



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Enfermedades Infecciosas y Microbiología Clínica

www.elsevier.es/eimc



Original article

Can “YouTube” help healthcare workers for learning accurate donning and doffing of personal protective equipments?



Betul Kozanhan^{a,*}, Mahmut Sami Tutar^b, Derya Arslan^c

^a Department of Anaesthesiology and Reanimation, Konya Training and Research Hospital, University of Health Sciences Turkey, Konya, Turkey

^b Department of Anaesthesiology and Reanimation, Konya Numune State Hospital, Konya, Turkey

^c Department of Pediatric Cardiology, University of Health Sciences Turkey, Konya Training and Research Hospital, Konya, Turkey

ARTICLE INFO

Article history:

Received 20 September 2020

Accepted 14 November 2020

Keywords:

YouTube

Covid-19

Donning

Doffing

Personal protective equipments

ABSTRACT

Introduction: Healthcare workers have a high risk of cross-infection during the care of Covid-19 cases. Personal protective equipment can reduce the risk. However, healthcare workers must be trained for the proper use of personal protective equipment to decrease exposure risk. This study aimed to investigate whether videos available on YouTube, presenting procedures of donning and doffing personal protective equipment, can be a useful learning resource for healthcare workers.

Methods: A search of YouTube was conducted using the keywords “Covid-19, personal protective equipment, donning, doffing”. Two investigators reviewed each video and collected the basic video information. Total videos were assessed independently as educationally useful and non-useful categories using a valid tool. The relationship of each video’s usefulness with viewers’ preferences and the upload source were analyzed.

Results: A total of 300 videos were assessed; 66 (22%) fulfilled the inclusion criteria. Total video scores of educationally useful videos were higher than non-useful ones; the differences were significant. Healthcare/government agencies and hospitals mostly created educationally useful videos, e-learning platforms, and individuals mainly created non-useful videos. Significant correlations were observed between the video’s usefulness and the total view and views per day.

Conclusions: During a pandemic, YouTube might be a resource for learning donning and doffing of personal protective equipment for healthcare workers if an appropriate selection process applied for determining educationally useful videos.

© 2020 Sociedad Española de

Enfermedades Infecciosas y Microbiología Clínica. Published by Elsevier España, S.L.U. All rights reserved.

¿Puede «YouTube» ayudar a los trabajadores de la salud a aprender a ponerse y quitarse con precisión los equipos de protección personal?

RESUMEN

Introducción: Los trabajadores de la salud tienen un alto riesgo de infección cruzada durante la atención de los casos de COVID-19. El equipo de protección personal puede reducir el riesgo. Sin embargo, los trabajadores de la salud deben estar capacitados para el uso adecuado del equipo de protección personal para disminuir el riesgo de exposición. Este estudio tuvo como objetivo investigar si los videos disponibles en YouTube, que presentan procedimientos para ponerse y quitarse el equipo de protección personal, pueden ser un recurso de aprendizaje útil para los trabajadores de la salud.

Métodos: Se realizó una búsqueda en YouTube utilizando las palabras clave «COVID-19, equipo de protección personal, ponerse, quitarse». Dos investigadores revisaron cada video y recopilaron la información básica del mismo. Los videos totales se evaluaron de forma independiente como categorías educativas útiles y no útiles utilizando una herramienta válida. Se analizó la relación de la utilidad de cada video con las preferencias de los espectadores y la fuente de carga.

Palabras clave:

YouTube

COVID-19

Poner

Quitar

Equipos de protección personal

Abbreviations: HCW, healthcare workers; PPE, personal protective equipment; CDC, Centers for Disease Control and Prevention; WHO, World Health Organization.

* Corresponding author.

E-mail address: betulkozhanhan@gmail.com (B. Kozanhan).

<https://doi.org/10.1016/j.eimc.2020.11.023>

2529-993X/© 2020 Sociedad Española de Enfermedades Infecciosas y Microbiología Clínica. Published by Elsevier España, S.L.U. All rights reserved.

Resultados: Se evaluaron un total de 300 videos; 66 (22%) cumplieron los criterios de inclusión. Los puntajes totales de videos útiles para la educación fueron más altos que los no útiles; las diferencias fueron significativas. Las agencias de salud/gubernamentales y los hospitales en su mayoría crearon videos útiles para la educación, plataformas de aprendizaje electrónico y las personas crearon principalmente videos no útiles. Se observaron correlaciones significativas entre la utilidad del video, la vista total y las vistas por día.

Conclusiones: Durante una pandemia, YouTube podría ser un recurso para aprender a ponerse y quitarse el equipo de protección personal para los trabajadores de la salud si se aplica un proceso de selección apropiado para determinar videos útiles desde el punto de vista educativo.

© 2020 Sociedad Española de Enfermedades Infecciosas y Microbiología Clínica. Publicado por Elsevier España, S.L.U. Todos los derechos reservados.

Introduction

On March 11, 2020, the World Health Organization (WHO) declared the Covid-19, caused by SARS-CoV-2, a pandemic.¹ Since December 31, 2019, and as of Oct 30, 2020, 44 888 869 confirmed cases of Covid-19 have reported, including 1 178 475 deaths.² Given the threat of Covid-19, it is essential to emphasize the use of appropriate measures for infection control in healthcare settings. Covid-19 can cause transmission person-to-person through a cough or respiratory droplets, contact with bodily fluids, or contaminated surfaces.³ Health care workers (HCWs), especially those performing aerosol-generating procedures on known or suspected Covid-19 patients, face an increased risk for exposure to the virus.⁴ Centres for Disease Control and Prevention (CDC), WHO and European Centre for Disease Prevention and Control (ECDC) proposed infection control interventions combining universal source control, early identification, and isolation of patients with suspected diseases and environmental disinfection to reduce transmission of Covid-19.^{5–7} Also, current recommendations advise wearing appropriate levels of personal protective equipment (PPE) in health care environments to protecting staff and other patients from Covid-2019 cross-infection.^{5–8} However, HCWs should rigorously follow all procedures for putting on (donning) and safely removing (doffing) PPE according to the correct sequence to decrease exposure risk. During the severe acute respiratory syndrome (SARS) pandemic, some HCW infections probably occurred from the incorrect usage of PPE.⁹ Therefore, it is crucial to assure that all HCWs must be trained for the proper use of PPE during the care of Covid-19 cases.

Social media platforms like Facebook and Twitter are an emerging tool for health communication during past major outbreaks; therefore, the CDC and WHO have regularly posted content discoverable on the internet in Covid-19 pandemic.¹⁰ YouTube, the second most popular social media platform, presents many medical videos prepared for HCWs as an educational visual guide for different procedures.^{11,12} Online visual images can improve the effectiveness of health education materials.¹³ If the educational videos in youtube are well designed, scientifically correct content, adequately presented, and meet the students' learning needs may provide useful conceptual links between theory and practice. However, YouTube does not have strict regulations or standards concerning the educational aspects of the videos. Therefore a bothersome number of misleading information in health-related videos shared on YouTube could present a risk to healthcare professionals or their patients.¹⁴

There is a lack of data in the literature evaluating the videos on YouTube about proper donning and doffing PPE as a resource for learning for HCWs. The present study aimed to evaluate the basic components and the usefulness of YouTube of videos presenting donning and doffing PPE.

Methods

Searching YouTube

YouTube (<http://www.youtube.com>) searched for videos containing relevant information about donning and doffing PPE on 17 May 2020. "Covid-19, donning/doffing PPE" was used as the search term. It was shown that over 90% of Internet users click on the first three pages of the query results.¹⁵ Two anesthesiologists specialist using PPE in routine daily practice independently evaluated the 300 videos on the first fifteen pages. The videos achieved using a default setting on YouTube and results sorted according to most viewed. This search method has applied in several studies linked to the evaluation of the educational value of YouTube for medical literature.^{16–18} A total of 114,000 videos yielded as a result of the search.

The levels of PPE for protection changes with types of transmission and airborne precautions also cover droplet and contact transmission. Therefore we only included the videos explaining the level of PPE for airborne protection. Videos excluded if they were (1) published before 2020, (2) in a language other than English, (3) with nonmedical content, (4) including an advertisement and containing live-action footage with no education format. Duplicated and irrelevant videos also excluded.

Data collection

For each video, the following data were collected: total views, duration on YouTube (day), views per day, video length (second), a scoring system that viewers can assign to videos (number of likes and dislikes), and source of uploads. Video power index (VPI) was calculated to assess the popularity of videos.

$$\begin{aligned} \text{VPI} &= \text{like ratio} \times \text{view ratio}/100; \text{ with like ratio} \\ &= \text{like} \times 100/(\text{like} + \text{dislike}) \text{ and view ratio} \\ &= \text{number of views/days} \end{aligned}$$

Sources of video upload

Videos divided into five groups conforming to the source of loading: (Source 1) universities and institutes, (Source 2) public/government health institutions and associations (Source 3) hospitals and health care centres, (Source 4) digital learning platforms, health information websites, medical advertisement for-profit companies, and (Source 5) individuals.

Table 1
Criteria used in evaluating the videos.

<i>Major criteria</i>	
1	Contents about donning and doffing PPE are scientifically correct.
2	Images are clear.
3	The creator/organization is mentioned.
4	The topic is clearly presented.
5	Sounds are clear, and background is free from noise.
<i>Minor criteria</i>	
1	The video covers the topic identified in the title.
2	Designed at the level of undergraduate medical science students.
3	The time to download is reasonable.
4	Information about the creator is up-to-date.
5	The educational objectives are stated.
6	Demonstrating the donning/doffing PPE procedure on a human instead of illustration.

Video assessment for educationally usefulness

Videos were categorized as educationally useful and non-useful using a valid instrument based on educational principles, with some modification to match the study's needs, developed by Azer SA (Table 1).¹⁹ This instrument includes five major and six minor criteria and covered the following parameters; the accuracy of content, clarity of the message given, authority, pedagogy, educational basis, and technical design. Two points for major criteria and one point for minor criteria were given for each step covered in the video. If an item is completed, the allocated score is given; if not, zero is given. Educationally useful videos should score 13 or higher, fulfilling all of the major criteria and at least 3 of the minor criteria. This instrument has been tested in several studies that evaluate the usefulness of videos created for surface anatomy, respiratory, cardiovascular, and nervous systems examination on YouTube.^{14,19–21} Two investigators independently evaluated all the videos. Investigators blinded to each other's evaluations. When there was an event of a discrepancy, a third investigator appraisal inquired for the final decision.

Evaluating the content

To standardize the evaluation of each video's content and the donning and doffing PPE procedure, the investigators used the European Centre for Disease Prevention and Control Guidance as a reference to guide their assessment.⁸ The content item in the criteria contained the following for donning PPE; preparing for donning, washing hands accurately, wearing the gown and FFP2 or FFP3 mask, testing the fit of the mask, wearing eye protection, and gloves accurately. For the doffing of the PPE, the content item in the criteria was as follows; removing gloves, gowns and eye protection accurately, leaving to clean area, removing masks correctly, washing the hands in each step, and check for correct doffing order.

Statistical analysis

The Statistical Package for the Social Sciences version 22 software (SPSS, Chicago, IL, USA) was used for statistical analyses. Numerical variables were presented as means \pm standard deviations or median and interquartile range (IQR) values. The normal distribution of the data checked using the Shapiro–Wilk test. In the comparison of numerical variables, the Independent-Samples *T* test or Mann–Whitney *U* test applied. Categorical variables presented as number (*n*) and percentage (%). In the comparison of categorical variables, the Chi-square and Fisher's Exact tests used. The relationship between total video score and basic video characteristics were analyzed with Pearson and Spearman correlation. Inter-rater agreement was determined using Cohen's kappa score. A *p* value of 0.05 or less was considered to be significant.

Results

Using the search term of “Covid-19, donning/doffing PPE”, the first 300 most viewed videos on YouTube reviewed. A total of 234 videos excluded and 66 included in the study for further analysis (Fig. 1). Of the 66 videos presenting donning and doffing PPE, nine videos (13.6%) contained only wearing PPE, six (9.1%) videos showed only doffing PPE, and 51 (77.3%) videos demonstrated both of them (Fig. 1). Donning and doffing sections were evaluated and compared separately in the videos (Fig. 1). Table 2 summarizes the descriptive statistics of the educationally useful and non-useful videos for donning and doffing PPE.

The median total views of these videos were 1701 (range: 180–12 089). The median length of these videos was 244 s (range: 179–340). The average duration on Youtube videos was for 48 ± 15 days. The median views per day for a video was 41.91 (range: 4.02–282.83). The median number of video power Index for a video was 1213 (range: 200–6600). Total scores of educationally useful videos were 14.81 ± 0.68 and 14.85 ± 0.60 for donning and doffing PPE presentations. Compared to non-educationally useful videos, the differences were significant ($p < 0.001$ for both). Non-educationally useful videos failed to fulfil the two of the major criteria for both donning and doffing PPE. The assessment of the total video scores the kappa statistic for the inter-observer agreement was 0.901 (95% CI: 0.819–0.983) and 0.895 (95% CI: 0.872–0.918), for donning and doffing videos, respectively, showing a high inter-rater correlation between evaluators. While educationally useful videos were mostly designed by healthcare agencies/government agencies and hospitals, non-useful videos were mainly created by e-learning platforms and individuals (Table 3). When we compare the source of upload among educationally useful and non-useful videos, the differences were significant for both donning and doffing PPE videos ($p = 0.013$ and 0.010, respectively).

The correlations between, the total video scores and the total view and views per day were significant for both the donning PPE videos ($r = 0.401$, $p = 0.001$), ($r = 0.415$, $p = 0.001$) and the doffing PPE videos ($r = 0.415$, $p = 0.001$) ($r = 0.410$, $p = 0.002$). There were no significant correlation between the total video scores and VPI, video length and duration on YouTube (day) for both donning PPE videos ($r = 0.211$, $p = 0.106$) ($r = 0.092$, $p = 0.486$) ($r = -0.057$, $p = 0.663$) and doffing PPE videos ($r = 0.209$, $p = 0.118$) ($r = -0.046$, $p = 0.735$), ($r = -0.050$, $p = 0.711$).

A detailed content analyses of YouTube videos were shown in Figs. 2 and 3. The frequency of proper practices in all steps was higher in educationally useful videos for both groups. However, only the frequency preparing for donning PPE and correctly washing hands before donning PPE was statistically significantly higher in educationally useful videos when compared to non-useful ones ($p = 0.011$ and $p = 0.004$). The frequency of washing hands in each step was statistically higher in educationally useful videos when compared to non-useful ones for doffing PPE videos ($p = 0.005$).

Discussion

During coronavirus pandemics, commitment to social distance has produced the choosing and application of technologies in medical education, comprising social media platforms. The quick and easy access, lack of charge, and registration make YouTube videos an attractive learning tool for medical students and residents. In this study, we aimed to evaluate the basic characteristics of YouTube videos prepared for donning and doffing PPE and determine whether these were educationally useful for HCWs in their self-regulated learning. This research is the first in the literature examining this issue. Our results show that almost half of them

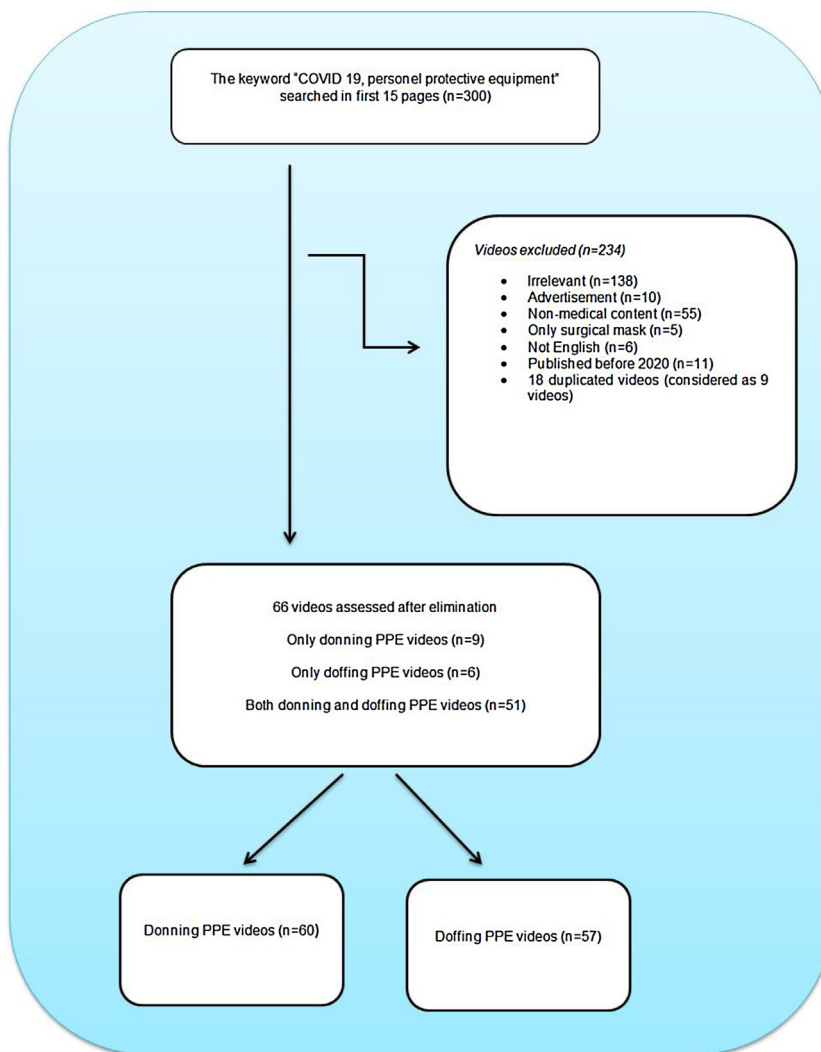


Fig. 1. Selection of eligible YouTube videos for the study.

Table 2
Analysis of basic videos characteristics and educational value of donning and doffing PPE videos.

	Number of videos n (%)	Total view	Video length, s	Duration on YouTube (day)	Views per day	VPI	Total video score
Donning PPE	60	1701 (183–10,938)	244 (171–345)	48 ± 14	41.91 (4.24–277.33)	1200 (200–6100)	12.07 ± 3.08
Educationally useful	27 (%45)	8563 (812–48,521)	270 (195–350)	47 ± 15	164.67 (19.80–808.68)	2200 (200–11990)	14.81 ± 0.68
Educationally not useful	33 (%55)	789 (132–3600)	200 (152–340)	49 ± 13	16.55 (2.75–77.97)	600 (200–3800)	9.82 ± 2.35
<i>p</i> value		0.003	0.126	0.621	0.002	0.101	<0.001
Doffing PPE	57	1840 (180–9589)	194 (129–312)	48 ± 14	42.92 (3.55–266.36)	1225 (200–5600)	12.28 ± 3.03
Educationally useful	27 (%47.4)	5400 (812–23,387)	210 (135–412)	47 ± 15	98.18 (19.63–427.24)	2200 (800–11990)	14.85 ± .60
Educationally not useful	30 (%52.6)	666 (92–3600)	173 (100–303)	49 ± 13	16.45 (1.90–77.97)	600 (200–3840)	9.97 ± 2.39
<i>p</i> value		0.006	0.250	0.573	0.004	0.081	<0.001

Variables were presented as mean ± standard deviation or median (Q1–Q3) or frequency (%), and *p* < 0.05 was expressed as bold point.

were useful for education. We also found that while universities, health care agencies/government agencies, and hospitals mostly created educationally useful videos, non-useful videos were mainly designed by e-learning platforms and individuals (Table 3).

Studies analyzing the educational value of medical YouTube videos generally focus on finding which video characteristics can be positively correlated with the video’s scientific accuracy. The most statistically analyzed parameters were reported as the number of

likes against the video scores and the source of loading against the video score.²² Although some studies have not found a significant relationship between usefulness and viewers’ responses other studies have shown that viewers prefer misleading videos.^{23–28} Azer SA reported that useful videos for learning surface anatomy have a higher view rate than non-useful ones.¹⁹ In this study, in line with Azer’s research, total views and views per day were significantly correlated with video usefulness. These results intend

Table 3
Sources of uploads among donning and doffing PPE videos.

	Source of uploads				
	University	National Health Agency	Hospital/Healthcare Centre	E-learning platform	Individuals
Donning PPE	10 (16.7%)	14 (23.3%)	13 (21.7%)	8 (13.3%)	15 (25.0%)
Educationally useful	5 (18.5%) ^{*,†}	9 (33.3%) [†]	8 (29.6%) [†]	4 (14.8%) ^{*,†}	1 (3.7%)*
Educationally not useful	5 (15.2%) ^{*,†}	5 (15.2%) [†]	5 (15.2%) [†]	4 (12.1%) ^{*,†}	14 (42.4%)*
<i>p</i> value			0.013		
Doffing PPE	10 (17.5%)	14 (24.6%)	10 (17.5%)	9 (15.8%)	14 (24.6%)
Educationally useful	5 (18.5%) ^{*,†}	10 (37.0%) [†]	6 (22.2%) [†]	5 (18.5%) ^{*,†}	1 (3.7%)*
Educationally not useful	5 (16.7%) ^{*,†}	4 (13.3%) [†]	4 (13.3%) [†]	4 (13.3%) ^{*,†}	13 (43.3%)*
<i>p</i> value			0.010		

Variables were presented as frequency (%), and $p < 0.05$ was expressed as bold point. Each superscript symbol (*,†) denotes a subset of source group categories whose column proportions do not differ significantly from each other at the 0.05 level.

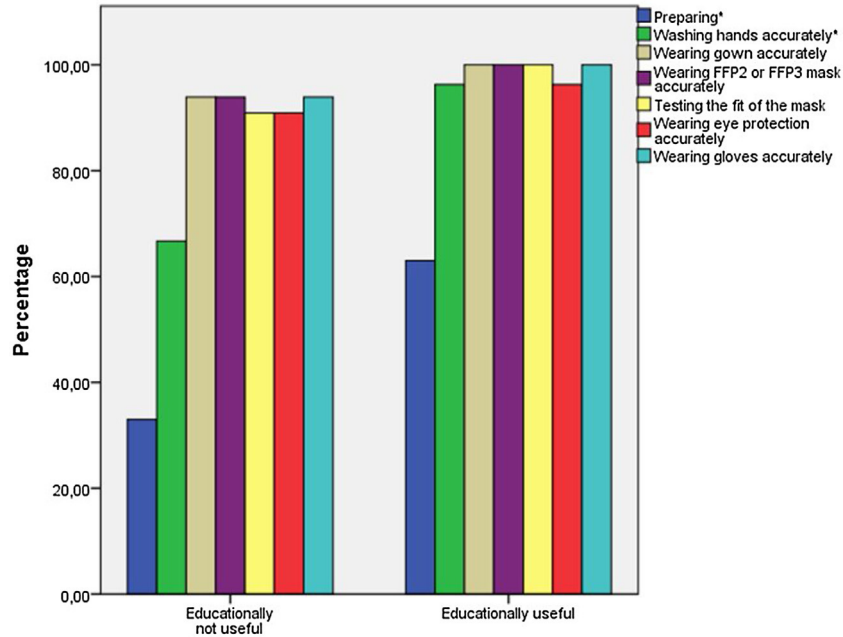


Fig. 2. Detailed content analyses of YouTube videos for donning PPE.

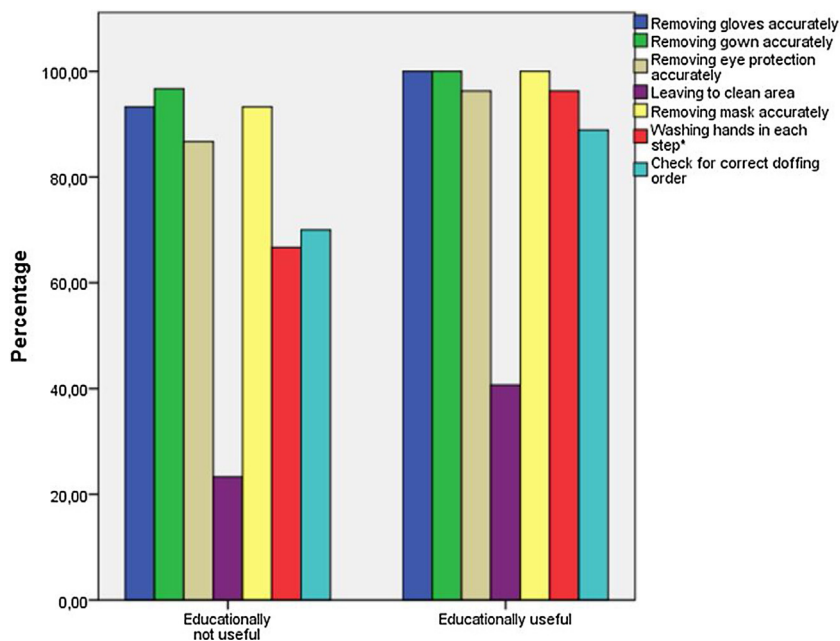


Fig. 3. Detailed content analyses of YouTube videos for doffing PPE.

that viewers are most likely watching videos with useful information about PPE donning and doffing. However, because viewers' video popularity index were similar between useful and non-useful groups, viewers were probably unlikely to notice the inaccurate content.

Covid-19 infections affected HCWs range from 11 to 29% among different countries.^{29–31} To prevent disease transmission in healthcare settings, donning and doffing procedures be performed by using a checklist for each step in a recommended sequence.⁸ Also, performing hand hygiene in each step is essential during doffing. We found that all recommended sequence steps were higher in educationally useful videos for donning PPE (Fig. 2). Also, "washing hands in each step" was statistically significantly higher in educationally useful videos than non-useful ones (Figs. 2 and 3). The risk of contamination HCWs may be reduced with an improvement in the competency of the staff's donning and doffing of PPE training.

During aerosol-generating procedures, there is an agreement among international organizations that N95, FFP2, or comparable standard respirators contribute better protection than surgical masks.^{5,32} However, all relevant staff members should undertake individual mask fit-testing to prevent the inhalation of small airborne particles before they contact patients. In the present study, useful videos showed a higher ratio for an accurate wearing technique for respirators than non-useful videos; however, this was not statistically significant.

Based on the findings obtained in this study, HCWs should use a preferred search strategy to find videos with the best and most comprehensive content. The videos created by public health institutions, hospitals, and universities tended to have a higher video score than videos uploaded by individuals. Also, these videos were more often classified as useful for education. Hence, HCWs can actively search for videos uploaded by such institutional resources. To find appropriate training videos for donning and doffing PPE on YouTube, first, HCWs should use a relevant keyword in the video selection, then identify the source of the video and the total view time criteria.

Limitations

This study has several limitations. First, this study shows a snapshot of only accessible information on YouTube during the beginning of the Covid-19 pandemic. However, as YouTube is a dynamic platform, the content may have changed over time as the outbreak has extended. Therefore, further research is needed to assess whether there is an increase in the quality and content of videos on YouTube in this regard. Second, the authors used an unvalidated but objective Covid-19 specific items based on international guidelines for evaluating the content of the videos. Finally, only-English-language videos were evaluated.

Conclusion

As a result, in this research, we found significant correlations in video usefulness and viewers' choices. YouTube can be used as a learning resource during the Covid-19 outbreak if applying an appropriate selection process. Reviewing the upload source and viewer responses can help to determine videos that are educationally useful for donning and doffing PPE procedures.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest

No potential conflict of interest was reported by the authors.

References

- World Health Organization. Pneumonia of unknown cause-China; 2020. Available from: <https://www.who.int/csr/don/05-january-2020-pneumonia-of-unknown-cause-china/en/> [cited at 30.05.20].
- World Health Organization. Weekly operational update on COVID-19: 30 October 2020. Situation report-61; 2020. Available from: <https://www.who.int/publications/m/item/weekly-operational-update-30-october-2020> [cited at 30.10.20].
- Chan JF-W, Yuan S, Kok K-H, Wang T K-K, Chu H, Yang J, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet*. 2020;395:514–23.
- Suárez-García I, de Aramayona López MM, Vicente AS, Abascal PL. SARS-CoV-2 infection among healthcare workers in a hospital in Madrid Spain. *J Hosp Infect*. 2020;106:357–63.
- Centers for Disease Control and Prevention. Interim infection prevention and control recommendations for patients with suspected or confirmed coronavirus disease 2019 (COVID-19) in healthcare settings; 2020. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html> [cited at 02.06.20].
- World Health Organization. Rational use of personal protective equipment for coronavirus disease (COVID-19): interim guidance; 2020. Available from: <https://apps.who.int/iris/handle/10665/331215> [cited at 30.05.20].
- European Centre for Disease Prevention and Control. Infection prevention and control and preparedness for COVID-19 in healthcare settings. Fifth update – 6 October; 2020. Available from: https://www.ecdc.europa.eu/sites/default/files/documents/Infection-prevention-and-control-in-healthcare-settings-COVID-19_5th.update.pdf [cited at 30.10.20].
- European Centre for Disease Prevention and Control. Guidance for wearing and removing personal protective equipment in healthcare settings for the care of patients with suspected or confirmed COVID-19; 2020. Available from: <https://www.ecdc.europa.eu/en/publications-data/guidance-wearing-and-removing-personal-protective-equipment-healthcare-settings> [cited at 28.05.20].
- Loeb M, McGeer A, Henry B, Ofner M, Rose D, Hlywka T, et al. SARS among critical care nurses Toronto. *Emerg Infect Dis*. 2004;10:251–5.
- Fung IC, Duke CH, Finch KC, Snook KR, Tseng PL, Hernandez AC, et al. Ebola virus disease and social media: a systematic review. *Am J Infect Control*. 2016;44:1660–71.
- Nason GJ, Kelly P, Kelly ME, Burke MJ, Aslam A, Giri SK, et al. YouTube as an educational tool regarding male urethral catheterization. *Scand J Urol*. 2015;49:189–92.
- Tackett S, Slinn K, Marshall T, Gaglani S, Waldman V, Desai R, et al. Medical education videos for the world: an analysis of viewing patterns for a YouTube channel. *Acad Med*. 2018;93:1150–6.
- Houts PS, Doak CC, Doak LG, Loscalzo MJ. The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. *Patient Educ Couns*. 2006;61:173–90.
- Azer SA, Algrain HA, AlKhelaif RA, AlEshaiwi SM. Evaluation of the educational value of YouTube videos about physical examination of the cardiovascular and respiratory systems. *J Med Internet Res*. 2013;15:e241.
- iProspect Search Engine User Behaviour Study. Available from: http://district4.extension.ifas.ufl.edu/Tech/TechPubs/WhitePaper_2006_SearchEngineUserBehavior.pdf.
- Rittberg R, Dissanayake T, Katz SJ. A qualitative analysis of methotrexate self-injection education videos on YouTube. *Clin Rheumatol*. 2016;35:1329–33.
- Singh AG, Singh S, Singh PP. YouTube for information on rheumatoid arthritis—a wakeup call? *J Rheumatol*. 2012;39:899–903.
- Wong K, Doong J, Trang T, Chien AL. YouTube videos on botulinum toxin A for wrinkles: a useful resource for patient education. *Dermatol Surg*. 2017;43:1466–73.
- Azer SA. Can "YouTube" help students in learning surface anatomy? *Surg Radiol Anat*. 2012;34:465–8.
- Azer SA, Aleshaiwi SM, Algrain HA, AlKhelaif RA. Nervous system examination on YouTube. *BMC Med Educ*. 2012;12:126.
- Azer SA. Understanding pharmacokinetics: are YouTube videos a useful learning resource? *Eur Rev Med Pharmacol Sci*. 2014;18:1957–67.
- Drozd B, Couvillon E, Suarez A. Medical YouTube videos and methods of evaluation: literature review. *JMIR Med Educ*. 2018;4:e3.
- Akgun T, Karabay CY, Kocabay G, Kalayci A, Oduncu V, Guler A, et al. Learning electrocardiogram on YouTube: how useful is it? *J Electrocardiol*. 2014;47:113–7.
- Sorensen JA, Pusz MD, Brietzke SE. YouTube as an information source for pediatric adenotonsillectomy and ear tube surgery. *Int J Pediatr Otorhinolaryngol*. 2014;78:65–70.
- Lee JS, Seo HS, Hong TH. YouTube as a potential training method for laparoscopic cholecystectomy. *Ann Surg Treat Res*. 2015;89:92–7.

26. MacLeod MG, Hoppe DJ, Simunovic N, Bhandari M, Philippon MJ, Ayeni OR. YouTube as an information source for femoroacetabular impingement: a systematic review of video content. *Arthroscopy*. 2015;31:136–42.
27. Kumar N, Pandey A, Venkatraman A, Garg N. Are video sharing web sites a useful source of information on hypertension? *J Am Soc Hypertens*. 2014;8:481–90.
28. Lee JS, Seo HS, Hong TH. YouTube as a source of patient information on gallstone disease. *World J Gastroenterol*. 2014;20:4066–70.
29. CDC COVID-19 Response Team. Preliminary estimates of the prevalence of selected underlying health conditions among patients with coronavirus disease 2019 — United States; 2020.
30. Folgueira MD, Munoz-Ruiperez C, Alonso-Lopez MA, Delgado R. SARS-CoV-2 infection in healthcare workers in a large public hospital in Madrid, Spain, during March; 2020, medRxiv. <https://doi.org/10.1101/2020.04.07.20055723>.
31. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan China. *JAMA*. 2020;323:1061–9.
32. Public Health Agency of Canada. Coronavirus disease (COVID-19): For health professionals; 2020. Available from: <https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals.html> [cited at 30/05/20].