singapore)	57.1%	Child algorithm: 4 to 5 cm	2/7 (28.6%)	KACPR (South Korea), SRFAC (Singapore)	57.1%

Table 4 (continued)

Paediatric Basic Life Support

Age group basic life support definitions 2020/2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Age group basic life support definitions 2015/2016	Proportion of member councils (%)	RCA member councils	Overall concordance
Child algorithm: Approximately 5 cm	4/7 (57.1%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)]		Child algorithm: Approximately 5 cm	4/7 (57.1%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)]	
Child algorithm: no specific depth	1/7 (14.3%)	JRC (Japan)		Child algorithm: no specific depth	1/7 (14.3%)	JRC (Japan)	
Adult algorithm (may include < 18 years old): 4 to 6 cm	1/7 (14.3%)	SRFAC (Singapore)	57.1%	Adult algorithm (may include < 18 years old): 4 to 6 cm	1/7 (14.3%)	SRFAC (Singapore)	57.1%
Adult algorithm (may include < 18 years old): 5 to 6 cm	4/7 (57.1%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)]		Adult algorithm (may include < 18 years old): 5 to 6 cm	4/7 (57.1%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)]	
Adult algorithm (may include < 18 years old): Approximately 5 cm, but $\leq$ 6 cm	2/7 (28.6%)	JRC (Japan), KACPR (South Korea)		Adult algorithm (may include < 18 years old): Approximately 5 cm, but $\leq$ 6 cm	2/7 (28.6%)	JRC (Japan), KACPR (South Korea)	
Paediatric Chest compression: Ventilation Ratio 2020/2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Paediatric Chest compression: Ventilation Ratio 2015/2016	Proportion of member councils (%)	RCA member councils	Overall concordance
Layperson, 1 rescuer- 30:2	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%	Layperson, 1 rescuer- 30:2	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%
Layperson, $\geq$2 rescuers- 15:2	4/7 (57.1%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)]	57.1%	Layperson, $\geq$2 rescuers- 15:2	4/7 (57.1%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)]	57.1%
Layperson, $\geq$2 rescuers- 30:2	3/7 (42.9%)	KACPR (South Korea), JRC (Japan), SRFAC (Singapore)		Layperson, $\geq$2 rescuers- 30:2	3/7 (42.9%)	KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	
Healthcare worker, 1 rescuer- 15:2	0/7 (0.0%)	-	100.0%	Healthcare worker, 1 rescuer- 15:2	0/7 (0.0%)	-	100.0%
Healthcare worker, 1 rescuer- 30:2	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)		Healthcare worker, 1 rescuer- 30:2	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	
Healthcare workers, $\geq$2 rescuers- 15:2	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%	Healthcare workers, $\geq$2 rescuers- 15:2	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%
Foreign body airway (severe, conscious) 2020 /	Proportion of member	RCA member councils	Overall concordance	Foreign body airway (severe, conscious) 2015/	Proportion of member	RCA member councils	Overall concordance

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Table 4 (continued)

Paediatric Basic Life Support

Age group basic life support definitions 2020/ 2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Age group basic life support definitions 2015/ 2016	Proportion of member councils (%)	RCA member councils	Overall concordance
2021	councils (%)			2016	councils (%)		
Infant: 5 black blows (X5), followed by chest thrust (X5)	**6/7 (85.7%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), SRFAC (Singapore)	**85.7%**[#]	Infant: 5 black blows (X5), followed by chest thrust (X5)	**1/7 (14.3%)***	SRFAC (Singapore)	**71.4%**[#]
Infant: a few back blows or chest thrust. The order does not matter.	1/7 (14.3%)	JRC (Japan)		Infant: a few back blows or chest thrust. The order does not matter.	1/7 (14.3%)	JRC (Japan)	
Infant: Not mentioned in guidelines	**0/7 (0.0%) ***	-		Infant: Not mentioned in guidelines	**5/7 (71.4%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea)	
Child: Abdominal thrusts (back blows not mentioned)	**5/7 (71.4%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], SRFAC (Singapore)	71.4%	Child: Abdominal thrusts (back blows not mentioned)	**1/7 (14.3%)***	SRFAC (Singapore)	71.4%
Child: Back blows only	**1/7 (14.3%)***	KACPR (South Korea)		Child: Back blows only	**0/7 (0.0%) ***	-	
Child: Back blows, if ineffective, abdominal thrusts	**1/7 (14.3%)***	JRC (Japan)		Child: Back blows, if ineffective, abdominal thrusts	**0/7 (0.0%) ***	-	
Child: Back blows, chest thrusts, or abdominal thrust.	**0/7 (0.0%) ***	-		Child: Back blows, chest thrusts, or abdominal thrust.	**1/7 (14.3%)***	JRC (Japan)	
Child: Not mentioned in guidelines	**0/7 (0.0%) ***	-		Child: Not mentioned in guidelines	**5/7 (71.4%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea)	
Adult (includes < 18 years): Abdominal thrusts (back blows not mentioned)	**5/7 (71.4%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], SRFAC (Singapore)	71.4%	Adult (includes < 18 years): Abdominal thrusts (back blows not mentioned)	**1/7 (14.3%)***	SRFAC (Singapore)	71.4%
Adult (includes < 18 years): Back blows, if ineffective, abdominal thrusts	**2/7 (28.6%)***	JRC (Japan), KACPR (South Korea)		Adult (includes < 18 years): Back blows, if ineffective, abdominal thrusts	**1/7 (14.3%)***	JRC (Japan)	
Adult (includes < 18 years): Not mentioned in guidelines	**0/7 (0.0%) ***	-		Adult (includes < 18 years): Not mentioned in guidelines	**5/7 (71.4%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea)	
Age group advanced life support definitions 2020/ 2021	Proportion of member councils	RCA member councils	Overall concordance	Age group basic life support definitions 2015/ 2016	Proportion of member councils	RCA member councils	Overall concordance

Table 4 (continued)

Paediatric Basic Life Support

Age group basic life support definitions 2020/ 2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Age group basic life support definitions 2015/ 2016	Proportion of member councils (%)	RCA member councils	Overall concordance
	(%)				(%)		
Infant: ≤1-year-old	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%	Infant: ≤1-year-old	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%
Paediatric algorithm: <18-years-old	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%	Paediatric algorithm: <18-years-old	7/7 (100.0%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	100.0%
Adult algorithms can be considered in < 18-years-old if pubertal or in high school grade 2 students or older	1/7 (14.3%)	JRC (Japan)	-	Adult algorithms can be considered in < 18-years-old if pubertal or in high school grade 2 students or older	1/7 (14.3%)	JRC (Japan)	-
Adult algorithms can be considered in adolescents 16–18 years-old in non-paediatric healthcare settings	1/7 (14.3%)	SRFAC (Singapore)	-	Adult algorithms can be considered in adolescents 16–18 years-old in non-paediatric healthcare settings	0/7 (0.0%)	-	-
Ventilation rate post advanced airways (Supraglottic airway devices or endotracheal intubation) 2020/2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Ventilation rate post advanced airways (Supraglottic airway devices or endotracheal intubation) 2015/2016	Proportion of member councils (%)	RCA member councils	Overall concordance
30 ventilations/minute - Infants (<1 year-old)	– **1/7 (14.3%)***	-SRFAC (Singapore)	**57.1%[#]**	30 ventilations/minute - Infants (<1 year-old)	– **0/7 (0.0%)***	-	**100.0%[#]**
20 to 30 ventilations/ minute - All ages < 18-years-old	– **4/7 (57.1%)***	- AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)]		20 to 30 ventilations/ minute - All ages < 18-years-old	– **0/7 (0.0%)***	-	
20 ventilations/minute – 1 to 12-years-old	– **1/7 (14.3%)***	- SRFAC (Singapore)		20 ventilations/minute – 1 to 12-years-old	– **0/7 (0.0%)***	-	
10 ventilations/minute - >12-years-old - All ages < 18-years-old	– **1/7 (14.3%)*** – **2/7 (28.6%)***	- SRFAC (Singapore) - JRC (Japan), KACPR (South Korea)		10 ventilations/minute - >12-years-old - All ages < 18-years-old	– **0/7 (0.0%)*** – **7/7 (100.0%)***	- - AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), JRC (Japan), SRFAC (Singapore)	
Initial defibrillation dose for paediatric cardiac arrest (shockable rhythm) 2020/ 2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Initial defibrillation dose for paediatric cardiac arrest (shockable rhythm) 2015/ 2016	Proportion of member councils (%)	RCA member councils	Overall concordance

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Table 4 (continued)

Paediatric Basic Life Support

Age group basic life support definitions 2020/2021	Proportion of member councils (%)	RCA member councils	Overall concordance	Age group basic life support definitions 2015/2016	Proportion of member councils (%)	RCA member councils	Overall concordance
2 J/kg	1/7 (14.3%)	KACPR (South Korea)	**71.4%#**	2 J/kg	1/7 (14.3%)	KACPR (South Korea)	**57.1%#**
2–4 J/kg	**5/7 (71.4%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], SRFAC (Singapore)		2–4 J/kg	**4/7 (57.1%)***	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)	
4 J/kg	**1/7 (14.3%)***	JRC (Japan)		4 J/kg	**2/7 (28.6%)***	JRC (Japan), SRFAC (Singapore)	
Subsequent defibrillation doses (2020/2021)	Proportion of member councils (%)	RCA member councils	Overall concordance	Subsequent defibrillation doses (2015/2016)	Proportion of member councils (%)	RCA member councils	Overall concordance
Subsequent doses 4 J/kg	1/7 (14.3%)	JRC (Japan)	85.7%	Subsequent doses 4 J/kg	1/7 (14.3%)	JRC (Japan)	85.7%
2nd 4 J/kg and then 4–10 J/kg	6/7 (85.7%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), SRFAC (Singapore)		2nd 4 J/kg and then 4–10 J/kg	6/7 (85.7%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], KACPR (South Korea), SRFAC (Singapore)	
Specific mention of timing for 1st dose of adrenaline (2020/2021)	Proportion of member councils (%)	RCA member councils	Overall concordance	Specific mention of timing for 1st dose of adrenaline (2015/2016)	Proportion of member councils (%)	RCA member councils	Overall concordance
After 1st shock and every 3 to 5 minutes	1/7 (14.3%)	KACPR (South Korea)	71.4%	After 1st shock and every 3 to 5 minutes	1/7 (14.3%)	KACPR (South Korea)	71.4%
After 2nd shock and every 3 to 5 minutes	5/7 (71.4%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], SRFAC (Singapore)		After 2nd shock and every 3 to 5 minutes	5/7 (71.4%)	AHA [PHACC (Philippines), NRCT (Taiwan), RCHK (Hong Kong), TRC (Thailand)], SRFAC (Singapore)	
Every 3 to 5 minutes (no specific mention of timing)	1/7 (14.3%)	JRC (Japan)		Every 3 to 5 minutes (no specific mention of timing)	1/7 (14.3%)	JRC (Japan)	

Note: As majority of the member councils of RCA endorsed AHA paediatric life support guidelines, overall percentage concordance was pegged to guidelines which were concordant with AHA's.

*changes present in proportion of resuscitation councils' life support guidelines when compared to earlier guidelines in 2015/2016.

changes in percentage overall concordance with AHA 2020/2021 guidelines, when compared to 2015/2016 guidelines.

Abbreviations: 1st – first, 2nd – second; AHA- American Heart Association; cm – centimeter, DA-CPR – Dispatch-assisted cardiopulmonary resuscitation; J/kg – joules per kilogram, JRC - Japan Resuscitation Council; KACPR - Korean Association of Cardiopulmonary Resuscitation; NRCT - National Resuscitation Council, Taiwan; PHACC - Philippine Heart Association Cardiopulmonary Resuscitation Council; RCA – Resuscitation Council of Asia; RCHK - Resuscitation Council of Hong Kong; SRFAC - Singapore Resuscitation and First Aid Council; TRC - Thai Resuscitation Council; X- times.

extrapolated from adult studies, retained from historical recommendations, or were based on experimental studies, or small non-interventional studies. Examples of which would include paediatric chest compression depth targets, ventilation rates post advanced airway placement intra-arrest and initial defibrillation dose for paediatric cardiac arrest with shockable rhythms.[2–8]

As four of the seven resuscitation member councils endorsed AHA's paediatric life support guidelines, comparisons between the AHA and those from JRC (Japan), KACPR (South Korea), and SRFAC (Singapore), were studied in this paper. RCA member councils who have their own local paediatric life support guidelines generally recommend shallower chest compression depth targets for infants and children than AHA. Unlike the rest of the guidelines, JRC (Japan) did not provide guidance for absolute compression depth targets in infants and children. RCA's recommendation for adult chest compression depth target is similar to ILCOR's: "approximately 5 cm, but less than 6 cm".[9,18] This is in contrast with AHA's recommended chest compression depth target of at 5 to 6 cm in adults, which is often worded as "at least 5 cm but not more than 6 cm".[19] Notably, this would mean that RCA's guidelines for chest compression depth target for adults would appear to be similar to AHA's recommended paediatric chest compression depth target of "approximately 5 cm" in children.[3] The three RCA member councils with their own published paediatric life support guidelines had local non-clinical (radiological and forensic) paediatric studies that supported shallower paediatric chest compression depth targets than those recommended by AHA, especially for infants and younger children.[20–24] AHA's paediatric absolute chest compression depth targets were informed by two small, retrospective observational studies.[3,25–27] Thus, considerations of these may have contributed to the differences paediatric in chest compression depth targets between and across these guidelines. A recent multi-national observational study that reported one-third anterior-posterior chest diameters in infants and children were not synonymous with their absolute chest compression depth targets of approximately 4, and 5 cm, respectively.[28] These suggest that there needs to be further clinical validation of chest compression depth targets, both relative and absolute, currently recommended in the paediatric life support guidelines. However, it is also important to note that bedside or ground application of using absolute chest compression depth targets is restricted to very limited settings whereby chest compression depth can be accurately measured and monitored using CPR feedback devices with advanced technology, using dual sensors, in appropriately-sized infants and children.

The recommendation of ventilation rate of 10 per minute post advanced airway placement during paediatric cardiac arrest was solely extrapolated from adult observational studies and animal studies.[2–8] A small observational paediatric study suggested that ventilation rates of at least 30 per minute in infants, and 25 per minute in children were associated with improved survival.[29] Thus, AHA changed their guidelines for ventilation rates post advanced airway placement intra-arrest.[3] However, it is generally thought that hyperventilation could result in decreased venous return and impair cerebral and coronary perfusion during cardiac arrest with ongoing chest compressions (low-flow states).[18,19,2–9,30] For adolescents, ventilation rates of ≥ 20 per minute, especially with advanced airways in place, would conventionally be considered hyperventilation. SRFAC (Singapore) modified their guidelines to align with these considerations.[6] JRC(Japan) and KACPR (South Korea) have chosen to retain their previous guidelines of ventilation rates of 10 per minute (for all ages) which simplifies training, till more robust evidence is available to suggest change.[5,8] Practical considerations in the application of life support guidelines could also contribute to the different recommendations in ventilation rates intra-arrest, post advanced airway placement. Changing life support guidelines would likely involve a lot of resources to re-align training material and modification of courses. It would also take time to achieve the necessary thresholds for high-quality resuscitation in paediatric cardiac arrest patients.[31]

The initial energy dose for defibrillation for paediatric cardiac arrest with shockable rhythms also varied. An observational in-hospital paediatric cardiac arrest study suggested that initial use of 2 J/kg was associated with improved survival.[32] However it has also been shown anecdotally in limited case series and case reports that defibrillation dose of up to 9–13.5 J/kg had been administered in paediatric cardiac arrest with shockable rhythms that resulted in good outcomes, especially in the context of the pre-hospital use of automated external defibrillators with standard pads in infants and toddlers.[33–35] This apparent conflicting evidence could also contribute to the variations seen across the guidelines. It may also be of interest that it has been reported that at least 30% of paediatric in-hospital cardiac arrest had defibrillation performed for non-shockable rhythms.[36] The optimal initial energy dose for defibrillation for both in-hospital and out-of-hospital in paediatric cardiac arrest patients with actual shockable rhythms would require further evaluation.

Guidelines also varied for timing of the first dose of epinephrine (adrenaline) in shockable rhythms. While early epinephrine (adrenaline) in paediatric cardiac arrests with non-shockable rhythms was associated with better clinical outcomes,[37] there is very limited evidence for this for shockable rhythms, especially in the in-hospital setting. For in-hospital adult cardiac arrests patients with shockable rhythms, there were observational studies that reported administration of epinephrine (adrenaline) pre-defibrillation or within two minutes after initial defibrillation were associated with poorer outcomes.[38,39]

There is limited scientific evidence and data in paediatric life support that appropriately address and support patient- and family-centred clinical outcomes directly, such as long-term neuro-behavioural and psychosocial outcomes of paediatric cardiac arrest victims and their carers.[40] While the majority of the elements in the paediatric life support guidelines were concordant, these minor variations may help highlight important knowledge gaps and prioritise paediatric resuscitation science research. These differences may also provide potential research opportunities (for example using natural cohort comparisons) to address these knowledge gaps, as randomised control trials are extremely challenging in paediatric cardiac arrest patients.

Conversely, there have been published literature on potential harm with the use of abdominal thrusts in conscious patients with severe FBAO.[41–47] Except for the infants (which were uniform and did not involve abdominal thrusts in all four guidelines), the child and adult (which may include older children and adolescents) algorithms for conscious victims with FBAO, varied considerably.[3,5–8] Only the algorithms by JRC (Japan) and KACPR (South Korea) were more aligned with ILCOR's first aid treatment recommendations.[2,5,7] For conscious child and adult victims with "severe" FABO, the guidelines from SFRAC (Singapore) and AHA (for RCA member councils that endorse its use) still emphasised performing abdominal thrusts with no mention of back blows in their algorithms.[3,6]

Evidence translation into life support guidelines may also be affected by resource availability. Paediatric DA-CPR instructions may not be uniformly available in certain sites, region, and countries. Japan, South Korea, and Singapore have EMS systems which routinely incorporate Dispatcher-assisted CPR instructions for bystanders. The resuscitation councils of these three countries included DA-CPR instructions as part of their basic life support guidelines and there was local data that supported its use.[48–55] These resource similarities (and differences for other Asian member councils) would thus impact on the concordance of paediatric basic life support guidelines.

The AGREE II instrument was used to objectively compare the four guidelines. While AHA scored the highest in the development rigour and applicability domains using the AGREE II instrument, many of the experimental studies were not taken into consideration in AHA's evidence evaluation as discussed. Of note, the Japanese paediatric life support guidelines were published as a manual, and not in a peer review journal, which affected its score in domain six (editorial independence). The three Asian resuscitation councils often evaluate ILCOR scientific evidence reviews and updates as part of their guideline development process and publish their guidelines every five years. SRFAC (Singapore) reviews ILCOR, AHA, and ERC evidence updates and their treatment recommendations, and hence their guidelines are published usually a year later than the other guidelines to allow evaluation and treatment consensus by the writing group.[6]

Ultimately, where evidence is deemed to be sufficiently robust, and if local resources are available, paediatric life support guidelines should ideally be uniform and there should be consensus development across the different resuscitation councils. This is especially important for paediatric basic life support since there has been a common RCA adult basic life support guideline published; but not for paediatrics.[9] A common life support guideline could potentially facilitate efforts for international or regional monitoring and audits. This could potentially improve paediatric cardiac arrest outcomes in Asia by facilitating common improvement programmes. Japan, South Korea, Singapore, Taiwan, and Thailand are clinical research network members of the Pan-Asian Resuscitation Outcomes Study (PAROS), which collect emergency medical services and academic centres out-of-hospital cardiac arrest registry data, which include the paediatric population.[56]

However, due to the different resource availability and limited scientific evidence that informed a proportion of paediatric cardiac arrest life support guidelines, it is uncertain if having a common algorithm for all member resuscitation councils of RCA would be overall advantageous at this point in time.

This paper provided an overview of paediatric life support guidelines. Highlighting the similarities between these guidelines could potentially lay the groundwork to work towards a common paediatric life support in Asia. It also discussed the differences between the guidelines among the councils, which could provide a framework for addressing specific knowledge gaps and prompt further research in these areas, and potentially map research opportunities for natural experiments.

While we have presented the paediatric life support guidelines endorsed by individual RCA member councils, we did not explore implementation of these recommendations within each country. There are additional important steps between scientific recommendations and implementation at the bedside or in the field. These may include, but are not limited, to local chapters of international first aid groups, EMS systems, non-paediatric versus paediatric healthcare settings, academic versus non-academic hospitals, which also have their setting-specific, manpower, training, and logistical considerations.

Conclusion

This was an overview and mapping of published Asian paediatric resuscitation algorithms. It highlights similarities across paediatric life support guidelines in Asian countries. There were some differences in components of paediatric life support which highlight important knowledge gaps in paediatric resuscitation science. These minor differences in approach of member councils' paediatric life support guidelines may also provide a framework for prioritising resuscitation research and highlight resuscitation research needs.

CRediT authorship contribution statement

Gene Y. Ong: Conceptualization, Resources, Methodology, Investigation, Formal analysis, Project administration, Writing – original draft. **Hiroshi Kurosawa:** Investigation, Methodology, Writing – review & editing. **Takanari Ikeyama:** Investigation, Methodology, Writing – review & editing. **June Dong Park:** Investigation, Writing – review & editing. **Poomiporn Katanyuwong:** Investigation, Writing – review & editing. **Olivia C.F. Reyes:** Investigation, Writing – review & editing. **En-Ting Wu:** Investigation, Writing – review & editing. **Kam Lun Ellis Hon:** Investigation, Writing – review & editing. **Ian K Maconochie:** Investigation, Writing – review & editing. **Lindsay N. Shepard:** Methodology, Investigation, Writing – review & editing. **Vinay M. Nadkarni:** Conceptualization, Methodology, Investigation, Writing – review & editing. **Kee Chong Ng:** Conceptualization, Methodology, Investigation, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

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