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Clinical questions on advanced life support answered by artificial intelligence. A comparison between ChatGPT, Google Bard and Microsoft Copilot.

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Word: 495 – Table 1

Dear Editor,

Artificial intelligence (AI) tools are increasingly utilised in medical environments but their implementation generated extensive discussion¹⁻³. Several AI tools are available online with free or paid accounts. ChatGPT (OpenAI, San Francisco, USA) uses unsupervised, supervised, and reinforcement learning techniques, offering paid user-friendly custom GPTs for specific tasks. Google's Bard (Google, Menlo Park, USA) provides free conversational AI services that use a set of deep learning algorithms to respond to questionnaires. Microsoft Copilot (Microsoft, Redmond, USA) combines language models with organisational data to enhance productivity and creativity. The efficacy and accuracy of these AI tools generally depend on their training, specialisation, model updates, and question complexity. In this study we aimed to compare the ability of ChatGPT 3.5, ChatGPT 4, two specifically built GPTs, Bard and Microsof Copilot to solve the pre-course Advanced Life Support (ALS) Multiple Choice Questionnaire (MCQ) of the European Resuscitation Council (ERC)⁴. For the GPTs, we created two different databases: the first, which we called "ERC Guidelines 2021", was created using all the 2021 ERC guidelines as a source of information, and the second, "ERC ALS manual 2021", where we only used the 2021 ERC ALS manual. To test the ability of the AI tools, we compared correct and incorrect responses and the average seconds to respond to each question. The precourse ALS MCQ includes 40 questions on different contents of the ERC ALS course covering various areas including the analysis of ECG strips. The test was conducted on December 18, 2023, with each AI tool always being asked the same guestion: 'What is the

correct answer? The test included the question along with the multiple-choice answers from the ALS MCQ. We compared the different responses from the different tools for each question except for ChatGPT3.5, which was unable to analyse the ECG strip. The results are presented in Table 1 and all raw data for each question in the Supplemental Materials. ChatGPT 4 had the highest number of correct answers, indicating it was the most accurate tool (accuracy 87.5% and error rate 2.5%). ChatGPT 3.5 had the fastest average response time but lower accuracy and a higher error rate compared to ChatGPT 4. Regarding the two GPTs, these tools had moderate levels of accuracy, with ERC ALS manual 2021 being slightly more accurate but also slower in response time. Regarding Bard and Copilot, these tool had a relatively high number of both correct and incorrect responses, suggesting variability in their performance. The experiment revealed that AI models tailored for ALS content underperformed in related queries, unlike general-purpose models like ChatGPT4. This is probably due to the improvement of ChatGPT4 over its predecessor, thanks to an enhanced architecture and more advanced training, which allows for better handling of complex scenarios. Research on AI tools and their integration into resuscitation medicine could be a game-changer for the future⁵. However, while recognising AI's potential to revolutionise resuscitation, a deep understanding of the algorithms is vital to enhance their safe and effective use.

Conflict of interest statement

No relationship exists between any of the authors and any commercial entity or product mentioned in this manuscript that might represent a conflict of interest. No inducements have been made by any commercial entity to submit the manuscript for publication. All within 3 years of beginning the work submitted. FS is the Chair-Elect of the European Resuscitation Council, ILCOR Chair of Social Media Working group, ILCOR BLS Task Force member and IRC Foundation member. LG is member of the Italian Resuscitation Council scientific committee. FC is the SEC ALS co-chair Education of the European Resuscitation Council and shareholder of a company (Simula) of CPR training and simulation materials. KM is the Chair of the European Resuscitation Council, Chair of the ILCOR Digital Communications Working Group and member of the ILCOR Education Implementation and Teams Task Force.

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Table 1. Results of different AI in response to ERC ALS pre-course MCQ questions analyzed with the Chi-Square test

Tools	Correct answers	Accuracy (%)	Incorrect answers	Unable to confirm the correct answer	Not applicable	Average response time per answer (seconds)	р
ChatGPT 3.5	17	42,25	13	0	10	3	0.001
ChatGPT 4	35	87,5	1	4	0	4	
GPT ERC ALS manual 2021	31	77,5	9	0	0	15	
GPT ERC Guidelines 2021	23	57,5	4	13	0	14	
Google Bard	23	57,5	17	0	0	9	
Microsoft Copilot	25	62,5	6	9	0	30	

Supplemental Data – Analysis of Varied Responses from Artificial Intelligence (AI) Tools to the ERC Pre-Course Advanced Life Support Multiple-Choice Questions (MCQ)

	Pre-Course Advanced Life Support MCQ	ERC Guidelines 2021 GPT	ERC ALS Manual 2021 GPT	ChatGPT 4	ChatGPT 3.5	Bard Google	Copilot Microsoft
1.	 ST-segment-elevation myocardial infarction (STEMI): a) Is always accompanied by chest pain b) Rarely causes VF. c) May present with ST depression in leads V1–3 of a 12-lead ECG. d) May never present with new left bundle branch block (LBBB) on the ECG. 	Correct	Correct	Correct	Correct	Correct	Correct
2.	 When using transcutaneous pacing: a) Electrical capture typically occurs with a current of 5–10 amps. b) May be unsuccessful in a patient with hyperkalaemia. c) Movement artefact will not inhibit the pacemaker. d) Electrical capture and generation of a QRS complex ensures return of a pulse. 	Correct	Correct	Correct	Incorrect	Correct	Correct
3.	 With regard to the ECG: a) Continuous monitoring via self-adhesive pads is preferable to using ECG electrodes. b) If adhesive electrodes are used for 3-lead monitoring, they should be applied over bone rather than muscle. c) The normal PR interval is more than 0.2 s. d) The normal QRS complex has a duration > 0.12 s. 	Correct	Incorrect	Correct	Incorrect	Incorrect	Incorrect
4.	 In drowning: a) There is immediate entry of water into the victim's lungs. b) Submersion duration is the strongest predictor of outcome. c) Following submersion, respiratory arrest does not precede cardiac arrest. d) Prophylactic antibiotic therapy should be given routinely. 	Unable to confirm the correct answer	Correct	Correct	Incorrect	Correct	Correct

5.	 You arrive at the bedside 4 min after the cardiac arrest of a 70 kg woman. An IV line is in place, there is no pulse. The ECG confirms asystole. Two nurses are performing CPR competently. You would recommend: a) Delivery of a 150 J shock. b) Sodium bicarbonate 500 mmol IV. c) Calcium chloride 5 mL 10% solution d) Adrenaline 1 mg IV. 	Correct	Correct	Correct	Correct	Correct	Correct
6.	 A 55-year-old man on CCU has a witnessed, monitored VF cardiac arrest. After the 3rd shock he develops sinus rhythm with a pulse and starts to breathe spontaneously. He is given oxygen via a reservoir mask with a flow of 15 L-1. Analysis of blood gas shows: Normal range: PaO2 22.6 kPa(FiO2 85%) pH 7.11 PaCO2 7.2 kPa Bicarbonate 14 mmol L-1 Base exces -10.6 mmol L-1 a) These results suggest that the patient has an acidaemia. b) These results suggest that oxygenation is appropriate for the inspired concentration. c) These results suggest that the patient has a compensatory metabolic alkalosis. d) These results suggest that 50 mmol of 8.4% sodium bicarbonate IV is required. 	Correct	Correct	Correct	Correct	Correct	Correct
7.	 Pulseless electrical activity (PEA): a) Is rarely the first monitored rhythm in a cardiac arrest. b) Is characterised by evidence of ventricular activity on the ECG that would normally be associated with a pulse. c) Should be treated by giving 300 mg amiodarone IV. d) Is rarely the cardiac arrest rhythm in patients with severe hypovolaemia. 	Correct	Correct	Correct	Incorrect	Incorrect	Correct

8.	 With regard to decisions about CPR: a) The best time to make an anticipatory decision about whether or not to attempt CPR is when a patient is admitted to hospital. b) If you consider that a patient should be 'for CPR' you should still discuss the decision with the patient. c) If it is agreed that a patient is 'for CPR' there is no need to document anything in the health records. d) If a DNACPR decision is made with a person who has an implanted cardioverter-defibrillator (ICD) the shock function of the ICD should then be deactivated. 	Correct	Correct	Correct	Correct	Incorrect	Correct
9.	 Adrenaline: a) Has purely alpha-adrenergic effects. b) Is associated with any long-term benefit to patients when given during a cardiac arrest. c) Decreases systemic vasoconstriction. d) Improves coronary and cerebral perfusion pressures during CPR. 	Unable to confirm the correct answer	Correct	Correct	Correct	Correct	Correct
10	 When monitoring the cardiac rhythm: a) A ventricular rate of between 60–100 beats min-1 is considered normal. b) Asystole presents as a completely straight line. c) At a standard paper speed of 25 mm s-1 the ventricular rate is calculated by dividing the number of large squares between consecutive R waves by 60. d) A ventricular tachycardia will always require immediate cardioversion. 	Unable to confirm the correct answer	Correct	Correct	Correct	Correct	Correct
11	 A 55-year-old woman presents with a 1 h history of crushing central chest pain, nausea and sweating. Her pulse rate is 38 min-1, BP 75/45 mmHg. The ECG monitor shows sinus bradycardia. You would recommend that: a) Atropine 500 mcg IV should be given. b) An adrenaline infusion, 20–100 mcg min-1, may be required. c) Opioid analgesia is contraindicated. d) 24% oxygen via a mask should be given until the results of arterial blood gas analysis are known. 	Correct	Correct	Correct	Incorrect	Correct	Correct

12	During CPR:	Correct	Correct	Correct	Incorrect	Incorrect	Correct
	a) There is a high risk of transmission of HIV virus						
	from patient to rescuer.						
	b) Personal protective equipment (PPE) should be						
	worn if the patient has SARS-CoV-2.						
	c) Wearing latex gloves provides sufficient protection						
	from the electrical current during defibrillation.						
	d) If ventilating with high-flow oxygen via an LMA, it						
	must be disconnected and placed at least 1 m away						
	before defibrillation.						
13.	Following successful resuscitation from VF cardiac	Correct	Correct	Correct	Correct	Incorrect	Correct
	arrest:						
	a) All patients should be given as close to 100%						
	oxygen as possible.						
	b) Intubated patient's lungs should be ventilated to						
	achieve a PaCO2 < 4.5 kPa.						
	c) largeted temperature management (IIM) is						
	recommended for adults after in-nospital cardiac						
	arrest who remain unresponsive after ROSC.						
	a) Absence of both pupiliary light and corneal reflexes						
	at 46 if can not be used to help predict outcome in						
 	Civing 9.4% acdium biographonato:	Corroct	Corroct	Corroct	Corroct	Incorroct	Corroct
14.	a) Doos not exacerbate an intracellular acidesis	Correct	Conect	Correct	Correct	Inconect	Conect
	 b) Is recommended after 5 min of CPR if ROSC has 						
	not been achieved						
	c) Should be considered as a treatment for						
	arrhythmias due to tricyclic antidepressant						
	overdose						
	d) Facilitates release of oxygen to the tissues.						
15	Immediate primary percutaneous coronary intervention	Correct	Correct	Correct	Correct	Correct	Correct
10.	(PPCI):		_	-	_	_	_
	a) Is the preferred treatment for a patient with chest						
	pain lasting more than 20 min and ST segment						
	depression in leads V4–V6 on their ECG.						
	b) Is the preferred treatment for a patient with chest						
	pain lasting more than 20 min and acute ST						
	segment elevation in leads V4–V6 on their ECG.						
	c) Is the first line treatment for unstable angina.						
	d) Should be achieved within 24h of the call for help						
	whenever possible.						

			<u> </u>	<u> </u>			
16.	The correct management of an adult patient in	Incorrect	Correct	Correct	Incorrect	Correct	Incorrect
	ventricular fibrillation includes:						
	a) Digoxin 500 mcg IV.						
	b) Adrenaline, 1 mg IV after every shock.						
	c) Atropine 3 mg after 2 loops.						
	d) An initial shock energy of at least 120 J.						
17	The following statement are correct	Incorrect	Incorrect	Correct	Incorrect	Correct	Correct
17.	a) Adrenaline 1 mg IV should be given to all patients in	moonroot	moonroot	Control	moonroot	0011000	Control
	cardiac arrest as soon as possible						
	b) Lidocaine 100 mg is the treatment of choice for all						
	b) Eldocarrie 100 mg is the treatment of choice for an						
	a) Adapaging is effective in the treatment of regular						
	c) Adenosine is enective in the treatment of regular						
	lachycardias.						
	d) The Initial dose of amiodarone for shock refractory						
	Ventricular fibrillation is 150 mg IV.					<u> </u>	
18.	Chest compressions:	Unable to	Correct	Correct	Correct	Correct	Correct
	a) Should not be interrupted even when an organised	confirm the					
	rhythm is seen during a 2min period of CPR unless	correct answer					
	patient shows signs of ROSC						
	b) Are interrupted for ventilation after tracheal						
	intubation has occurred.						
	c) Should be performed at a rate of 60 min-1 in adults.						
	d) Should be interrupted to palpate a pulse in any						
	unresponsive patient with agonal breathing.						
19	In acute severe asthma:	Unable to	Correct	Correct	Correct	Incorrect	Correct
	a) Cardiac arrest is mainly secondary to hypercaphia.	confirm the					
	b) Oxygen should be titrated to achieve an SpO2 of	correct answer					
	88–90%.						
	c) A PaCO2 of 6 kPa is a sign of good outcome						
	d) Magnesium sulfate 2 g (8 mmol of Mg++) IV may						
	produce bronchodilatation						
20	In a natient with suspected anaphylaxis:	Correct	Correct	Correct	Incorrect	Incorrect	Correct
20.	a) Skin and mucosal changes are uncommon features	Concor	Concor	Concor	mooncot	mooncot	Concor
	b) Adrenaline 0.5 mg IM is the first line treatment of						
	b) Adjenance 0.5 mg ini is the mist line treatment of						
	a) Staraida muat ha giyan aarly						
	d) Colloide are proferred to an estalloide for restarium						
	a) Colloids are preferred to crystalloids for restoring						
	the circulation.					1	

-							1
21.	 A 65-year-old man with a 2 h history of central chest pain develops a broad QRS tachyarrhythmia that appears regular with a rate of approximately 180 beats min-1. His blood pressure is 86/54. The following treatment should be given: a) Immediate cardioversion should be attempted. b) If there were no adverse signs, and the QRS complex were narrow and regular, amiodarone 300 mg IV should be given. c) As he has no adverse signs, the QRS complex is > 0.12 s and regular, adenosine 6 mg IV should be given. d) If there were no adverse signs, and the QRS complex were broad and regular verapamil 10 mg IV should be given. 	Unable to confirm the correct answer	Incorrect	Correct	Incorrect	Correct	Correct
22.	Severe hyperkalaemia:	Unable to	Incorrect	Correct	Incorrect	Incorrect	Incorrect
	a) Is defined as a plasma potassium concentration of >	confirm the					
	5.5 mmol L-1.	correct answer					
	the ECG						
	c) May be caused by heart failure.						
	d) Can be treated by giving 10 mL 1% calcium chloride						
	IV.	-					
23.	With regard to decisions about CPR:	Correct	Incorrect	Correct	Correct	Correct	Correct
	is the presence of a recorded valid DNACPR						
	decision.						
	2) Any patient is entitled to receive CPR in the event of						
	cardiac arrest if they insist on it.						
	 Overall responsibility for decisions about CPR fests with the senior clinician in charge of the patient's 						
	care.						
	4) If a patient lacks capacity to make a decision about						
	CPR their family must be asked to decide whether						
1	or not CPR should be attempted.						

24.	 In second-degree atrioventricular (AV) heart block a) There are always more QRS complexes than P waves. b) The PR interval is always regular. c) Immediate treatment for a bradycardia will be required. d) When it is Mobitz type II there is a risk of asystole. 	Unable to confirm the correct answer	Correct	Correct	Correct	Correct	Correct
25.	 During advanced life support (ALS): a) Higher defibrillation energies may be required in patients whose cardiac arrest has been caused by asthma. b) The amplitude of the VF waveform is relevant in determining the need for a shock. c) Self-adhesive pads must be placed always in the antero-posterior position in a patient with an implantable cardioverter-defibrillator (ICD). d) If you notice a rhythm change during ventilations from asystole to VF, a shock should immediately be given. 	Unable to confirm the correct answer	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect
26.	 In a patient suspected of having an acute coronary syndrome (ACS): a) A single, normal 12-lead ECG excludes this as a possible diagnosis. b) Troponin values above the normal range always indicate myocardial infarction. c) Thrombolysis is contraindicated if the patient has had a surgical procedure within the last month. d) Fibrinolytic therapy is less effective than PCI. 	Unable to confirm the correct answer	Correct	Correct	Correct	Incorrect	Incorrect

27.	A 28-year-old man, known to have asthma has been	Unable to	Correct	Correct	Correct	Incorrect	Incorrect
	very wheezy for 6 h and has had no relief from his	confirm the					
	inhalers. On examination he is breathless at rest,	correct answer					
	unable to complete sentences and has a respiratory						
	rate of 36 min-1, there is poor air entry and wheeze						
	throughout both lung fields. While breathing oxygen						
	from a reservoir mask (flow 15 L min-1), analysis of an						
	arterial blood sample shows:						
	PaO ₂ 11 kPa (FiO2 80%)						
	pH 7.22						
	PaCO ₂ 5,96 kPa						
	Bicarbonate 16.3 mmol L-1						
	Base excess -7 mmol L-1						
	a) Oxygenation is higher than predicted from the						
	inspired concentration.						
	 b) As PaCO2 is normal, we could expect a good 						
	outcome.						
	c) These suggest that the patient has a compensatory						
	metabolic alkalosis.						
	d) These suggest that the patient is getting tired.		-		-	-	
28.	A 35-year-old lady is on the ward following a	Unable to	Correct	Correct	Correct	Incorrect	Correct
	cholecystectomy. She complains of abdominal pain and	confirm the					
	appears pale and sweaty:	correct answer					
	a) A respiratory rate of 30 breaths min-1 may be a sign						
	of deterioration.						
	b) Her early warning score (EWS) will not detect						
	evidence of deterioration.						
	c) A normal systelic blood pressure rules out the						
	possibility of shock.						
	u) Looking for a source of hypovolaemia is the first						
	The effectiveness of a resuscitation team may be	l Inable to	Correct	Correct	Correct	Correct	Correct
29.	improved by:	confirm the	Conect	Conect	Conect	Conect	Conect
	a) Early identification of a team leader	correct answer					
	b) The team leader carrying out all the necessary						
	interventions.						
	c) Meeting and assigning roles during the arrest						
	d) Ensuring that the most senior person acts as the						
	team leader.						

30.	 Following successful resuscitation from a cardiac arrest: a) The patient may be hyperkalaemic. b) Maintain the patient's blood glucose between 4.0– 8.0 mmol L-1. c) Cerebral perfusion returns to normal immediately with ROSC. d) Seizures occur in > 50% of patients who remain comatose. 	Incorrect	Incorrect	Correct	Incorrect	Incorrect	Correct
31.	With reference to the 12-lead ECG:	Correct	Correct	Correct	NA	Incorrect	Unable to confirm the correct answer
	d) Aspirin should be avoided.						
32.	 With reference to the rhythm strip: With reference to the rhythm strip: WMMMMMMMM a) This rhythm can be associated with a spontaneous circulation. b) Adrenaline 1 mg IV is the initial treatment of choice. c) A precordial thump is always indicated. d) Defibrillation is the treatment of choice in the pulseless patient. 	Correct	Correct	Correct	NA	Correct	Correct

33.	 With reference to the rhythm strip (paper speed 25mm/s): a) The ventricular rate is in the range 90–110 min-1. b) The rhythm is regular. c) The rhythm is supraventricular in origin. d) The rhythm is atrial flutter. 	Incorrect	Incorrect	Unable to confirm the correct answer	NA	Incorrect	Unable to confirm the correct answer
34.	 With reference to the rhythm strip: a) The rhythm is regular. b) The rhythm originates in the ventricles. c) P waves are clearly present. d) Heart rate is under 100 beats per minute 	Correct	Incorrect	Unable to confirm the correct answer	NA	Correct	Unable to confirm the correct answer
35.	 With reference to the rhythm strip: a) The ventricular rate is in the range of 35–45 min-1. b) Atropine may be indicated. c) The atrial rate is in the range 40–50 min-1. d) The duration of the QRS complex is normal. 	Correct	Correct	Unable to confirm the correct answer	NA	Incorrect	Unable to confirm the correct answer
36.	 With reference to the rhythm strip: A patient with this rhythm will not have a pulse. If the patient is dyspnoeic and hypotensive, systolic blood pressure 80 mmHg, transvenous pacing may be appropriate. The patient is not at risk of developing asystole. 	Correct	Correct	Correct	NA	Correct	Unable to confirm the correct answer

37.	 With reference to the rhythm strip: a) The ventricular rate is in the range 50–60 min-1. b) The PR interval is normal. c) Atropine 0.5 mg IV is the initial treatment of this rhythm in a patient with adverse signs. d) Adrenaline is contraindicated in the presence of this rhythm. 	Correct	Correct	Unable to confirm the correct answer	NA	Correct	Unable to confirm the correct answer
38.	 With reference to the rhythm strip: With reference to the rhythm strip: a) The ventricular rate is greater than 200 min-1. b) The rhythm is irregular. c) The QRS complex is normal. d) P waves are clearly visible. 	Correct	Correct	Correct	NA	Correct	Unable to confirm the correct answer
39.	 With reference to the rhythm strip: With reference to the rhythm strip: With reference to the rhythm strip: a) Atropine may be appropriate treatment for this rhythm. b) If the patient is conscious, this rhythm does not require any treatment. c) In the presence of a systolic blood pressure of 70 mmHg, a synchronised cardioversion is the treatment of choice. d) Amiodarone is the first option to treat adverse features. 	Correct	Correct	Correct	NA	Correct	Unable to confirm the correct answer
40.	 With reference to the rhythm strip: a) The ventricular rate is in the range 60–80 min-1. b) The rhythm is complete heart block. c) External pacing may be indicated. d) Amiodarone 300 mg IV should be given. 	Correct	Correct	Correct	NA	Correct	Unable to confirm the correct answer