YOUTUBE AS A SOURCE OF INFORMATION ON CARBON MONOXIDE POISONING: A CONTENT-QUALITY ANALYSIS

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Abstract

Objectives: The variety of clinical presentation on the topic of carbon monoxide (CO) intoxication ranges from slight headache to coma or death. YouTube allows patients to search not only for entertainment but also medical advice. Therefore, the aim of this study was to evaluate the content and quality of YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience. **Material and Methods:** On the December 8, 2020 a YouTube search was conducted for the following phrases: "carbon monoxide poisoning," "carbon monoxide symptoms," "CO poisoning," "carbon monoxide asphyxiation," "carbon monoxide intoxication" using the "incognito mode" and without attachment to Google Account. The search results were set as: "default" in the YouTube browser. The first 50 results were taken into consideration. Two raters, a specialist in emergency medicine and a specialist in clinical toxicology rated videos with Quality Criteria for Consumer Health Information (DISCERN), Global Quality Score (GQS) and *Journal of the American Medical Association* (JAMA). "VidIQ Vision for YouTube" plug-in was used. **Results:** Ninety-five videos were included. The interclass coefficient for DISCERN, GQS and JAMA scores were: 0.8, 0.74 and 0.62 reaching good and moderate reliability. The mean DISCERN/GQS/JAMA was 28.1 (SD 7.9), 2.5 (SD 0.8) and 1.1 (SD 0.7) respectively. Higher DISCERN/GQS/JAMA had videos providing information on: exposure time, treatment options, hyperbaric chamber indications as well as physician speaker ($p < 0.05$). Video Power Index was higher when the video contained animations and presented patients own history of CO exposure but not influenced the DISCERN/GQS/JAMA scores. Videos providing misleading information had a higher like ratio. **Conclusions:** The overall video quality was poor indicating inappropriate educational and informative value for patients who search information about carbon monoxide poisoning. Int J Occup Med Environ Health. 2022;35(3):285–95

INTRODUCTION

Created in 2005, YouTube (YT) (www.youtube.com; YouTube LLC, San Bruno, CA) is currently one of the most popular online video-sharing platforms in the world [1]. Primarily designed for entertainment, YT provides medical information on various medical topics, yet its credibility may appear controversial. As a consequence, the content and quality of information presented to the viewer was recently evaluated in various papers [2–6]. None of the articles did evaluate the topic of carbon monoxide (CO). Carbon monoxide is a colourless, odourless and tasteless gas, which causes an estimate of 50 000 intoxications and of 1000–2000 deaths in the US every year [7,8]. Malfunctioning indoor heating systems, indoor burning of charcoal or improperly located gasoline-powered generators can be the cause of CO production. Clinical spectrum is dependent on the carboxyhaemoglobin levels and varies from non-specific symptoms: fatigue, headaches, nausea to myocardial injury or encephalopathy.

The aim of this study was to evaluate the content and quality of YT videos concerning CO intoxication as a source of knowledge for non-medical audience.

MATERIAL AND METHODS

Search strategy

On the December 8, 2020 a YT search was conducted for the following phrases: "carbon monoxide poisoning," "carbon monoxide symptoms," "CO poisoning," "carbon monoxide asphyxiation," "carbon monoxide intoxication" with the use of "incognito mode" and no attachment to Google account. The search results were set as "default" in the YT browser. The first 50 search results were taken into consideration. Two raters, a specialist in emergency medicine and a specialist in clinical toxicology, rated videos with the Quality Criteria for Consumer Health Information (DISCERN), Global Quality Score (GQS) and *Journal of the American Medical Association*

(JAMA) scales. Medical information considered unproven, inaccurate or not evidence-based was considered misleading. The assessment was done independently by 2 authors with 5 years of experience in emergency medicine and 20 years in toxicology. If any disagreements between the authors occurred, the doubts were discussed in detail.

In order to investigate the quantitative information "VidIQ Vision for YouTube" plug-in was used.

The following data describing was gathered:

– audience engagement – total number of views, channel subscribers, average daily subscribers, average daily views, number of YT comments, YT likes and dislikes;

– Facebook data – reactions, comments, likes, shares;

– video statistics – channel tags and country of origin, duration (s), words/min, video description word count, referrers, upload date, video tags.

Video Power Index (VPI) and the YT "like ratio" were calculated as follows:

$$VPI = [(likes \times 100/(likes + dislikes)) \times (views/day)/100] \quad (1)$$

$$Like\ ratio = [(likes/likes + dislikes) \times 100] \quad (2)$$

Video substantive content was analysed for data: definition, clear information, epidemiology, CO formation, pathomechanism, symptoms, exposure time, first aid, diagnostics, relevance of time until treatment, treatment options, hospitalization indications, hyperbaric chamber indications, complications, delayed neuropsychiatric syndrome, results of treatment/prognosis, risk groups (pediatrics, elderly, pregnancy, heart disease, chronic obstructive pulmonary disease [COPD], etc.), management in pregnancy, speaker identity (physician or patient), safety methods, toxicology centre helplines, radiological findings, animations, actor scenes/flashbacks, diagrams.

Exclusion Criteria

Non-English videos, duplicates, videos lasting >1 h, multiple repetitions, accident reports, irrelevant videos (e.g., music videos) were excluded.

Additional video quality analysis

Three scoring systems, DISCERN, GQS and JAMA, were used for analysis.

The DISCERN scoring system consists of 16 questions in which 15 are for video quality assessment and the 16th is used for an overall quality of the rater. Questions are rated from 1 – when the quality criteria are unfulfilled to 5 – when entirely fulfilled [9]. Movies acquire 15–75 pts. Videos were classified "excellent" (63–75 pts), "good" (51–62 pts), "average" (39–50 pts), "poor" (28–38 pts) and "very poor" (<28 pts).

The GQS rates 1–5 (1 for "poor quality" to 5 for "excellent flow and quality") [10].

The JAMA score grants 1 pt for every feature: authorship, attribution, currency and disclosures [11].

Videos were divided according to the country of origin, upload time <5 or ≥5 years ago, <50 or ≥50 comments, <50 or ≥50 average daily views.

Uploaders were divided into 7 following categories: physician channel, hospital channel, safety educational channel, attorney channel, health related channel, TV programme fragments and other.

Statistical analysis and other calculations

Normality was verified with the use of the Lilliefors test and subsequently calculated according to the test results. Intraclass correlation coefficient (ICC) was used to compare differences between raters. PQStat v. 1.8.0 (PQStat Software, Poznań, Poland) was used for statistical analysis using Mann-Whitney U test and Spearman's rank correlation coefficient. Descriptive statistics consisted of arithmetic mean, median, range and standard deviation. Variables were compared. Google Sheets, Microsoft Excel and Microsoft PowerPoint were used for graphical visualisation. Statistical significance was $p < 0.05$.

RESULTS

There were 350 videos taken into consideration and 95 videos were included after removal of duplicates and irrelevant positions (Figure 1).

Health related channel group was the source of 30 videos. The following numerous group included TV programme fragments (N = 19). The amount of videos categorised as hospital channel and other was equal (N = 15). "Safety educational channel" provided 10 videos. Physician channel and attorney channel were responsible for the lowest number of movies (N = 3 for both). Figure 2 presents video uploader groups.

Video uploaders

Out of all groups the TV programme fragments had a statistically lower DISCERN score $p = 0.02$ in comparison with other video uploaders.

Video descriptive statistics

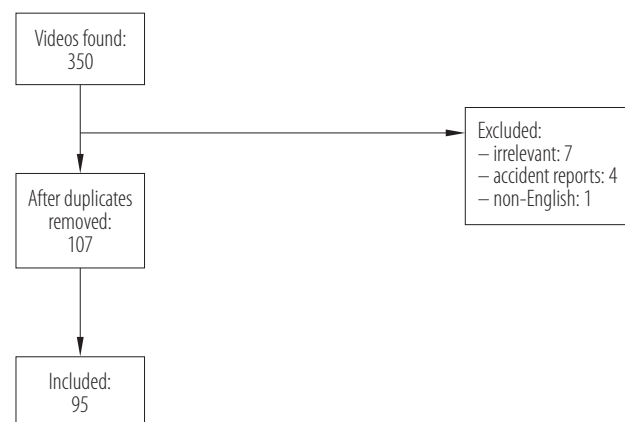The video descriptive statistics are presented in Table 1.

Figure 1. Video study inclusion in the study concerning CO poisoning as a source of knowledge for non-medical audience, the search conducted on December 8, 2020
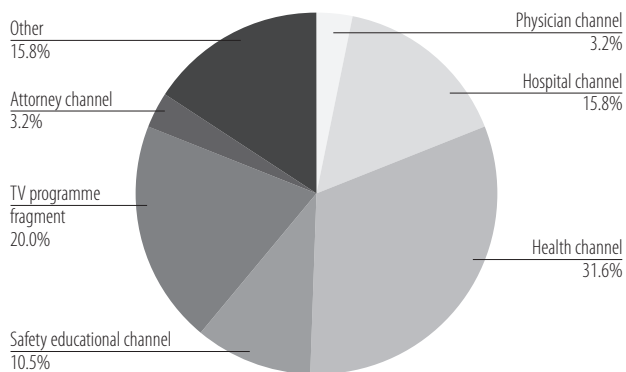
Figure 2. Source of upload of the video concerning CO poisoning, the search conducted on December 8, 2020

Video quality analysis

The majority of videos included the mechanism of CO formation (76%, N = 72). Symptoms were mentioned in 74% videos (N = 70). Definition of CO poisoning and clear information were present in 66% (N = 63). In 52% of videos, methods of preventing CO poisoning were described (N = 49). In 45% the speaker was a physician (N = 43). Pathomechanism description was presented in 41% (N = 39) while the epidemiology in 33% (N = 31). Treatment options were mentioned in 32% (N = 30). First aid was noted in 31% (N = 29) of movies, delayed neuropsychiatric syndrome appeared in 29% (N = 28).

Animations, actor scenes/flashbacks and patient speaker were present in 29%, 26% and 22% respectively. The importance of exposure time was outlined in 19% (N = 18) of movies whereas diagnostics featured in 17% (N = 16). Hyperbaric chamber indications were shown in 17% (N = 16), intoxication complications in 16% (N = 15). Risk

Table 1. Descriptive statistic of video variables in the study on the YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience (December 8, 2020)

Variable	YouTube videos		
	M	Me	SD
Views [n]	20 639.0319	3906.5	49 734.9899
Days since upload [n]	1461.8	1174	1047.12267
Channel subscribers [n]	530 533.872	8045	1 913 239.36
Duration [s]	350.168421	197	444.247814
Words/min [n]	144.723377	148	35.881981
Referrers (external webpages) [n]	10.294737	0	48.949578
YouTube			
comments [n]	24.707317	1.5	61.367842
likes [n]	186.595745	18	500.89834
dislikes [n]	7.677419	2	15.428067
Facebook			
reactions [n]	39.684211	5	100.405588
comments [n]	9.326316	0	24.837961
shares [n]	30.884211	10	62.300894
Like ratio [n]	0.949476	0.974574	0.069142
Video Power Index (VPI) [n]	19.12211	3.175842	55.430589
Average daily views [n]	18.895076	3.041308	55.248317
Channel average daily subscribers [n]	579.271331	8.636149	2337.26666

groups, toxicology centre – helplines and diagrams were presented in 9% (N = 9). The relevance of early therapy and results of treatment/prognosis was noted in 8% (N = 8) of videos. Factual errors and explained anatomy were presented in 6% (N = 6). Only 4% (N = 4) of posts mentioned management in pregnancy. Equal amount of material provided radiological findings. Finally, indications for hospitalization were presented only in 2% (N = 2) of all videos.

Video quality evaluation

The mean scores for both raters (R) were:
– DISCERN: R1 = 26.66 (range 16–64) and R2 = 29.64 (range 18–63),
– GQS: R1 = 2.51 and R2 = 2.62,
– JAMA: R1 = 0.79 and R2 = 1.5.

Table 2. The Intraclass Correlation Coefficient (ICC) in the study on the YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience (December 8, 2020)

| Scoring systems	Absolute agreement[a]	95% CI
DISCERN	0.797976	0.601163–0.886164
GQS	0.74178	0.613053–0.827815
JAMA	0.618213	0.070252–0.813262

DISCERN – the DISCERN instrument; GQS – Global Quality Score;
JAMA – *Journal of the American Medical Association.*
[a] Two-way random, average score – randomly selected k raters, estimation of average k raters reliability.

The mean DISCERN/GQS/JAMA was 28.1 (SD 7.9), 2.5 (SD 0.8) and 1.1 (SD 0.7), respectively. The average score for 1 question for both raters was 1.88. The ICC between 2 raters for DISCERN, GQS and JAMA (Table 2) reached good and moderate reliability [12]. The comparison of both raters is shown in Figure 3. Top 5 DISCERN scores are presented in Table 3.

Spearman linear correlation between scales was calculated achieving r = 0.61, 0.3, 0.37 with p < 0.05 for DISCERN/GQS, DISCERN/JAMA and GQS/JAMA, respectively (Table 4).

The average highest rated question was number 6 scoring 3.66 ("Is it balanced and unbiased?") and the second highest rated question ("Does it achieve its aims?") – 3.56.
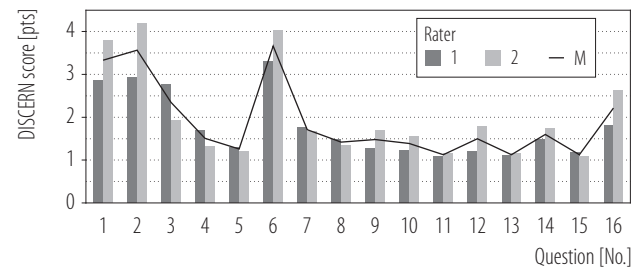
Rater 1 – a specialist in emergency medicine; rater 2 – a specialist in clinical toxicology.

Figure 3. Single question DISCERN score in the study on the YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience (December 8, 2020)

Table 3. Top 5 videos with the highest DISCERN score in the study on the YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience (December 8, 2020)

DISCERN score	Source of upload	Title	Web link
63.5 pts	AETCM Emergency Medicine	Carbon monoxide poisoning	https://www.youtube.com/watch?v=gjJVt0-VSt0
55 pts	Learning in 10	Carbon Monoxide Poisoning	https://www.youtube.com/watch?v=PXaPbTHYx90
49.5 pts	Thornhill Medical	How is Carbon Monoxide poisoning being treated? - Carbon Monoxide Awareness Week 4/5	https://www.youtube.com/watch?v=-3qWYX11y88
46.5 pts	UPMC	Potential Antidote for Carbon Monoxide Poisoning	UPMC	https://www.youtube.com/watch?v=LNTD-WEjKlo
42.5 pts	Kloss and Bruce	Carbon Monoxide Poisoning	https://www.youtube.com/watch?v=8g_N5wcW4JA

Table 4. Spearman linear correlation between scales in the study on the YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience (December 8, 2020)

Variable	r	95% CI	p
DISCERN/GQS	0.607478	0.457791–0.723674	<0.000001
DISCERN/JAMA	0.304767	0.103988–0.481679	0.002674
GQS/JAMA	0.367812	0.173709–0.534405	0.000245

Abbreviation as in Table 2.

Questions 11, 13 and 15, verifying the information considering treatment risks, how treatment choice affects quality of life and the appearance of shared decision-making proposal, had the lowest mean DISCERN score with the value equally of 1.13.

Higher DISCERN/GQS/JAMA had videos providing information on: time of exposure, treatment options or hyperbaric chamber indications as well as videos with a physician (p < 0.05) (Table 5).

Higher DISCERN/GQS had videos providing information on: CO definition, "clear information," intoxication pathomechanisms, diagnostics, treatment results and intoxication during pregnancy (p < 0.05) with no significant differences to JAMA score p > 0.05.

Videos ≥10 min scored higher in all 3 scoring systems than material <10 min (p < 0.05) (Table 6). Upload posted ≥5 years ago, with ≥50 or <50 comments, ≥50 or <50 average daily views did not occur significant in any scoring system.

Audience engagement

Videos providing misleading information, presenting complications had a higher like ratio. Higher number of Facebook shares was observed in videos providing the definition, actor scenes, clear information and animations. Diagrams, animations, actor scenes and patient speaker positively influenced average daily views. Videos that included intoxication pathomechanisms, patient as speaker had a higher number of YT comments. Videos

Table 5. Statistically significant relationships and selected qualitative video content in the study on the YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience (December 8, 2020)

Variable	Video [n]		pᵃ
	with variable	without variable	
Exposure time			
DISCERN	77	18	0.0028
GQS	77	18	0.000089
JAMA	77	18	0.043585
Treatment options			
DISCERN	65	30	<0.000001
GQS	65	30	0.000008
JAMA	65	30	0.024878
Hyperbaric chamber indications			
DISCERN	79	16	0.000017
GQS	79	16	0.001591
JAMA	79	16	0.0098
Physician speaker			
DISCERN	52	43	0.014565
GQS	52	43	0.025122
JAMA	52	43	0.000661

Abbreviations as in Table 2.
ᵃ Value bilateral (asymptotic).

with animations (p < 0.01), including patient as speaker (p < 0.01) had a higher VPI but without correlation with DISCERN/GQS/JAMA scores (p > 0.05) (Table 7). Productions of USA origin were commented on Facebook more frequently than videos from other countries (p = 0.049); however, no difference in DISCERN occurred (p > 0.05). Top 5 videos with the highest VPI score are presented in Table 8.

DISCUSSION

Videos presented on YT and related to CO covered information and content of low quality. The mean DISCERN

Table 6. The DISCERN instrument (DISCERN), Global Quality Score (GQS) and *Journal of the American Medical Association* (JAMA) score depending on video duration in the study on the YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience (December 8, 2020)

Variable	Participants [n]	Score [pts]		p
		M±SD	Me	
DISCERN				
<10 min	83	27.084337±6.473595	25.5	
≥10 min	12	35.5±12.822211	29.75	0.012222
GQS				
<10 min	83	2.463855±0.768206	2.5	
≥10 min	12	3.25±0.811844	3	0.003932
JAMA				
<10 min	83	1.024096±0.624224	1	
≥10 min	12	1.791667±1.096655	1.5	0.005837

Table 7. Statistically significant relationships with audience engagement in the study on the YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience (December 8, 2020)

Variables	YouTube videos					p
	with variable		including video quality variable [n]	without variable		
	M	Me		M	Me	
Facebook shares						
definition	52.103175	13	63	39.921875	4.5	0.041383
clear information	52.738095	13	63	38.671875	3.5	0.018478
animations	60.86	17	25	43.407143	5	0.006454
actor scenes	62.52381	23	21	43.878378	6.5	0.006109
Like ratio						
complications	62.2	1	15	42.16	0.966587	0.00539
factual errors	47.059524	0.976132	6	23.666667	0.894483	0.029989
Average daily views						
patient speaker	63.631579	11.972851	19	44.092105	2.358222	0.005804
animations	59.88	8.822133	25	43.757143	1.996754	0.012215
actor scenes	58.809524	10.147971	21	44.932432	2.654939	0.042213
diagrams	66.666667	10.10793	9	46.046512	2.646792	0.033285
YouTube comments						
poisoning pathomechanism	47.558824	5	34	37.208333	1	0.047028
patient speaker	56.777778	9.5	18	37.203125	1	0.001591
Video Power Index						
patient speaker	59.526316	11.079354	19	41.746479	2.415789	0.00854
animations	57.818182	8.853829	22	41.514706	2.024917	0.011097

Table 8. Top 5 videos with the highest Video Power Index (VPI) score in the study on the YouTube videos concerning CO poisoning as a source of knowledge for non-medical audience (December 8, 2020)

VPI score	DISCERN score [pts] (M)	Source of upload	Title	Web Link
367.6 pts	23	Inside Edition	Woman's Mysterious Illness Turns Out to Be Carbon Monoxide Poisoning	https://www.youtube.com/watch?v=xvxWRFtc9gA
348.3 pts	23	Taking Off	Pilot Dan Bass Unconscious As Mooney Crashes CO Poisoning - InTheHangar Ep 77	https://www.youtube.com/watch?v=MfzfP5CZBj8
112.0 pts	19.5	ABC News	Carbon monoxide to blame for deaths of family of 4 and their dogs: Authorities	https://www.youtube.com/watch?v=w0JhWh5OlEY
103.7 pts	20	ABC News	1 child dead, 6 others hospitalized for carbon-monoxide poisoning at Michigan hotel pool	https://www.youtube.com/watch?v=wFqcBVFAshY
80.5 pts	20.5	UW Medicine	Beware carbon monoxide poisoning during cold spells	https://www.youtube.com/watch?v=ZwV-qE0dr_4

score was 28.1 which is classified on the lower border of the "poor" bracket. Fully reliable information is not presented to patients seeking knowledge on CO poisoning. YouTube videos have insufficient quality ranging 27–42 DISCERN pts. Only 1 series of stroke videos was graded "average" (39–50 pts) [2–4,6,13]. The utmost of posts contained CO formation mechanisms, symptoms, definition, clear information and safety measures. Szmuda et al. [3,4] works on hydrocephalus and stroke shown similar outcomes with the difference in appearance of treatment results, which were omitted in 92% of CO videos.

Relevant information missing

Carbon monoxide poisoning during pregnancy puts in jeopardy both the mother and foetus, in which CO elimination time is 5 times greater [14]. Information concerning pregnancy was absent in 95.7% of CO videos. Similarly, this issue was omitted in over 99% of evaluated arteriovenous malformation posts on YT [15].

Misleading information

Carbon monoxide video analysis revealed 6 videos containing misleading information. Potentially life-threatening misinformation included safety of a running vehicle

in closed spaces, safety of exhaust emissions, neglecting CO appearance in the natural environment. Motor vehicle CO intoxications account for 0.9–4.0 unintentional and 4.9–10.0 intentional deaths per million person-year [16]. Recent research showed that car exhaust emissions can be a source of intoxication even in open space with unfavourable weather conditions [17]. Assuring that car fumes are safe can be potentially catastrophic. Consequences are hard to estimate and may lead to patient–doctor relationship conflicts [18,19].

The amount of misleading information varies depending on the topic from 5% in arteriovenous malformations up to even 77% in prostate cancer videos [15,20–22]. In our study false information presented a higher like ratio. Research data is inconclusive. Useful videos can be less popular than useless videos [23,24]. In contrast, Madathil et al. [25] review found little difference in view count between the misleading and accurate posts.

Audience engagement

Audience was more attracted by videos providing animations or patient speaker. Nevertheless, no correlation to any of the 3 scoring systems and VPI occurred. This hazardous phenomenon was observed in previous stud-

ies [5,26]. The top 5 VPI videos had a mean of 21 DIS-CERN score indicating very poor quality. Three out of top 5 highest DISCERN videos were narrated by a physician, although none of them reached over the 20th highest VPI video. This indicates that high quality information alone is insufficiently audience engaging. The particular presence of animations to clarify medical knowledge positively influences VPI [2,15].

Educational video content

YouTube is more frequently used as a learning tool by medical students, or even by surgeons to prepare for surgery [27,28]. In our study, 52% of the videos presented details of safety measures against CO intoxication, and approximately 29 videos provided first aid hints. None of the videos presenting prevention methods reached the top 5 DISCERN nor top 5 VPI list. Only 1 video with first aid information was in the top 5 DISCERN videos and none in the top VPI list. Comparable results were presented by Butler [29] where the average video score on thermal burn first aid was under 50% of the accepted by the study method. Moreover, the viewers were not attracted by higher quality videos. Therefore, physicians should be cautious in recommending YT videos as a source of information on CO intoxication prevention and first aid.

Treatment options

Surprisingly, only 32% of videos presented treatment options, 17% included hyperbaric chamber indications and only 2% provided that hospitalization should be considered. Inclusion of treatment options correlated with better video quality and was also present in the study considering narcolepsy [2].

Future directions

We believe that should the presented results be taken into account, future video material will be more informative and attractive to the non-medical viewer. For better video

optimization, hospitals and medical societies should consider factors influencing audience engagement when creating future content. In our opinion, a similar study needs to be performed in the next few years to verify if the video quality has increased. Next studies can examine how patients refer to YT information about CO poisoning and whether they regard this information as valuable after watching particular videos.

Limitations

The analysis conducted on YT was only restricted to 50 videos on the topic of CO. Different browser setting can result in different search results. The authors did not include videos other than in English. There is still lack of a unified system to assess misinformation in videos. Some authors argue whether the accepted scoring systems should be used for YT material. Any of the used scales was not primarily designed for YT video assessment [10,30].

CONCLUSIONS

Our study results indicate that the overall quality of YT videos concerning CO is poor, the information accessible to the audience can be misleading and does not provide an expected amount of information for a non-medical viewer to fully understand the threat of CO intoxication.

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