

PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Training and education of healthcare workers during viral epidemics: A systematic review
AUTHORS	Nayahangan, Leizl Joy; Konge, Lars; Russell, Lene; Andersen, Steven

VERSION 1 – REVIEW

REVIEWER	Professor Jennifer Weller University of Auckland
REVIEW RETURNED	12-Sep-2020

GENERAL COMMENTS	<p>This is an important topic. The manuscript is well written. The systematic review is described in sufficient detail and follows appropriate steps.</p> <p>I wondered about the exclusion criteria - in particular: exclusion of descriptive studies which could have answered the first research question; exclusion of studies not published in English, considering that most of the reports up until Covid-19 would have concerned epidemics in non-English speaking nations; and finally the exclusion of studies that reported organisational outcomes, when this is considered a component of Kirkpatrick's Level 4 outcomes. I'd suggest better justification of the exclusion criteria and / or more explicit discussion in the limitations section.</p> <p>The authors don't report on the quality of the studies, despite reference to the poor quality of some of the studies in the discussion. I'd suggest the study quality is important and should be reported using an appropriate quality metric.</p> <p>Overall, I wasn't sure what the main messages were that could inform practice. Apart from identifying a dearth of experimental studies, it would be helpful to explicitly state what new knowledge or understanding has been added by this review.</p> <p>Perhaps something to consider is how to build evidence on educational interventions during a life-threatening epidemic or pandemic - can we use the usual evaluative research methods, or is something else required?</p> <p>Another thing to consider is the timing of interventions - it would seem sensible to use times between epidemics to test interventions - was this reported in the included studies? Perhaps that could be a recommendation.</p> <p>Specific comments 5/28 suggest reword 'were called on duty' 9/12 - Typo 'three hundred four' , missing 'and' 9/36 - the statement 'only six were studies were randomised controlled trials - this language suggests that RCTs were the best option for the evaluations. As above, it would be useful to understand more about how RCTs can be conducted during a</p>
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	<p>national health crisis, if indeed that was when they were conducted.</p> <p>10/18 - this is an interesting point - the difficulty in putting into place PPE skills learnt during a course when faced with the clinical reality is really important - others have described cognitive overload when trying to manage PPE and aerosol precautions at the same time as managing a difficult clinical situation - perhaps this is where we should be focussing some attention? Was there enough data in the studies to further explore this limitation?</p> <p>12/20 - "Change in organizational practice" is reported in one study - this seems inconsistent with the exclusion criteria (page 7 line 25) which explicitly excludes studies 'reporting on organizational outcomes.' Suggest clarification.</p> <p>The discussion is a somewhat generic overview of appropriate methods of education for clinical staff. It would be useful to explicitly say how this systematic review has added a better understanding of evidence-based interventions specific to epidemic or pandemic threats that threaten health care workers as well as patients.</p> <p>15 / 10 - a comparison of the percentage increases in knowledge between different interventions of different durations with different metrics doesn't seem plausible to me and it's not mentioned in the results. I'd suggest it's not comparing like with like and if study data are going to be compared this should be addressed in methods and results.</p> <p>16/4 - 'Implications and perspectives'</p> <p>Many of the recommendations or observations don't clearly relate to the results - e.g. 'implementation remains a challenge' - I may have missed it but I didn't see the challenges of implementation reported.</p> <p>16/39 - the statement that 'none any [sic] of of the interventions included in the review has followed a structured model for curriculum development nor has undergone rigorous evaluation' suggest the studies were evaluated for quality but this isn't reported in the methods or results - please clarify.</p> <p>16/47 a recommendation for medical educators to share and publish their experience is at odds with the exclusion of descriptive studies in the review - there has been a vast outpouring of descriptive submissions in the form of letters to the editor in recent times.</p> <p>17/26 the claim that 'many of the included studies were not conducted to the highest standards and published in minor clinical journals' is not supported by the methods and results - this goes back to the need for a quality assessment of the studies. How did you decide a journal was 'minor'? Are you referring to journals published in the countries where the epidemics were occurring? I'd propose that a study should be evaluated on its merit, not on the journal where it was published.</p> <p>The conclusion doesn't really follow from the results. A'scattered focus' seems pejorative - who's to say the studies weren't completely apt for the context in which they were used. The call for standardized training is not supported by the study data. It may be a good idea - were there common elements from the studies that could usefully be synthesised into a standardised approach?</p>
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REVIEWER	Olushayo Oluseun Olu World Health Organization Juba, South Sudan
REVIEW RETURNED	19-Sep-2020

<p>GENERAL COMMENTS</p>	<p>General comments</p> <p>In general, this is a well-researched and written manuscript on a very important topic. Training and equipping of healthcare workers on viral diseases is very critical in preventing nosocomial infection, disability and death of healthcare workers thus contributing to health system resilience. I do believe that if published, this paper will contribute significantly to the body of knowledge on the management of viral disease outbreaks such as the ongoing COVID-19 pandemic. However, the authors are encouraged to do more work to improve the quality of the manuscript particularly the introduction and discussion sections. While the language of the document is generally good, the authors are advised to pay attention to minor typographical and grammatical errors (for instance lines 7 and 35 of page 4). In view of the foregoing, please find below some specific comments which could help you to improve your manuscript.</p> <p>Specific comments</p> <p>Title</p> <p>While this title is good, the authors could further improve it to reflect the key findings of their study. For instance, you had concluded that the reviewed studies consistently showed positive benefits (see lines 47-50 of page 14); thus, you could rephrase your title as follow:</p> <p>“Training and educational interventions during viral epidemics have positive effects on health workers confidence and knowledge: A systematic review”</p> <p>Abstract</p> <p>This section is well written and can be understood as a standalone document</p> <p>Introduction</p> <ul style="list-style-type: none"> • While this section appears to be well written, there is inadequate information on the background and justification for this study. I would therefore advise that you beef up and reorganize the section as follow: <ul style="list-style-type: none"> o Paragraph 1: The emerging viral diseases and their impact on the health system and its resilience. A brief description of the impact of these diseases on the building blocks of the health system particularly human resources for health would be useful in building a strong justification for your study. o Paragraph 2: Why is the training of health workers on viral diseases important? For instance, to improve knowledge and skills of healthcare workers on how to better manage patients for better clinical outcomes and to protect themselves from nosocomial infections (which is usually a major cause of morbidity, mortality, disability and psychological stress). This would ensure better public outcomes during outbreaks of viral diseases o Paragraph 3: What are the justifications for this study? What are the knowledge gaps on the training of healthcare workers on viral diseases that this study seeks to address? A brief review of literature would help the authors to identify these gaps which would then be used to strengthen the justification for their study. This would also help the authors to better define their study objectives and research questions.
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	<ul style="list-style-type: none"> • Please define a clear objective(s) for your study; in other words what would answering your research questions lead to? <p>Methods The study methodology used (PRISMA) is well recognized and this section is well written. However, why did you exclude studies reporting on organizational outcomes? I do believe that this would have been a vital inclusion criterion which would help you to further understand the impact of educational interventions on public health outcomes during viral disease outbreaks</p> <p>Results This is very well grouped and presented</p> <p>Discussions Although this section has most of the required elements, the authors would need to do more to improve its quality. The authors are advised to focus on discussing and rationalizing their findings rather than repeating the results here. For instance, while you have presented “competency category” and in the results, this was not adequately discussed in this section. Please see specific areas of improvement below:</p> <ul style="list-style-type: none"> • Line 13-37 of page 12: These sound more like results and should be deleted or reorganized to discuss and rationalize the findings on the target population and educational content of the studies. For instance, what are the educational needs of healthcare workers in the management of viral diseases? Do the educational contents of the studies reviewed adequately address the needs of the healthcare workers? Do the studies cover all categories of healthcare workers who are involved in the management of viral diseases? What are the gaps and required actions in this regard? • Line 37-55 of page 13: which of these methods are more effective based on the findings of your systematic review? • Line 18-20 of page 14: I do believe that in addition to training objectives and evaluation, delivery method could also influence the training outcome, what was the experience in this study? • Line 29-35 of page 14: what are the specific recommendations on how to improve evaluation of the impact of training on clinical practice in the future? • Line 35-44 of page 14: Why is this unsurprising? Please elaborate the reasons in your manuscript • Line 1 to 59 of page 15: This sounds more like conclusions; I would therefore suggest that you merge with the conclusion section. <p>Based on the foregoing, I would suggest that you reorganize this section as follow:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Paragraph 1: a very brief statement of the main objectives, research question and key findings of your systematic review and a summary statement on whether the research questions have been answered or not? <input type="checkbox"/> Paragraphs 2-4: exhaustive discussion and rationalization of the key findings of the study as presented in your results section i.e. study characteristics, educational content and competency category, training delivery and effects and level of educational outcome. Which factors could have been responsible for the observed trends? What were the findings of other similar studies?
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	<p>Are they comparable to your findings? What are the policy implications of your findings?</p> <p><input type="checkbox"/> Paragraph 5: study limitations</p> <p>Conclusions Please merge this section with the section on “implication and perspective”. The new section should then come after the study limitation and should be divided into two subsections namely 1. Conclusions and 2. Recommendations</p>
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REVIEWER	Edson Martinez University of Sao Paulo, Brazil
REVIEW RETURNED	05-Dec-2020

GENERAL COMMENTS	<p>The authors provide a well written and comprehensive review about training and education of healthcare workers during viral epidemics. To achieve this goal, the authors used standard methods in systematic reviews. This review study was performed in accordance to PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses. All items on the checklist have been executed where applicable. I have a few minor comment for the attention of the authors. In page 9 authors state that "Heterogeneity of the included studies precluded metanalysis". It is important to provide more details on the inadequacy of the data for a meta-analysis, including a brief description of the discrepancies between the studies and potential sources of heterogeneity. Perhaps this can be included in the discussion section.</p>
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VERSION 1 – AUTHOR RESPONSE

Reviewer: 1

Comments to the Author

This is an important topic. The manuscript is well written. The systematic review is described in sufficient detail and follows appropriate steps.

R1. We thank the reviewer for the commendation and for recognising the importance of this study.

I wondered about the exclusion criteria - in particular: exclusion of descriptive studies which could have answered the first research question; exclusion of studies not published in English, considering that most of the reports up until Covid-19 would have concerned epidemics in non-English speaking nations; and finally the exclusion of studies that reported organisational outcomes, when this is considered a component of Kirkpatrick's Level 4 outcomes. I'd suggest better justification of the exclusion criteria and / or more explicit discussion in the limitations section.

R1.1. This is an important comment regarding the exclusion criteria: we recognise that there might be non-English studies that could have helped answer our first research question (i.e. “What are the educational content and types of competencies being trained in relation to HCW as a result of a major viral epidemic”). We have included this in the limitations section:

“Another limitation is the exclusion of non-English language studies which could have helped answer the first research question given that most of the reports concerning viral epidemics come from non-English speaking nations.”

In regard to organisational outcomes, we did not convey this clearly in the manuscript. We only excluded studies that reported on changes in organisational systems or processes to mitigate a viral epidemic but not necessarily in relation to training nor any measures to evaluate the effect of training, which was our intention. Examples of this include establishing emergency health preparedness and response efforts to ensure readiness of response team, as well as using computer simulation to practice school closure strategies.

We have clarified this in the Study eligibility section that now reads:

“We considered all studies on educational or training interventions developed, evaluated and/or implemented in response to major global viral outbreaks transmitted via close person-to-person contact from 2000 to 2020: SARS, H1N1, MERS, EVD, and COVID-19. Inclusion criteria included studies reporting on development, implementation and evaluation of educational interventions for HCW while the exclusion criteria were studies that were not in English language, descriptive studies, and those reporting on organizational outcomes with no relevance to training nor any outcome measures to evaluate the effect of training (Table 1).”

The authors don't report on the quality of the studies, despite reference to the poor quality of some of the studies in the discussion. I'd suggest the study quality is important and should be reported using an appropriate quality metric.

R1.2. We have indeed performed a quality appraisal of the educational studies using a published tool. Nonetheless, we unfortunately did not signpost this clearly enough as an educational study quality assessment. The quality appraisal tool we used is a recently published structured and comprehensive criterion-based checklist by Meinema et al., which evaluates and scores educational interventions based on thorough descriptions provided in the different stages of program development- from preparation (learning needs and intervention development process) to Intervention (that includes theory, learning objectives, content, participants, context/settings, educational strategies, delivery, assessment etc) and Evaluation (includes planned and unplanned changes, and satisfaction). We have revised the Methods, Results and Discussion sections to exemplify on the quality appraisal performed. Please see below the changes:

Methods:

“The following details were extracted: general study information including study design; viral illness; target learner population and learner level; competency category; educational modality; description of intervention; description of educational outcomes; quality appraisal of the educational intervention in different stages (preparation, intervention and evaluation) based on a structured criterion-based checklist; and level of educational outcome based on Kirkpatrick's levels and education evidence.”

Results:

Please see Table S1. The ratings of the quality appraisal performed by the authors are included in Table S1 (Supplementary table) which presents the overview of the included educational interventional studies. The mean scores for each stage (preparation, intervention and evaluation) are presented under “Quality appraisal using the educational intervention checklist”.

Discussion:

“We recommend medical educators to share and publish their actual results or design of educational studies as additional resources in keeping with high standards and to collect evidence for their educational interventions. To ensure that key information are gathered and reported, the criterion-based checklist that was used in this study can guide the development and implementation of quality educational interventions”

Overall, I wasn't sure what the main messages were that could inform practice. Apart from identifying a dearth of experimental studies, it would be helpful to explicitly state what new knowledge or understanding has been added by this review. Perhaps something to consider is how to build evidence on educational interventions during a life-threatening epidemic or pandemic - can we use the usual evaluative research methods, or is something else required?

R1.3.

We appreciate the reviewer's comment and have further exemplified these findings in the discussion section of the revised manuscript so that the take home messages from this systematic review are clearer. As the reviewer has suggested, we considered looking into how to establish evidence during a life-threatening epidemic or pandemic, and we strongly recommend that as medical educators, we have the responsibilities to ensure that educational interventions and best practices are evidence-based before another pandemic happens. In the discussion, we have suggested the use of educational frameworks to guide the development of training programs such as Kern's six step approach to curriculum development. Furthermore, we have added a statement regarding appraisal of educational interventions by using a criterion-based checklist based on the comments (see our response in R1.2), as well as the following statement to the discussion:

"We recommend that educational interventional studies such as randomised controlled trials are performed before another pandemic happens in order to gather and establish evidence-based educational practices that will best equip and certify healthcare workers with the competences needed in the front lines."

Another thing to consider is the timing of interventions - it would seem sensible to use times between epidemics to test interventions - was this reported in the included studies? Perhaps that could be a recommendation.

R1.4. We agree with the reviewer that it is not optimal to gather evidence for educational interventions during an outbreak when the life of patients is at stake. We therefore strongly recommend that such educational interventional studies are performed before an epidemic outbreak happens. It will also be relevant to establish these as regular courses for healthcare workers and establish certification initiatives to ensure that front liners are competent and well-equipped at all times. We have also elaborated in response to R1.3.

Specific comments

5/28 suggest reword 'were called on duty'

9/12 - Typo 'three hundred four' , missing 'and'

R1.5. Thank you - these have now been changed.

9/36 - the statement 'only six were studies were randomised controlled trials - this language suggests that RCTs were the best option for the evaluations. As above, it would be useful to understand more about how RCTs can be conducted during a national health crisis, if indeed that was when they were conducted.

R1.6. We agree that whether RCT is the appropriate method depends on the study aim. We have revised this sentence and also expanded on how RCTs can be conducted during national health crises (also following suggestions in R1.3)

10/18 - this is an interesting point - the difficulty in putting into place PPE skills learnt during a course when faced with the clinical reality is really important - others have described cognitive overload when trying to manage PPE and aerosol precautions at the same time as managing a difficult clinical situation - perhaps this is where we should be focussing some attention? Was there enough data in the studies to further explore this limitation?

R1.7. Thank you for this interesting point. We agree with the reviewer that many studies are now focused not only on how to put on and take off PPEs but also how to maintain the integrity of the PPE and reduce the risk of self-contamination during this difficult situation (see p. 9, lines 6-8 in revised manuscript). It would indeed be very interesting to explore this further, however, this is beyond the scope of this systematic review which aimed to provide an overview of educational interventions including their effects and not solely focus on one type of content/intervention.

12/20 - 'Change in organizational practice' is reported in one study - this seems inconsistent with the exclusion criteria (page 7 line 25) which explicitly excludes studies 'reporting on organizational outcomes.' Suggest clarification.

R1.8. We have clarified how organisational outcomes were considered in the Study Eligibility (see R1.1.), which we hope makes sense in relation to our research questions

The discussion is a somewhat generic overview of appropriate methods of education for clinical staff. It would be useful to explicitly say how this systematic review has added a better understanding of evidence-based interventions specific to epidemic or pandemic threats that threaten health care workers as well as patients.

R1.9. The primary aims of this systematic review were to explore training and education during viral epidemics and provide an overview of the evidence for these studies, as well as the effects of these interventions to prepare healthcare workers. Secondly, we aimed to find gaps in literature and provide suggestions and recommendations for further and future studies. We agree with the reviewer that there is a need to better understand how training interventions- when developed systematically- are able to aid and equip healthcare workers in the midst of a viral epidemic. We have added these as recommendations in the revised manuscript- please refer to our answers above in R1.2 and R1.3.

15 / 10 - a comparison of the percentage increases in knowledge between different interventions of different durations with different metrics doesn't seem plausible to me and it's not mentioned in the results. I'd suggest it's not comparing like with like and if study data are going to be compared this should be addressed in methods and results.

R1.10. We completely agree with the that we cannot compare “like with like”, nor “apples versus oranges” and this was exactly our point with this sentence in the discussion - to illustrate the difficulty to compare training interventions based on specific parameters such as time or length of training, which highlights that it is not plausible to provide recommendations based on reported effects. The two interventions are perfect examples, where the length of time (3-days versus 3-hours) does not necessarily lead to optimal outcomes. To provide clarity to this statement, this now reads as:

“Interestingly, duration of the training intervention did not seem to correlate with the relative effect on the educational outcome: for example, a 3-day workshop on EVD management resulted in an increase of correctly answered questions from a pre-workshop median of 7 to a post-workshop median of 9 (~29% increase); whereas a 3-hr training session on EVD awareness demonstrated an improvement in knowledge from the mean baseline score of 3.93 to a mean score of 13.18 after intervention (~235% increase).”

16/4 - 'Implications and perspectives'

Many of the recommendations or observations don't clearly relate to the results - e.g. 'implementation remains a challenge' - I may have missed it but I didn't see the challenges of implementation reported.

R1.11. We thank the reviewer for this observation. We have now revised this statement:

“The current pandemic has highlighted that despite many relevant training interventions already developed, these seem to not have been widely adapted or implemented.”

16/39 - the statement that 'not any [sic] of the interventions included in the review has followed a structured model for curriculum development nor has undergone rigorous evaluation' suggest the studies were evaluated for quality but this isn't reported in the methods or results - please clarify.

R1.12. We hope that our explanation and the clarification we provided above regarding quality appraisal explains this statement better- please see R1.2.

16/47 a recommendation for medical educators to share and publish their experience is at odds with the exclusion of descriptive studies in the review - there has been a vast outpouring of descriptive submissions in the form of letters to the editor in recent times.

R1.13. We agree with the reviewer regarding this statement. The numbers of letters to the editor, and descriptive submissions increased in the last few months in light of the recent pandemic, with little addition to the evidence-base of training interventions. We recognise this and have rephrased this statement so that it now reads:

“We recommend medical educators to share and publish their actual results or design of educational studies as additional resources in keeping with high standards and to collect evidence for their educational interventions”

17/26 the claim that 'many of the included studies were not conducted to the highest standards and published in minor clinical journals' is not supported by the methods and results - this goes back to the need for a quality assessment of the studies. How did you decide a journal was 'minor'? Are you referring to journals published in the countries where the epidemics were occurring? I'd propose that a study should be evaluated on its merit, not on the journal where it was published.

R1.14. This statement was based on the quality assessment (see R1.2). Nonetheless, we agree with the reviewer and have deleted this phrase to maintain the focus on the quality of the studies rather than journal of publication.

The conclusion doesn't really follow from the results. A 'scattered focus' seems pejorative - who's to say the studies weren't completely apt for the context in which they were used. The call for standardized training is not supported by the study data. It may be a good idea - were there common elements from the studies that could usefully be synthesised into a standardised approach?

R1.15. We thank the reviewer for this comment. Based on our findings, the educational content, training delivery and outcome measures vary in these studies, which make direct comparisons impossible (R1.10) and make specific recommendations difficult. We changed “standardised training”

to “evidence-based training” to further illuminate the need to perform studies in between epidemics or pandemics. Scattered focus is now changed to “a variety of studies”- this represents the characteristics of the included studies better. This now reads as:

“Published educational interventional studies in relation to training during viral epidemics demonstrate a variety of educational content, design, strategies and modes of delivery. Overall, the included studies consistently reported positive benefits of any structured training intervention including positive effects on confidence and knowledge. However, there are very few studies evaluating that these training efforts transfer into improved clinical performance and better patient outcomes. Development and implementation of evidence-based training programs that can be easily adapted locally are required for the medical community to be well-prepared for the next viral epidemic outbreak.”

Reviewer: 2

Comments to the Author

General comments

In general, this is a well-researched and written manuscript on a very important topic. Training and equipping of healthcare workers on viral diseases is very critical in preventing nosocomial infection, disability and death of healthcare workers thus contributing to health system resilience. I do believe that if published, this paper will contribute significantly to the body of knowledge on the management of viral disease outbreaks such as the ongoing COVID-19 pandemic. However, the authors are encouraged to do more work to improve the quality of the manuscript particularly the introduction and discussion sections.

We thank the reviewer for this comment and for stressing the importance of the study.

While the language of the document is generally good, the authors are advised to pay attention to minor typographical and grammatical errors (for instance lines 7 and 35 of page 4)-

R2.1 We have reviewed the text to catch minor typographical and grammatical errors to the best of our abilities. We also looked at the specific places suggested (page 4, lines 7 and 35) but we cannot pinpoint these in the version that we have, we therefore assume that these might refer to the following:

“Currently, the entire world is facing a pandemic with the novel coronavirus disease (COVID-19), a new and fast spreading viral agent that challenged and overwhelmed healthcare delivery and capacity as well as human resources.”

In view of the foregoing, please find below some specific comments which could help you to improve your manuscript.

Specific comments

Title

While this title is good, the authors could further improve it to reflect the key findings of their study. For instance, you had concluded that the reviewed studies consistently showed positive benefits (see lines 47-50 of page 14); thus, you could rephrase your title as follow:

“Training and educational interventions during viral epidemics have positive effects on health workers confidence and knowledge: A systematic review”

R2.2. We have considered the reviewers suggestion and discussed this in the author group but have decided to keep the original title of the manuscript as it provides a broad overview of the educational interventions and the effects on training. While some findings from this systematic review may be positive, we also found that some of the educational interventions were not at par to the highest standards and is therefore difficult to provide definite recommendations in the title.

Abstract

This section is well written and can be understood as a standalone document

R2.3. We thank the reviewer for the kind comment regarding the abstract. As suggested by the Editor, we have structured the abstract to follow the PRISMA guidelines and hope that the abstract remains clear and well-written.

Introduction

While this section appears to be well written, there is inadequate information on the background and justification for this study. I would therefore advise that you beef up and reorganize the section as follow:

R2.4. We have revised the introduction as suggested to provide adequate information and justification, however, we also had to be mindful of word count limitations and therefore made the paragraphs brief and, hopefully, concise.

Paragraph 1: The emerging viral diseases and their impact on the health system and its resilience. A brief description of the impact of these diseases on the building blocks of the health system particularly human resources for health would be useful in building a strong justification for your study.

R2.5. We have exemplified the impact of these viral epidemics on the healthcare system, in particular human resources where healthcare workers had to be re-assigned to infected patients and in order to provide the best care, they had to be trained in a haste to keep up with the increasing surge of cases. We have revised this section in the introduction so that it now reads:

“Currently, the entire world is facing a pandemic with the novel coronavirus disease (COVID-19), demonstrating how a new and fast spreading viral agent that can challenge and even overwhelm healthcare delivery and capacity as well as human resources.”

Paragraph 2: Why is the training of health workers on viral diseases important? For instance, to improve knowledge and skills of healthcare workers on how to better manage patients for better clinical outcomes and to protect themselves from nosocomial infections (which is usually a major cause of morbidity, mortality, disability and psychological stress). This would ensure better public outcomes during outbreaks of viral diseases

R2.6. We have now revised paragraph 2 as suggested by the reviewer to focus on the importance of training of healthcare workers to provide the best care for patients and at the same time protect themselves from nosocomial infections. This now reads as:

“Healthcare professionals from across different areas were called to help and needed to learn new procedures including correct use of personal protective equipment (PPE) and management of critically ill patients on ventilatory support.⁹ To ensure adequate resources and staffing, it was necessary to quickly train a large number of healthcare workers (HCW) to be on the frontlines. Ideally, training and education in preparation for a new infectious threat should be continuous and planned ahead of time. Specialized training equips healthcare workers with the knowledge and skills to safely provide patient care; to reduce fatalities during an outbreak; and to prevent and control nosocomial infections.”

Paragraph 3: What are the justifications for this study? What are the knowledge gaps on the training of healthcare workers on viral diseases that this study seeks to address? A brief review of literature would help the authors to identify these gaps which would then be used to strengthen the justification for their study. This would also help the authors to better define their study objectives and research questions.

R2.7. Thank you – we also revised paragraph 3 to reflect the reviewer’s suggestions. We hope the introduction reads better and provides adequate information leading to the aim of the study. This now reads as:

“The experiences learned from previous viral epidemics have helped some countries such as China and Saudi Arabia to deal with and respond to the current COVID-19 pandemic. However, this is not always the case: some countries that ranked high in the preparedness for pandemics assessed via the Global Health Security Index showed inconsistencies with their actual performance during the current COVID-19 pandemic. While there are key capacities that were considered in this performance assessment, the current pandemic has highlighted the need to increase the number of sufficiently trained healthcare workers. There remains an urgent need for best practices on development and implementation of training programs during an epidemic.”

•Please define a clear objective(s) for your study; in other words what would answering your research questions lead to?

R2.8. We have expanded the overall aim following the research questions. This section now reads:

“The overall aim of the study was to provide an overview of the published literature in relation to training and education of HCW during viral epidemics and to explore the educational content of these interventions and the level of competencies being trained. We also sought to present a status on the evidence of effects of these training interventions”

Methods

The study methodology used (PRISMA) is well recognized and this section is well written. However, why did you exclude studies reporting on organizational outcomes? I do believe that this would have been a vital inclusion criterion which would help you to further understand the impact of educational interventions on public health outcomes during viral disease outbreaks.

R2.9. Thank you to the reviewer for this important point. We have revised this section and provided a better definition of organisational outcomes. Please see our response to reviewer 1 in R1.3.

Results

This is very well grouped and presented

R2.10. Thank you.

Discussions

Although this section has most of the required elements, the authors would need to do more to improve its quality. The authors are advised to focus on discussing and rationalizing their findings rather than repeating the results here. For instance, while you have presented “competency category” and in the results, this was not adequately discussed in this section. Please see specific areas of improvement below:

•Line 13-37 of page 12: These sound more like results and should be deleted or reorganized to discuss and rationalize the findings on the target population and educational content of the studies. For instance, what are the educational needs of healthcare workers in the management of viral diseases? Do the educational contents of the studies reviewed adequately address the needs of the healthcare workers?

R2.11. We agree with the reviewer on this important point. As educators, we recognise the importance of performing a needs assessment to ensure that the education and training interventions are aligned to current needs. In this systematic review, we synthesized and summarised all training interventions that occurred in the last 20 years and found a variety of different training programs that arose to fast-train healthcare workers- an example of which is donning and doffing of personal protective equipment or PPEs. While it is also important to ensure that the educational content of training programs adequately address the needs of healthcare workers, it is not the scope of this study. In the current systematic review, we specifically aimed to focus on the effects of the training interventions.

As a side note, we have actually performed a needs assessment process to address this specific topic (i.e. identifying the needs of healthcare workers) in another study that is currently under review.

Do the studies cover all categories of healthcare workers who are involved in the management of viral diseases?

R2.12. We included studies that trained healthcare workers in the management of viral epidemics. These include doctors, nurses, lab technicians, anaesthesiologists, helicopter emergency crew, respiratory therapists and many more. These categories are summarised in the supplementary table (Table S1).

What are the gaps and required actions in this regard? Adapted to local context (check implications and perspective)

R2.13. Thank you - please see our response to reviewer 1, in R1.9, also referring to R1.2 and R1.3.

•Line 37-55 of page 13: which of these methods are more effective based on the findings of your systematic review?

R2.14. We found a variety of training interventions that were initiated during viral epidemics based on what is feasible (e.g. e-learning for wider dissemination) and what the immediate needs are in the local setting. All educational strategies seem to be effective in some way (i.e. anything is better than nothing), however, all three major strategies (traditional didactic, e-learning and simulation-based training) have merit depending on context and educational aim if they are used appropriately within a structured curriculum to achieve optimal learning experience.

•Line 18-20 of page 14: I do believe that in addition to training objectives and evaluation, delivery method could also influence the training outcome, what was the experience in this study?

R2.15. We absolutely agree with the reviewer that learning objectives must be well-defined and delivery methods carefully selected to achieve optimal training outcomes. We have explained this further in our response above, please see R2.14

•Line 29-35 of page 14: what are the specific recommendations on how to improve evaluation of the impact of training on clinical practice in the future?

R2.16. In this systematic review, we used Kirkpatrick's four-level training evaluation model and we recommend the use of this as a guide to set learning objectives and evaluate learning outcomes. The four levels start with:

Level 1- covering learners' views on the learning experience, its organisation, presentation, content, teaching methods, and aspects of the instructional organisation, materials, quality of instruction; Level 2a- Modification of attitudes/perceptions; Level 2b- Modification of knowledge/skills such as acquisition of concepts, procedures, problem-solving, psychomotor and social skills; Level 3- behavioural change by documenting the transfer of learning to the workplace; Level 4a- Organisational change and Level 4b- benefits to patients.

We reiterate in this systematic review the evaluation of the effect of an educational intervention based on Level 2b and above, to ensure the acquisition of knowledge and skills, how it is transferred to the workplace, how it impacts the organisation and ultimately how it benefits the patients.

•Line 35-44 of page 14: Why is this unsurprising? Please elaborate the reasons in your manuscript

R2.17. We refer this statement to the fact that "something is always better than nothing, or something plus something is better than something alone." Furthermore, self-assessment (i.e. confidence or satisfaction of a course) most often results in high scores which says very little about the actual performance or outcome. We have included the reference for this statement in the revised manuscript on lines 18-20, page 14.

•Line 1 to 59 of page 15: This sounds more like conclusions; I would therefore suggest that you merge with the conclusion section.

Based on the foregoing, I would suggest that you reorganize this section as follow:

♣Paragraph 1: a very brief statement of the main objectives, research question and key findings of your systematic review and a summary statement on whether the research questions have been answered or not?

♣Paragraphs 2-4: exhaustive discussion and rationalization of the key findings of the study as

presented in your results section i.e. study characteristics, educational content and competency category, training delivery and effects and level of educational outcome. Which factors could have been responsible for the observed trends? What were the findings of other similar studies? Are they comparable to your findings? What are the policy implications of your findings?

♣Paragraph 5: study limitations

Conclusions

Please merge this section with the section on “implication and perspective”. The new section should then come after the study limitation and should be divided into two subsections namely 1.

Conclusions and 2. Recommendations

R2.18. We appreciate the reviewer’s suggestion to merge implications and perspectives to the conclusion. From our data synthesis and the conclusion that the studies provided a varied overview of educational content, educational methodologies and evaluation strategies, we find it inexpedient to provide concrete recommendations i.e. what training is best. We have also clarified this further in response to Reviewer 1 in R1.10. In consequence, we would like to maintain the subheading “Implications and Perspectives”.

Reviewer: 3

Comments to the Author

The authors provide a well written and comprehensive review about training and education of healthcare workers during viral epidemics. To achieve this goal, the authors used standard methods in systematic reviews. This review study was performed in accordance to PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses. All items on the checklist have been executed where applicable. I have a few minor comments for the attention of the authors. In page 9 authors state that "Heterogeneity of the included studies precluded metanalysis". It is important to provide more details on the inadequacy of the data for a meta-analysis, including a brief description of the discrepancies between the studies and potential sources of heterogeneity. Perhaps this can be included in the discussion section.

We thank the reviewer for this comment. We decided a priori not to perform a meta-analysis based on our specific research questions and the expected diverse training interventions and outcomes in the included studies. The word “precluded” in the statement above as the reviewer pointed out, does not reflect this. We removed this statement and included the decision a priori in the methods section that now reads:

“It was decided a priori to forego meta-analyses because of our specific research questions and the expected variety of study population, interventions, context and educational outcomes.”

VERSION 2 – REVIEW

REVIEWER	Weller, Jennifer University of Auckland, Centre for Medical and health Sciences Education
REVIEW RETURNED	29-Jan-2021

GENERAL COMMENTS

The authors have done a good job at responding to my suggestions - a number of typos and grammatical errors have crept in which I have noted in in highlights and comments in the attached file.

The reviewer provided a marked copy with additional comments. Please contact the publisher for full details.