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Should videolaryngoscopy be routinely used for airway management? An approach from different scenarios in medical practice

¿Debe ser la videolaringoscopia la rutina en el manejo de la vía aérea? Una aproximación desde escenarios de la práctica médica

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Abstract

During the past two decades, the videolaryngoscope (VDL) has become a valuable and effective tool for the management of the airway, not just in the realm of anesthesiology, but also in other medical specialties in clinical scenarios requiring tracheal intubation. In countries such as the United States, this represents over 15 million cases in the operating room and 650,000 outside the OR. The overall accumulated incidence of difficult airway is 6.8% events in routine practice and between 0.1 and 0.3 % of failed intubations, both associated with complications such as desaturation, airway injury, hemodynamic instability and death. Notwithstanding the fact that the VDL has proven advantages such as improved visualization of the glottis, higher first attempt success rates, and a shortened learning curve, most of the time its use is limited to rescue attempts or as a secondary option. The aim of this article is to comment the advantages and limitations of the VDL vs. the direct laryngoscope in a wide range of clinical settings, including the operating room, intensive care units, emergency departments, pediatrics, obstetrics, and Covid-19 to consider its routine use.

Key words

Videolaryngoscopy; Laryngoscopy; Airway management; Critical care; Intratracheal intubation; Anesthesiology.

Resumen

En las últimas dos décadas, el videolaringoscopio (VDL) se ha convertido en una herramienta valiosa y eficaz para el manejo de la vía aérea no solo en el ámbito de anestesiología, sino en otras especialidades médicas durante escenarios clínicos que requieren la intubación traqueal y las cuales, en países como Estados Unidos corresponden anualmente a más de 15 millones dentro de salas de cirugía y 650.000 fuera de ella. Aproximadamente, hay una incidencia global acumulada de 6,8 % de eventos de vía aérea difícil en la práctica rutinaria y 0,1 al 0,3 % de intubaciones fallidas, ambas asociadas a complicaciones como desaturación, daño en la vía aérea, inestabilidad hemodinámica y muerte. Pese a que el VDL ha demostrado ventajas como mejoría de la visualización de la glotis, aumento de tasa de éxito al primer intento y menor curva de aprendizaje, su uso en la mayoría de las veces se ve limitado como dispositivo de rescate o de manera secundaria. El propósito de este artículo es comentar acerca de las ventajas y limitaciones del VDL vs. el laringoscopio directo en un variado número de escenarios clínicos, como salas de cirugía, unidades de cuidado intensivo, emergenciología, pediatría, obstetricia y covid-19, con el fin de considerar si su uso debiera hacerse de manera rutinaria.

Palabras clave

Videolaringoscopia; Laringoscopia; Manejo de la vía aérea; Cuidados críticos; Intubación intratraqueal; Anestesiología.

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INTRODUCTION

Traditionally, the management of the airway (AW) has been a skill practiced by various medical specialties, but particularly by anesthesiology. Since the development of orotracheal intubation (OTI) direct laryngoscopy (DL) has been classically considered the gold standard for most patients. However, negative outcomes in airway management have been reported over time, usually associated with increased morbidity and mortality of patients. (1)

The videolaryngoscope (VDL) as a device used in the management of the airway has become extremely popular since the Glidescope® model was introduced in 2001. (2) Its relevance is based on the possibility to use the VDL in a wide range of clinical scenarios to facilitate the OTI and potentially reducing adverse events, particularly in situations involving a difficult airway which is considered the main cause of AW complications. (3) Difficult airway represents 6.8% of all the intubations performed in routine practice worldwide. (4)

Since the advent of the classical laryngoscopes back in the forties, numerous devices have become available for the management of the AW, including laryngeal masks, bougies, fibrobronchoscopes and videolaryngoscopes. The latter provides significant advantages as compared to DL due to the enhanced visualization of the glottis, minimal cervical manipulation, higher success rates in OTI, reduced learning curve, and the possibility of external assistance during the procedure (Table 1). (5) Consequently, the use of the VDL has become increasingly popular with a growing number of practitioners adopting its use not just in anticipated difficult airway cases or rescue intubation, but in routine practice, giving rise to a new paradigm of whether it may be considered the new standard device for OTI, based on efficacy and safety of the results. (3)

The objective of this article is to comment the advantages and limitations of the VDL as compared to direct laryngoscopy in clinical scenarios involving AW management in the operating room, the intensive care unit (ICU), emergency departments, pediatrics, obstetrics and patients with Covid-19, in order to determine its routine use.

Table 1. Videolaryngoscope in the management of the airway.

Advantages	Disadvantages
No airway axes alignment required	Even with adequate visualization of the glottis, the insertion of the endotracheal tube may be difficult
Improved glottic view	Costs and availability of the device
Improved intubation first-attempt success rate	A large number of models available (difficult to standardize)
Reduced learning curve	Probably longer OTI times
No cervical mobilization required	Potential limitation to developing/ maintaining skills in the use of the direct laryngoscope
Possibility for external assistance during the procedure	Two-dimension view with no perception of depth

Source: Authors, from Chemsian et al. (5)

A non-systematic literature review was conducted in PubMed, Proquest, ScienceDirect and OvidSP. The advanced search was based on related MeSH terms included in the title, the abstract or keywords: Videolaryngoscopy, Direct laryngoscopy, Difficult airway, airway management, Intensive Care Unit, Rescue Intubation, Anesthesiology, Operating room, Pediatrics, Obstetrics, Emergency Medicine, COVID-19, Outcomes, safety, complications, and feasibility. The search began in July 2022 limited to articles published since 2001 (the year of the introduction of the first VDL) until December 2022. The articles were then selected based on the title and the most relevant abstracts that were cited in each of the scenarios discussed.

THE VIDEOLARYNGOSPY VERSUS DIRECT LARYNGOSCOPY DEBATE - SCENARIOS

Elective orotracheal intubation in the absence of predictors for difficult airway

In all likelihood, the most frequent scenario for the anesthesiologist in the operating room involves patients undergoing general anesthesia with an indication for OTI. A randomized clinical trial published in 2019 with 360 patients compared both approaches, taking into account exclusion criteria of patients with a history or any predictor for difficult airway (DAW) during the physical examination. The primary objective was the first-attempt success rate and associated complications. The results showed that videolaryngoscopy had a first-attempt success rate of 96.1 % and 100 % with more than one attempt, as compared to direct laryngoscopy with 90.1 % and 94.5 %, respectively. In terms of complications, the only statistically significant results showed a reduction in orotracheal lesions and hoarseness with the VDL. (6)

Anticipated difficult airway

Consistent with the information reviewed, the strongest evidence on the superiority of the VDL over DL is in this clinical scenario. The 2022 airway management guidelines of the American Society of Anesthesiology (ASA) recommend VDL with a level of evidence category A1-B. The guidelines include a meta-analysis of 10 randomized, controlled clinical trials comparing VDL against DL in patients with anticipated DAW, showing improved laryngeal view, higher frequency of successful intubations, a higher rate of first-attempt intubations, and less external manipulation maneuvers. (7) However, the intubation time exhibits contradictory results. A prospective study with 200 patients showed a shorter average intubation time using the VDL of 40 seconds, versus 60 seconds with DL (p = 0.0173). In the subgroup analysis, patients with a Cormack-Lehane III-IV classification showed a significantly longer difference with 52 seconds vs. 110 seconds, respectively (p=0.005). (8) In contrast, a prospective study with 112 patients with at least one predictor for DAW found that the intubation time using the Glidescope® was 33 (18-68) seconds and 27 (17-94) seconds using the DCI videolaryngoscope model, compared to the direct laryngoscope: 22.5 (12-49) seconds. (9)

Moreover, the decision tree approach of the 2022 ASA Guidelines for the management of DAW recommends that in case of suspicious: 1) difficult laryngoscopy or intubation; 2) difficult ventilation using face mask / supraglottic device, and 3) significant or increased risk of aspiration, awake intubation (AI) is one of the safest options for this type of patients. (10) Several studies have tried to compare different devices and their effectiveness in DL scenarios. Clinical trials comparing the VDL vs. the optic fiberscope have resulted in similar first-attempt success rates (96 % for either technique; p < 0.9999). (11) A meta-analysis of eight clinical trials found shorter intubation times with the VDL versus the fiberbronchoscope; however, the failure rate, the first-attempt rate, sore throat and low oxygen saturation were similar with both interventions. (12) With regards to the comparison with DL, another meta-analysis with 17 controlled clinical trials showed that the Glidescope® VDL required shorter intubation times (weighted means of 43 seconds, 95 % CI [-72 to -14 seconds]) and exhibited higher first-attempt success rates (RR 1.8; 95 CI % [1.4 to 2.4]) by non-expert practitioners; nonetheless, these results were no different when compared against expert practitioners. (13)

Despite the documented information, a recent analysis of the national difficult airway database of the Difficult Airway Society – DAS - of 2022, with a total of 675 patients with confirmed DAW in the United Kingdom reported that in case of an anticipated difficult airway, the primary management by anesthesiologists was DL with 44 % (n = 172/391) as compared to 35 % (n = 137/391) with VDL. (14) Failure to use advanced technologies routinely for the management of the AW when identifying a potentially difficult intubation is remarkable; hence, further efforts and dissemination are needed to prioritize the use of these technologies, particularly in this scenario.

Unanticipated difficult airway-rescue intubation

Unanticipated difficult airway is more frequent than we usually believe. A retrospective analysis of a 2015 Danish database with 188,064 OTI found that the incidence of difficulty in the management of the AW was 1.86 % (3,391 cases) of which 93 % (3,154 cases) were unanticipated. (15) However, the analysis of the DAS Difficult Airway database reported that the management of the DAW was anticipated in 58 % (391) of the patients and unanticipated in 42 % (284). (14) This shows the high probability of having a DAW regardless of the absence of predictors or past history.

One other retrospective, observational trial published in 2016 analyzed 1,427 cases of failed intubation out of 346,862 cases, comparing five rescue intubation techniques and it also found that the VL success rate exhibited the best performance (92 %), as compared against supraglottic devices with intubation channel (78 %), flexible fiberscope (78 %), lighted stylet (77 %) and optical stylet (67 %). The Glidescope® model was the most frequently used and broadly available. Additionally, a chronological analysis of rescue techniques in the AW showed that in 2004 the VDL was only used by 30 % of the anesthesiologists, in contrast to almost 90 % in 2012 (16).

Favorable studies have been reported in emergency medicine services such as a single-center prospective observational 5-year study comparing the effectiveness of the VDL model C-MAC vs. the DL in rescue intubation in 460 adults following the first failed attempt; 86.5 % was performed by the same operator (all of them were emergency medicine specialists). The results showed that CMAC was used in 141 cases, of which 116 (82.3 %; 95 % CI [75.0 %-88.2 %]) were successful as compared to 94 DL cases, of which 58 (61.7 %; 95 % CI [51.1 %-71.5 %]) were successful. The multivariate analysis indicated that the use of CMAC was associated with an OR of 3.5 (95 % CI [1.9-6.7]) in the intubation success rate following the first DL failed attempt. (17)

Intensive Care Unit

The AW approach in critically ill patients may be considered very different from elective intubation in the OR and presents additional challenges for the practitioner. First, a DAW is considered to be anatomical and “physiological” – this latter term was recently coined by Mosier et al., - based on physiological alterations such as hypoxemia, metabolic acidosis, hypotension and ventricular dysfunction, all of which predispose patients to more complications. (18) Additionally, most of the procedures are urgent and emergent,

hence preventing previous optimization due to lack of time. (19,20)

The use of the videolaryngoscope in the ICU is more recent than in the OR; hence, the evidence of increased first-attempt OTI procedures, the reduction in the number of difficult intubations, or procedure-associated complications is still being debated. (21) A meta-analysis involving nine clinical trials showed that in contrast to direct laryngoscopy, the VDL reduces the risk of difficult intubations, decreases the number of Cormack-Lehane III and IV glottic views and esophageal intubation and increases the first-attempt OTI success rate. (22) Another meta-analysis on emergency OTI outside the OR found a positive result for first-attempt success, with an OR of 2.02 (95 % CI [1.43-0.85]; p<0.001) when the VLD was used in the ICU. (23) Additionally, a randomized clinical trial (RCT) published in JAMA which compared first-attempt intubation using VDL vs. DL in 371 ICU patients, failed to identify any differences in the intention-to-treat or per-protocol analysis in first-attempt intubation. This trial also found an increase in terms of severe complications such as cardiorespiratory arrest, severe hypotension or hypoxemia, which were associated with the use of the VDL - 6.7% (1.8%-11.6%) p = 0.01; however, there are multiple factors that may impact this result, including for instance the fact that 85% of the practitioners responsible for the OTI were not experts, failure in passing the endotracheal tube despite the improved glottic view, an anatomical and physiological DAW, and lastly, failure to abort the attempt in a timely manner. (24)

The DAS clinical guidelines for orotracheal intubation in critical patients recommends the use of the videolaryngoscope whenever a difficult AW is present, or as a rescue device after failed DL. (25) The intubation and extubation guidelines of the French Society of Anesthesia and Resuscitation (SFAR) have included the VDL in the DAW algorithm, as the first choice in the presence of a score ≥ 3 in the MACOCHA scale, and likewise, as a rescue strategy when DL intubation fails (26,27) Similarly, the British Guidelines for OTI management in critical adult patients, recommend that the VDL should be available and be considered an option for all patients. (25)

The authors of this article consider that further emergent and better quality evidence is required to establish the effectiveness of VDL vs. DL in the intensive care unit, keeping in mind that most meta-analysis are highly heterogeneous and numerous factors that may affect the interpretation of the results. (28)

Pediatrics

The AW approach in pediatrics may be more challenging than in adults, particularly in neonates and infants. Classically, AW variations have been described in children such as the prominent occiput, a smaller anterior and cephalic larynx, the narrowest point in the cricoid cartilage, longer epiglottis, proportionally larger tongue and shorter neck. (29) Consequently, it is likely that the incidence of difficult laryngoscopy (Cormack-Lehane class ≥ III) may be higher in infant patients as compared to older children. (30)

The use of the VDL in pediatrics could enhance the visualization of multiple congenital and acquired conditions, in addition to limiting neck movement during laryngoscopy. A meta-analysis with 14 studies showed improved glottic visualization; however, this was at the expense of longer intubation times and failure rates (31), which in this population group may have deleterious effects in terms of: 1) longer intubation times with the VDL which cannot be tolerated because of a decreased functional residual capacity and safe apnea time; 2) multiple VDL designs available with larger size blades and handles making more difficult its manipulation in the pharynx and hypopharynx; 3) indirect tube passage, especially with hyper-angulated blades, and 4) infrequent use which hinders the development of skills using the device. (32)

There is still a lack of quality evidence for the routine use of the VDL in pediatric patients as a result of the broad diversity of devices and potential scenarios (particularly age). Further evidence is required to facilitate the description of the device and to increase the first-attempt success rate. Training of the practitioners responsible for pediatric OTI in the use of one single device and in non-emergency scenarios, prior to its use in emergency settings, keeping in mind the anatomical and physiological differences of this particular population. (33,34)

Obstetrics

It has been estimated that the incidence of failed intubation in obstetric patients is 2.6 per 1,000 general anesthesia (GA) procedures, with a maternal mortality of 2.3 per every 100,000 GA. (35) There are many clinical factors predisposing to a DAW, such as overweight, breast size, edema of the AW mucosa, reduced functional residual capacity and the lower esophageal sphincter tone, in addition to a situational and humane component in the delivery of care. (36)

The role of the VDL in obstetrics may be even more difficult to assess than in other areas of anesthesiology because of the particular difficulties in conducting research in this type of patients and the small number of cases under general anesthesia, which usually is administered for category 1 cesarean sections or in cases in which neuraxial anesthesia is contraindicated. (37)

Considering the vast experience with the use of the VDL in non-obstetric population and the management of emergency situations outside the hospital setting with the additional use of the bougie, several authors have suggested the VDL as a first line device for all tracheal intubations. (38) The Association of Obstetric Anesthesiologists and the Difficult Airway Society published the guidelines for the management of difficult and failed intubation of obstetric patients,

recommending that the VDL should be available for all obstetric general anesthesia procedures. Nevertheless, the most recent study — a meta-analysis conducted in 2021 with three randomized clinical trials – failed to find any differences in the first-attempt success rates between VDL and DL, despite the enhanced laryngeal view. However, the summary of the evidence from observational studies does highlight the usefulness of the VDL in scenarios predictive of DWA and rescue intubation. (39)

Emergency medicine

Intubation outside the OR, including the resuscitation suites and medical transport services, is probably the most challenging scenario for the definitive management of the airway, because of the above-mentioned anatomical and physiological differences present in critical patients. There are risk factors for mortality and peri-intubation collapse such as hypoxemia or hypotension, high shock index, absence of pre-oxygenation and emergent intubation (40,41). Hence, the management of the AW must be efficient and fast.

Difficult intubation is usually defined as ≥3 failed attempts and presents in 6.6 % and 12 % of intubations in critical patients (42); however, there has been a progressive reduction down to 1.5 % thanks to the use of the VDL and other techniques to optimize OTI in emergency medicine settings. (43) Observational studies have found a positive correlation between the use of the VDL (C-MAC device) and both successful intubation and successful first-attempt intubation, with an OR of 12.7 (95 % CI [4.1-38.8]) and an OR of 2.2 (95 % CI [1.2-3.8]), respectively. (44). Moreover, the glottic view with Cormack-Lehane I and II classification was 93.6 % in the VDL cases and 82.8 % with DL. (44) Even its use by residents has been associated with a lower incidence of esophageal intubation - 1 % with VDL in contrast to 5.1 % with DL. (45)

Another retrospective analysis of databases from 25 hospitals in the United States, comprising 6,938 OTI attempts in the emergency department contrasting VDL vs. LD + additional maneuvers and use of DAW devices, found that in practically every case (90.9 %) VDL exhibited the highest first-attempt success rate, regardless of the use of the ramp, the bougie or external manipulation of the larynx (even all of the above together) as compared to DL. (46)

However, a systematic review and a meta-analysis of RCTs and observational studies in 2017, published by the British Journal of Anesthesia comparing VDL and DL, failed to identify any differences in first-attempt intubation with an overall OR of 1.28, (IC 95% [0.99-1.65]), including emergency settings and pre-admission care; in contrast, there was a positive relationship between first-attempt success by inexperienced versus skilled practitioners, with an OR of 1.95 (95 % CI [1.45-2.64]). Nevertheless, again the significant heterogeneity could be considered when comparing the results, in addition to the failure to analyze the different VDL models or confounding factors such as the DAW characteristics of patients. (23)

Covid-19

From the onset of the SARS-CoV-2 pandemic, the role of the VDL for the management of the AW in patients with respiratory failure and covid-19 gained an exponential popularity. It was recommended by different scientific societies as the device of choice in first-attempt OTI on the grounds of safety, accuracy and speed when managing these patients. (47) A cross-sectional study assessed the preferences in the management of OTI in Covid-19 patients and found that among a group of 2,411 physicians from 19 Latin American countries, the VDL was the preferred device with 64.8 %; However, in actual practice, the most frequently used device was the DL with 57.9 %, followed by the VDL with 37.5 %. The more experienced clinicians in the management of the AW were the ones who performed most of the OTI procedures, representing 61.6 %. (48)

The evidence is clear, as shown by an observational prospective study with 150 patients undergoing OTI due to severe hypoxemia/respiratory failure and Covid-19, in which the VDL was used in 91.3 % of the cases, with an 88% first-attempt success rate; furthermore, there was less aerosol exposure because of the distance between the examiner and the patient. (49)

At the time of this article's publication, it could argued that we are living through a transition period into the "Post-COVID era". The massive vaccination campaigns and the strategies for preventing the transmission were key to what was called the "return to normality". However, as stated by the authors Mari Davies and Iljaz Hodzovic, the management of the airway has probably changed forever. Most likely, the availability of the VDL has increased in healthcare institutions in which it was not available, or in hospital areas in which there was limited availability. One may conclude that the routine use of the VDL translates into improved safety for both the patient and the healthcare staff, and better visualization of the glottis with the potential for external assistance, changing the paradigm from "I intubate" to "we intubate"; this new paradigm allows for improving skills through continuous reinforcement. (50)

Limitations

Probably the fact that the VDL is not always available may be one of the most relevant factors for the non-routine use of the device – there is limited information published on the topic. Nonetheless, an international survey conducted in 2015 in 61 countries, showed a difference between 45% access to a VDL in low income countries and 95% in high-income countries. (51) A more recent publication indicated that of 2,411 physicians administering OTI in patients with Covid-19 in 19 Latin American Countries, 72.1 % had access to a VDL as of October 2020 (48). Latin America however is one of the continents with the highest

inequality around the world, and hence the published data do not reflect the reality experienced by the health institutions in the region.

The availability of VDL primarily depends on the huge difference in the cost of a conventional laryngoscope versus a videolaryngoscope. The former has an approximate cost of 150 US dollars, including a set of different blades, while the average price of a VDL is 1,500 US dollars in 2020. (52) However, the world market of VDL was valued at 352.7 billion dollars for that same year and it is estimated to grow at a compounded annual growth rate of 18.1 % between 2021 and 2028. (53)

To a large extent, this technology is not affordable for low and medium-income countries, where the availability of the device is always an issue mostly associated with its purchase price and the maintenance of the equipment. (54) For this reason, during the pandemic, and intending to reduce the exposure to aerosols during endotracheal intubation, the development of "low-cost videolaryngoscopes" became highly popular in low-income countries, introducing modifications to the conventional laryngoscopes using available materials, attaching small baroscopes to the blade surface and transmitting the image directly to the screen of a Smartphone or a Tablet. (52,55) Although the information is limited and to a certain extent anecdotal, the results show that this approach may increase the average distance of intubation by 11.6 cm in addition to improving the visualization of the glottis. (52)

A review article entitled "Videolaryngoscopes: Are they the solution for the management of the difficult AW or just one additional strategy?" published by the Colombian Journal of Anesthesiology in 2015, already emphasized the need for further cost-effectiveness studies comparing the VDL versus the DL, and apparently the net cost including price, maintenance costs, battery and hygiene could be higher with the videolaryngoscope. However, there is a need to assess recent economic studies on the cost-benefit of both devices and reach more substantial conclusions.

Finally, another relevant factor is the skills for airway management using the direct laryngoscope. This is a basic skill particularly in anesthesiology and it has proven to be reliable, reproducible and low cost. Several authors and experts consider that being able to master this basic skill should be a prerequisite to moving on to more sophisticated tools for the AW; hence, performing an "easy" psychomotor activity should not be technology-dependent. (56) However, this is just an assumption which is not supported by any scientific evidence.

Key points and reflections about the routine use of the VDL

1. Generally speaking, there has been an increase in first-attempt intubation success rates using the VDL, improved visualization of the glottis is achieved, and less hypoxemic events under various clinical scenarios. This may translate into a potential benefit in terms of less airway complications. (23,57)

2. VDLs are more expensive than DLs; however, the VDL is becoming increasingly popular and this growing demand may lead to increased supply with a subsequent price regulation making the device more affordable to institutions, particularly in developing countries.

3. If VDLs were to become the standard of care for the AW, the scientific societies shall then change the algorithms previously published, recommending the use of the VDL not only for anticipated difficult airway cases or rescue intubation, but also specifying the device or the steps to follow in case of a failed videolaryngoscopy.

4. Although the VDL learning curve has been shown to be shorter as compared to other devices for the management of the AW, the limited availability of equipment may result in insufficient training of many practitioners in this area, and consequently in a gap in the development of the necessary skills for the use of this technology.

5. Due to the range of devices available in the market, it is difficult to assess the performance of each type of VDL in different clinical scenarios. This may lead to some uncertainty about to the selection and optimal management of the VDL, depending on the type of patient or clinical situation.

6. The limited availability of VDLs or the lack of training of the practitioners responsible for managing the airway, implies that we should not rule out, limit or lose the skills in the use of other devices for OTI. Therefore, it is critical for the practitioners to maintain their skills in the management of different devices and both continue to improve the access to, and training in the use of the VDL (58)

CONCLUSION

The VDL has proven to be an effective and safe device for OTI in different clinical scenarios (59), delivering significant improvements in the visualization of the glottis, successful first-attempt intubation, rescue intubation and anticipated difficult airway situations. Presently, a number of scientific societies have recommended its availability or routine use for all OTIs. (25,47,60) However, the availability and the price of the device hinder its routine use, even in institutions that enjoy high revenues. This situation may change in the future as a result of globalization, increased supply-demand and the evidence in terms of patient safety; the recommendation for a universal use of the device may transform the VDL into the gold standard for OTI.

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Conflict of interest

The authors declare they have no conflicts of interest to disclose.

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