# QUESTION

## Should CPR by rescuers wearing PPE vs. CPR by rescuers not wearing PPE be used for survival, quality and fatigue of providers delivering Basic Life Support?

| | |
|---|---|
| **POPULATION:** | Providers delivering Basic Life Support |
| **INTERVENTION:** | CPR by rescuers wearing PPE |
| **COMPARISON:** | CPR by rescuers not wearing PPE |
| **MAIN OUTCOMES:** | Survival; CPR quality such as compression depth, compression rate, target depth, target rate, hands-off time, target release; rescuer's fatigue; time to procedure of interest; neurocognitive performance |
| **SETTING:** | Adults and children in any setting of cardiac arrest including simulated cardiac arrest |
| **PERSPECTIVE:** | |
| **BACKGROUND:** | |
| **CONFLICT OF INTERESTS:** | |

# ASSESSMENT

## Problem
Is the problem a priority?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ No<br>○ Probably no<br>○ Probably yes<br>● Yes<br>○ Varies<br>○ Don't know | The COVID-19 pandemic has infected 624 million people globally with nearly 6.5 million deaths as of Oct. 2022. CPR is one of the possible procedures leading to aerosol generation and is associated with a risk of transmission of infection to rescuers. Therefore, healthcare providers have been using personal protective equipment (PPE) including various types of gowns and masks. Several studies suggest that PPE might impair CPR performance and increase rescuer fatigue. However, other studies suggest that PPE including masks with and without valves do not impair the quality of CPR. In addition, masks were found to cause rescuer's breathing discomfort, heat and humidity build-up. Other theoretical side effects include increased CO2 partial pressure and decreased oxygen levels in the blood due to rebreathing. | |

## Desirable Effects
How substantial are the desirable anticipated effects?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ Trivial<br>○ Small<br>● Moderate<br>○ Large<br>○ Varies<br>○ Don't know | Wearing PPE has a desirable effect on decreasing the possible transmission of infection from cardiac arrest patients. Studies report the transmission of diseases such as severe acute respiratory syndome (SARS) and middle east respiratory syndrome (MERS) during CPR. Therefore, international CPR guidelines recommend that providers should wear PPE when performing CPR.<br>However, wearing PPE does not improve the quality of CPR (17 studies) or increase the survival (1 studies) of cardiac arrest patients, though it may reduce transmission of infection from healthcare providers to vulnerable patients. Therefore, direct patient benefits are limited.<br><br>Among included studies, there was only 1 patient-centric outcomes such as survival. A retrospective study compared conventional PPE (before period, n=73) vs enhanced PPE (after period, n=57) including PAPR (powered air-purifying respirator) in emergency department setting (Ko 2021 1291). The use of enhanced PPE affected the performance of CPR to some extent but did not alter patient outcomes compared to the conventional PPE group. The rate of ROSC in the ED (49.3% vs. 43.8%; p = 0.597) and 1-month survival (8.2% vs. 3.5%; p = 0.465) were all lower in the enhanced PPE group, although the difference was not statistically significant. In multivariable logistic regression analyses, using enhanced PPE was not associated with the ROSC rate (OR = 0.79, 95% CI: 0.38–1.67; p = 0.542) or 1 month survival (OR = 0.38, 95% CI: 0.07–2.10; p = 0.266). | |

## Undesirable Effects
How substantial are the undesirable anticipated effects?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ Large<br>○ Moderate<br>● Small<br>○ Trivial<br>○ Varies<br>○ Don't know | Wearing PPE may increase rescuer fatigue, which could theoretically influence CPR quality and patient outcomes. The Borg score (a measure of fatigue) after 2- min of chest compressions was significantly higher in the N95-mask group than in the surgical mask group (16 vs. 14, p = 0.027; Tian 2021 434). However, the pooled effect did not show any significant difference in CPR quality between PPE vs no PPE. Very low-quality evidence from 2 observational simulation studies showed significantly higher fatigue (VAS score) in the PPE group. All studies varied substantially in the procedures used, including the type of PPE used, the design of simulated scenarios, the duration of CPR performed, and the measures of CPR quality used. | |

## Certainty of evidence
What is the overall certainty of the evidence of effects?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|

● Very low
○ Low
○ Moderate
○ High
○ No included studies

All included studies examining CPR quality provide indirect evidence as they are manikin simulation studies. However, among 9 outcomes (6 from RCT, 3 from observational study), 7 outcomes assessed have very low and 2 outcomes assessed to low certainty of evidence.

| Outcomes | Anticipated absolute effects* (95% CI) | | Relative effect (95% CI) | № of participants (studies) | Certainty of the evidence (GRADE) | Comments |
|---|---|---|---|---|---|---|
| | Risk with CPR by rescuers not wearing PPE | Risk with CPR by rescuers wearing PPE | | | | |
| compression depth (comp depth) assessed with: mm | The mean compression depth was **0** mm | MD **1.75 mm lower** (4.31 lower to 0.81 higher) | - | 356 (5 RCTs) | ⨁◯◯◯ Very low [a,b,c,d] | |
| compression rate (rate) assessed with: /min | The mean compression rate was **0** /min | MD **1.03 /min lower** (5.79 lower to 3.72 higher) | - | 356 (5 RCTs) | ⨁◯◯◯ Very low [a,b,c,d] | |
| target depth assessed with: % | The mean target depth was **0** % | MD **6.54 % lower** (25.29 lower to 12.21 higher) | - | 228 (4 RCTs) | ⨁◯◯◯ Very low [a,b,c,e] | |
| target rate assessed with: % | The mean target rate was **0** % | MD **3.67 % lower** (18.26 lower to 10.91 higher) | - | 160 (3 RCTs) | ⨁◯◯◯ Very low [a,b,c,e] | |
| hands-off time assessed with: sec | The mean hands-off time was **0** sec | MD **5.06 sec higher** (1.69 lower to 11.81 higher) | - | 80 (2 RCTs) | ⨁◯◯◯ Very low [a,b,c,e] | |
| target release assessed with: % | The mean target release was **0** % | MD **4.3 % higher** (0.83 higher to 7.78 higher) | - | 116 (2 RCTs) | ⨁◯◯◯ Very low [a,b,c,e] | |
| compression depth assessed with: mm | The mean compression depth was **0** mm | MD **4.43 mm lower** (8.9 lower to 0.04 higher) | - | 504 (4 observational studies) | ⨁◯◯◯ Very low [a,f,g,h] | |
| compression rate assessed with: /min | The mean compression rate was **0** /min | MD **2.35 /min lower** (5.88 lower to 1.18 higher) | - | 504 (4 observational studies) | ⨁◯◯◯ Very low [a,f,g] | |
| fatigue assessed with: VAS (10 points) | The mean fatigue was **0** | MD **2.68 higher** (1.38 higher to 3.97 higher) | - | 248 (2 observational studies) | ⨁◯◯◯ Very low [a,f,g] | |

a. manikin simulation studies
b. incomplete outcome data
c. possible selective reporting
d. insufficient sample
e. random sequence generating and allocation concealment
f. confounding bias
g. Bias in classification of interventions
h. 2 studies favor no PPE, while 2 studies non-significant

## Values

Is there important uncertainty about or variability in how much people value the main outcomes?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ Important uncertainty or variability<br>● Possibly important uncertainty or variability<br>○ Probably no important uncertainty or variability<br>○ No important uncertainty or variability | Main patient outcome was survival, and neurologically intact survival. Core outcome set for cardiac arrest (COSCA) has confirmed importance of these outcomes to patients. High quality CPR is vital to survival. | |

## Balance of effects

Does the balance between desirable and undesirable effects favor the intervention or the comparison?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ Favors the comparison<br>○ Probably favors the comparison<br>○ Does not favor either the intervention or the comparison<br>● Probably favors the intervention<br>○ Favors the intervention<br>○ Varies<br>○ Don't know | In terms of survival or CPR quality (outcomes of this PICO), wearing PPE has a moderate desirable effect and a small undesirable effect. PPE is recommended to protect healthcare providers from the transmission when performing CPR in patients with suspected infection. Combining the available evidence, PPE does not significantly affect the quality of CPR, but increases the fatigue of rescuers. Therefore, if an infection is suspected or uncertain, PPE should be worn as indicated. There is a possibility of early fatigue, so replacing the rescuer at an appropriate time is recommended. | |

## Resources required

How large are the resource requirements (costs)?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ Large costs<br>○ Moderate costs<br>○ Negligible costs and savings<br>○ Moderate savings<br>○ Large savings<br>● Varies<br>○ Don't know | The cost for PPE may vary in terms of PPE type from simple mask to PAPR, and on the location where CPR is performed. | |

## Certainty of evidence of required resources

What is the certainty of the evidence of resource requirements (costs)?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ Very low<br>○ Low<br>○ Moderate<br>○ High<br>● No included studies | There were no studies identified describing the resource and economic impact of using PPE especially in the cardiac arrest setting. | |

## Cost effectiveness

Does the cost-effectiveness of the intervention favor the intervention or the comparison?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ Favors the comparison<br>○ Probably favors the comparison<br>○ Does not favor either the intervention or the comparison<br>● Probably favors the intervention<br>○ Favors the intervention<br>○ Varies<br>○ No included studies | A study from Kenya indicated that investing in adequate PPE to protect all healthcare workers would result in a 10-fold cost return and prevent over 70% of infections among HCWs. An extra investment of USD 1.56 million will be required to achieve the reduced number of HCW cases and deaths under the adequate PPE scenario. With this investment, an average of 30,041 healthcare worker cases and 416 healthcare worker deaths will be averted. Overall, the return on investment (ROI) from productivity gains is estimated to be USD 170.64 million, translating into a 11.04 times ROI (Kazungu 2021 992). However, the cost-effectiveness may vary according to the country. | |

## Equity

What would be the impact on health equity?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ Reduced<br>○ Probably reduced<br>○ Probably no impact<br>○ Probably increased<br>○ Increased<br>○ Varies<br>● Don't know | There were no studies identified describing the health equity of using PPE especially in the cardiac arrest setting. | |

## Acceptability

Is the intervention acceptable to key stakeholders?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|

| | |
|---|---|
| ○ No<br>○ Probably no<br>○ Probably yes<br>● Yes<br>○ Varies<br>○ Don't know | Wearing various levels of PPE is being implemented in most countries during the global COVID-19 pandemic. |

## Feasibility

Is the intervention feasible to implement?

| JUDGEMENT | RESEARCH EVIDENCE | ADDITIONAL CONSIDERATIONS |
|---|---|---|
| ○ No<br>○ Probably no<br>○ Probably yes<br>● Yes<br>○ Varies<br>○ Don't know | Wearing various levels of PPE is being implemented in most countries during the global COVID-19 pandemic. | |

# SUMMARY OF JUDGEMENTS

| | JUDGEMENT | | | | | | |
|---|---|---|---|---|---|---|---|
| **PROBLEM** | No | Probably no | Probably yes | **Yes** | | Varies | Don't know |
| **DESIRABLE EFFECTS** | Trivial | Small | **Moderate** | Large | | Varies | Don't know |
| **UNDESIRABLE EFFECTS** | Large | Moderate | **Small** | Trivial | | Varies | Don't know |
| **CERTAINTY OF EVIDENCE** | **Very low** | Low | Moderate | High | | | No included studies |
| **VALUES** | Important uncertainty or variability | **Possibly important uncertainty or variability** | Probably no important uncertainty or variability | No important uncertainty or variability | | | |
| **BALANCE OF EFFECTS** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | **Probably favors the intervention** | Favors the intervention | Varies | Don't know |
| **RESOURCES REQUIRED** | Large costs | Moderate costs | Negligible costs and savings | Moderate savings | Large savings | **Varies** | Don't know |
| **CERTAINTY OF EVIDENCE OF REQUIRED RESOURCES** | Very low | Low | Moderate | High | | | **No included studies** |
| **COST EFFECTIVENESS** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | **Probably favors the intervention** | Favors the intervention | Varies | No included studies |
| **EQUITY** | Reduced | Probably reduced | Probably no impact | Probably increased | Increased | Varies | **Don't know** |
| **ACCEPTABILITY** | No | Probably no | Probably yes | **Yes** | | Varies | Don't know |
| **FEASIBILITY** | No | Probably no | Probably yes | **Yes** | | Varies | Don't know |

# TYPE OF RECOMMENDATION

| Strong recommendation against the intervention | Conditional recommendation against the intervention | Conditional recommendation for either the intervention or the comparison | **Conditional recommendation for the intervention** | Strong recommendation for the intervention |
|---|---|---|---|---|
| ○ | ○ | ○ | ● | ○ |

# CONCLUSIONS

## Recommendation

We suggest monitoring the fatigue of rescuers when performing CPR while wearing PPE (Weak recommendation, Very low certainty of evidence).

## Justification

In making this treatment recommendation, we put a high value on protecting healthcare providers from potential infection transmission and consistency with current recommendations on the use of PPE. Although studies indicate an increased incidence of rescuer fatigue with CPR while wearing PPE, there was no effect on CPR quality. Furthermore, there was a lack of clinical studies examining the impact of PPE on patient outcomes. The Task Force considered a treatment recommendation that included an option to shorten CPR cycles while wearing PPE; however, we decided against this as there was no evidence that PPE influenced CPR quality. A shorter CPR cycle may also increase hands-off-chest time. A recent systematic review (BLS #346: Timing of CPR cycles) also suggested against pausing chest compressions at intervals other than every two minutes to assess the cardiac rhythm.
The studies included in this review were predominately simulation manikin-based studies and varied significantly in the procedures used, including the type of PPE, the design of simulated scenarios, the duration of CPR performed, and the measures of CPR quality used. As such, results should be interpreted carefully and may not be generalisable to clinical setting.

## Subgroup considerations

In this analysis, RCT and non-RCT were analyzed separately. If there are more studies in the future, subgroup analysis according to PPE level (level C or D), type of respirator (N95, PAPR), adult or children, and CPR time (prolonged or not) are necessary.

## Implementation considerations

Wearing PPE is already widely implemented in most countries during the global COVID-19 pandemic.

## Monitoring and evaluation

If PPE is worn during CPR, appropriate monitoring should be done to prevent deterioration of CPR quality due to rescuer fatigue.

## Research priorities

1. Clinical studies examining the effect of PPE on patient outcome
2. Clinical studies examining the effect of PPE on CPR quality
3. Examine the relationship between PPE use, CPR duration and rescuer fatigue.
4. Clinical studies should consider the best type of PPE or appropriate modification strategies to mitigate rescuer fatigue.

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## REFERENCES SUMMARY