Potassium titanyl phosphate 532 nm laser for treatment of facial vascular lesions: a prospective analysis of 27 cases

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Background
Facial vascular lesions are often disfiguring. Potassium titanyl phosphate (KTP) laser is an appropriate vascular-selective therapy. This prospective study was conducted in Mosul, Iraq, and intended to evaluate KTP laser in treating such lesions.

Patients and methods
The study involved infantile hemangioma smaller than 3 cm, port-wine stain (PWS), and telangiectasia in light-skin patients. Pretherapy pictures were taken. KTP laser (532 nm wavelength) with 1-mm spot size was used in multiple sessions under local or general anesthesia (for adults and children, respectively). Ice cubes were used for cooling. The immediate clinical endpoint in telangiectasia was blood vessels clearance. Post-therapy photographs were evaluated and improvement graded from poor to excellent.

Results
There were 27 patients (21 females) aged 7 months–50 years, with a mean of 15.2± 14.3 years. There were 15 (55.6%) PWSs, eight (29.6%) hemangiomas, and four (14.8%) telangiectasias. All hemangiomas were infantile. PWS, on the contrary, occurred in an age range of 3–36 years. Patients with telangiectasia were 11–50 years old. Near half of PWSs were in the maxillary region. The nose was a common site for both hemangioma (*n*=3) and telangiectasia (*n*=3). PWS had more treatment sessions (6.6) compared with hemangioma (4.25) and telangiectasia (4). Overall, 55.6% of patients had good to excellent results. The best results were obtained in telangiectasia and hemangioma. There were few transient complications, and the commonest was blistering (*n*=22, 82%).

Conclusion
KTP laser is an effective safe therapy for facial telangiectasia and hemangioma but is less satisfactory in PWS.

Keywords:
hemangioma, laser, port-wine stain, potassium titanyl phosphate, telangiectasia

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Introduction

LASER is an acronym of the words Light Amplification by Stimulated Emission of Radiation. Since its introduction in 1967, laser therapy has provided a great benefit to both patients and physicians [1,2]. In the late 1960s and early 1970s, laser treatment of vascular lesions used to be provided by continuous-wave lasers such as the Argon laser [3]. Despite their effectiveness, these lasers caused unacceptable adverse effects like scarring and dyspigmentation as laser energy was not confined to the target structure (blood vessels) but extended to surrounding tissues such as collagen and melanin [4,5].

In 1983, Anderson and Parrish have revolutionized the treatment of vascular lesions by introducing their theory of selective photothermolysis [2,3]. The theory dictates that laser energy can be specifically deposited within a target tissue (a chromophore) to result in controlled, thermal injury with minimal collateral destruction [3]. Intravascular oxyhemoglobin acts as a chromophore whose heating by laser results in vascular injury [4,5]. Potassium titanyl phosphate (KTP) laser system uses ND: YAG crystal with a KTP crystal that doubles the frequency emitting a wavelength of 532 nm [3,4]. It has the advantage of being small, portable, and appropriate for small vessels ablation [3,4]. However, it is only suitable for patients with light skin (Fitzpatrick type I–III) [3–5].

Patients with vascular lesions such as port-wine stain (PWS), hemangioma, and telangiectasia often seek treatment because of pain, bleeding, disfigurement, and/or psychological reason [3]. PWSs, also called capillary malformation, are composed of an abnormal

dermal plexus of dilated capillaries 100– 1000 μm underneath a normal epidermis [2,6]. Telangiectasias are small cutaneous vessels 0.1– 1.0 mm in diameter [3]. Hemangiomas are vascular endothelial cell neoplasms characterized by early rapid proliferation and eventual regression [2].

Nowadays, plenty of laser devices are available, making selection of an appropriate laser system a bit confusing [3]. It is important to understand the basic features of the laser device and setting the parameters in accordance to the biology of the specific vascular lesion. To the best of our knowledge, there is only one study from Iraq using KTP laser for treatment of 10 PWSs [7]. The aim of this study was to evaluate the outcome of this type of laser in a group of Iraqi patients with vascular lesions of the face in view of the published literature.

Patients and methods

Over an 18-month period (30 October 2012–30 April 2014), 27 patients (21 females and six males) with three types of vascular lesions in the face (PWS, hemangioma, and telangiectasia) were admitted to Plastic Surgery Department/Al-Jumhori Teaching Hospital/Mosul/Iraq and received a laser therapy. The Ethical Committee of our hospital has approved doing this study. The patients in this prospective study were chosen as follows:

Inclusion criteria

The following were the inclusion criteria:

(1) Of the six known types of skin [1], Fitzpatrick skin types I–IV were included. Type I is pale, porcelain, or ivory skin; type II is fair, beige, or cream colored; type III is light brown, golden, or olive; type IV is caramel or medium brown; type V is bronze or rich brown; and type VI is mahogany or dark brown.
(2) Infants with facial hemangiomas less than 3 cm receiving no previous therapy were included.

Exclusion criteria

The following were the exclusion criteria:

(1) Chronic dermatoses.
(2) Tattoos at the treatment area.
(3) Patients predisposed to keloid formation.
(4) Previous herpes simplex infection.
(5) Previous plastic surgery.
(6) History of excessive sun exposure.
(7) Pregnancy.
(8) Epilepsy.
(9) Allergy to local anesthesia.
(10) Patients on anticoagulants.

Clinical evaluation

Clinical history, demographic features, and physical signs particularly the size of the vascular lesion and color of PWS (pink, red, or purple) were noted. Advantages and disadvantages of laser therapy were explained, and informed consents of the patients or their families were obtained. The number of treatment sessions and the anticipated outcome were also discussed. A pretherapy photograph was obtained for comparison with subsequent post-therapy photographs.

Equipment

Nuvolas KTP laser device was used (Fig. 1a). This is a diode-pumped solid-state frequency-doubled ND: YAG laser with a wavelength of 532 nm (green). For safety, the patients wore oculoplastic eye cup (Fig. 1b), whereas the surgeon and other personnel in the theater wore goggles (Fig. 1c). Corneal eye shields were unavailable; thus, lesions in the eyelids were excluded.

Anesthesia

General anesthesia was used for infants and children, whereas adults were treated under local anesthesia (local infiltration, nerve block, or topical anesthesia using lidocaine gel or EMLA (eutectic mixture of local anesthesia: 2.5% prilocaine and 2.5% lidocaine) cream. The gel or cream was applied 2 h before laser therapy.

Procedure

Multiple sessions were required ranging from 1 to 10 spaced 4–6 weeks apart. Laser settings were adjusted according to the site, color, and depth of the lesion. In this study, a power of 8 Watts, energy of 61–81 J/cm^2, pulse duration of 60–80 ms, frequency of 1–2 P/s, and spot size of 1 mm were chosen. A spot to spot technique was used. The handpiece was moved in a continuous manner to prevent pulse overlap that may result in scarring. The laser beam was directed toward the lesion perpendicularly to maintain fluency and effectiveness of laser. The immediate clinical endpoint in telangiectasia was clearance of blood vessels. In case of PWS, the edges were treated first to outline the lesion and avoid accidental shooting of normal skin. To decrease epidermal damage and permit using a high dose of laser, cooling was necessary. This was achieved by applying ice cubes held in gloves to the treated area.

Post-therapy care

Post-therapy care included the following:

(1) Corticosteroid and antibiotic ointment (Zeta-Cort: betnosam+fucidin) three times/day for 3–5 days.
(2) Cold sponging to alleviate pain and edema.
(3) Analgesia (acetaminophen syrup for children and tablets for adults).
(4) Washing of the area was allowed after 48 h using nonirritant soap.
(5) Exposure to sun was permitted after the second week.
(6) The patients were discharged home the same day and asked to come for follow-up 1 and 4 weeks later.

Evaluation of treatment outcome

Pretreatment and 3-month post-treatment photographs (Figs 2–5) of each patient were independently evaluated by a plastic surgeon and dermatologist. The lesion characteristics such as overall appearance, size, color lightening, texture, and boundaries were evaluated and scored. Improvement was graded as poor (0–25%), fair (26–50%), good (51–75%), very good (76–95%), and excellent (more than 95%).

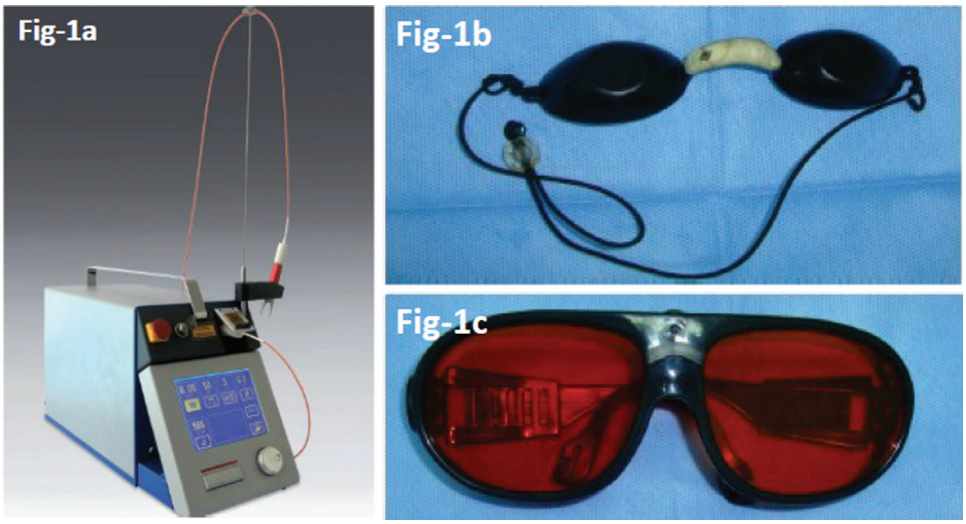
Results

Female-to-male ratio was 3.5 : 1. The mean age was 15.2 ±14.3 years. The youngest patient was a 7-month-old male infant with a hemangioma of the nose and the oldest was a man of 50 years with telangiectasia of the nose. Table 1 displays the age and sex distribution of the patients.

Infants younger than 2 years (n=8) comprised 29.6% of the patients. The peak age was in the second decade (n=7, 26%).

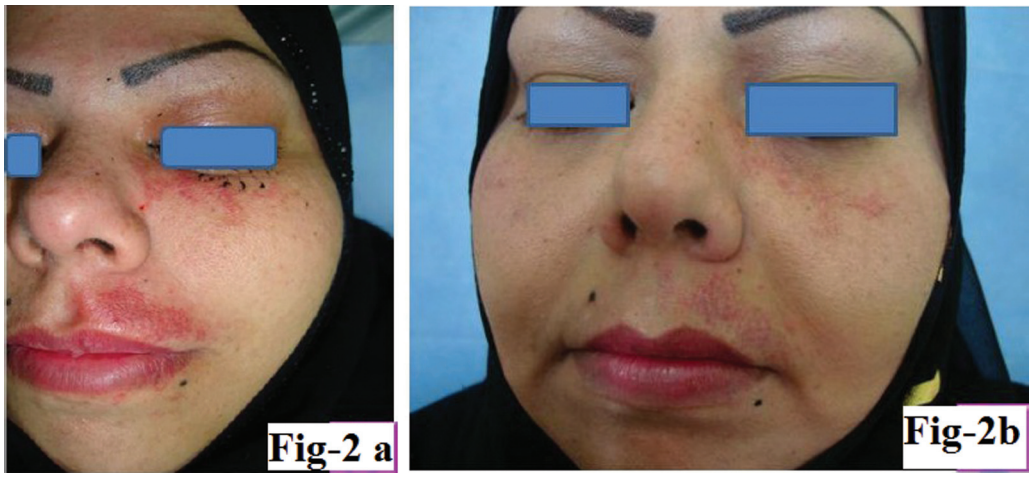
Table 2 shows sex versus type of the lesions.

Figure 1



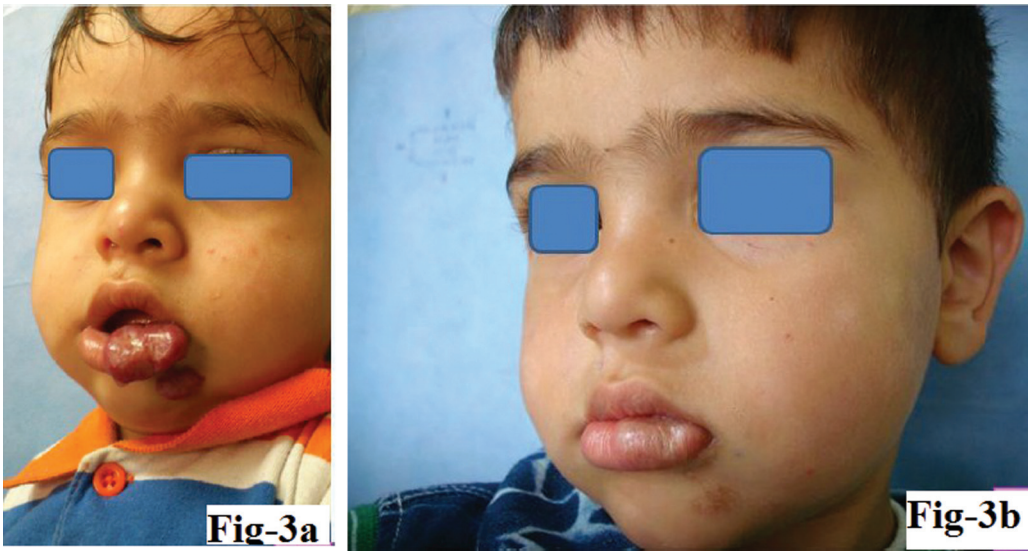
(a) Nuvolas potassium titanyl phosphate laser device. (b) Oculoplastic eye cup for the patient. (c) Goggles for the operator.

Figure 2



A 36-year-old woman with port-wine stain. (a) A pretreatment photograph. (b) A post-treatment photograph after three sessions of potassium titanyl phosphate laser treatment showing good result.

Figure 3



A 21-month-old male child with hemangioma of lower lip. (a) A pretreatment photograph. (b) A post-treatment photograph after 10 sessions potassium titanyl phosphate laser showing excellent result.

Figure 4

A 18-month-old girl with capillary hemangioma of the face. (a) A pretreatment photograph. (b) A post-treatment photograph after four sessions potassium titanyl phosphate laser treatment showing an excellent result.

More than half of the patients (55.6%) had PWS, mostly females (14 out of 15 patients), whereas telangiectasia constituted 14.8% of the patients, mainly males (3/4). Regarding hemangioma, three-quarters of patients (n=6) had superficial (capillary) and two had combined (superficial and deep) types. Likewise, there were six (75%) females. One case was noted at birth, four within 2 weeks, and three after 2 weeks. PWS lesions had a range of colors (pink, n=6; purple, n=5; dark purple, n=3 and red, n=1).

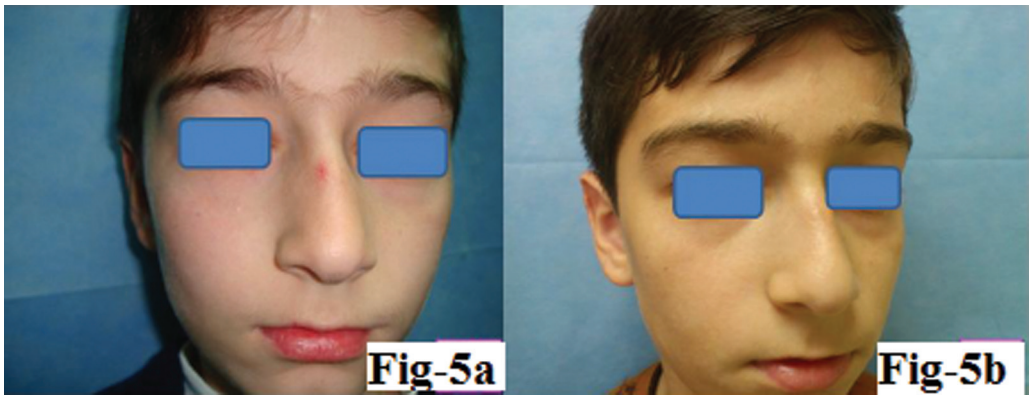
Table 3 displays the distribution of the vascular facial lesions by age.

All hemangiomas (n=8) were infantile (<2 years). PWS, on the contrary, occurred in an age range of 3–36 years, with a peak in the second decade. Patients with telangiectasia were 11–50 years old, distributed in the second and fifth decades.

Regarding the type of anesthesia, 13 adult patients received local anesthesia, whereas the remaining patients (14 infants and children) received general anesthesia.

Table 4 shows the distribution of vascular lesions in the face.

Figure 5



A 11-year-old boy with nasal telangiectasia. (a) A pretreatment photograph. (b) A post-treatment photograph after one session of potassium titanyl phosphate laser treatment showing excellent result.

Table 1 Age and sex distribution

Age	Female	Males	Total [*n* (%)]
6–12 months	3	1	4 (14.8)
13–24 months	3	1	4 (14.8)
3–10 years	4	0	4 (14.8)
11–20 years	6	1	7 (26)
21–30 years	3	0	3 (11.1)
31–40 years	2	1	3 (11.1)
41–50 years	0	2	2 (7.4)
Total [*n* (%)]	21 (77.8)	6 (22.2)	27 (100)

Table 2 Sex versus type of vascular lesions

Type	Females	Males	Total [*n* (%)]
Port-wine stain	14	1	15 (55.6)
Hemangioma	6	2	8 (29.6)
Telangiectasia	1	3	4 (14.8)
Total [*n* (%)]	21 (77.8)	6 (22.2)	27 (100)

Nearly half of the PWS lesions (47%) were located in the maxillary region, whereas one-third of the lesions (n=5, 33.3%) were located in ophthalmic or ophthalmic and maxillary regions. The nose was a common site for both hemangioma and telangiectasia (three cases each). Table 5 shows the type of vascular lesion versus number of treatment sessions.

It seems that patients with PWS had a higher average number of treatment sessions (6.6) compared with those with hemangioma (4.25) and telangiectasia (4). Table 6 displays the outcome of laser therapy.

Overall, more than half of the patients (n=15, 55.6%) had good to excellent results. The best results were obtained in telangiectasia (Fig. 6a and b) and hemangioma (Fig. 7a and b) as almost all patients had good to excellent results, whereas patients with PWS had less satisfactory results (11 of 15 patients had poor to fair results vs. four patients with good results) (Fig. 8a and b). Table 7 shows the post-therapy complications.

The commonest complication was blistering (n=22, 82%), whereas the least common was hypopigmentation (n=2, 7%). Most of these complications resolved within 1-week period.

Discussion

Vascular lesions of the face are often unsightly. Beside their negative cosmetic effect, they can cause pain and bleeding. Dermatologists and plastic and vascular surgeons are often consulted to provide a management. Selecting an appropriate therapeutic option for a particular patient is frequently influenced by many factors. The natural history of the lesion, its location, and severity of presenting symptoms and signs are few to mention. Management options may range from simple observation to open surgery.

In this study, three facial vascular lesions were managed by laser therapy. Since its early introduction in 1967, laser therapy has greatly benefited both patients and physicians [2]. It is important to take into account the specific characteristics of the vascular disorder when we select the appropriate laser device. Maximum destruction of the target 'chromophore' and minimal injury to adjacent structures can be achieved by properly manipulating the wavelength, pulse duration, energy density, and laser spot size [2,3].

More than half of our patients (n=15) had PWS. This is a congenital malformation that typically presents at birth with a prevalence of 0.3–0.5% [2,6,8–11]. Our patients

Table 3 Age versus type of vascular lesion

Age	Port-wine stain	Hemangioma	Telangiectasia	Total [*n* (%)]
6–12 months	0	4	0	4 (14.8)
13–24 months	0	4	0	4 (14.8)
3–10 years	4	0	0	4 (14.8)
11–20 years	5	0	2	7 (26)
21–30 years	3	0	0	3 (11.1)
31–40 years	3	0	0	3 (11.1)
41–50 years	0	0	2	2 (7.4)
Total [*n* (%)]	15 (55.6)	8 (29.6)	4 (14.8)	27 (100)

Table 4 Distribution of vascular lesions in the face

Port-wine stain in trigeminal nerve dermatomes		Hemangiomas		Telangiectasia
Dermatome	*n* (%)	Region of face	*n* (%)	*n* (%)
V1 (ophthalmic region)	2 (13)	Forehead	0	1
V2 (maxillary region)	7 (47)	Cheek	2	0
V3 (mandibular region)	3 (20)	Nose	3	3
V1+V2	3 (20)	Lip	2	0
Total	15 (100)	Chin	1	0
		Total	8	4

Table 5 Type of vascular lesion versus number of treatment sessions

Type of lesions	Number of treatment sessions										Range of sessions	Average number of sessions	Total number of patients
	1	2	3	4	5	6	7	8	9	10			
Port-wine stain	0	0	**3**	2	0	3	1	1	1	**4**	3–10	6.6	15
Hemangioma	0	*2*	2	2	0	1	0	0	0	*1*	2–10	4.25	8
Telangiectasia	***1***	0	0	***2***	0	0	***1***	0	0	0	1–7	4	4
Total number of patients	1	2	5	6	0	4	2	1	1	5	–	–	27

Table 6 Outcome of laser therapy

Lesion	Poor	Fair	Good	Very good	Excellent	Total
Port-wine stain	3	8	4	0	0	15
Hemangioma	0	1	2	0	5	8
Telangiectasia	0	0	1	0	3	4
Total [*n* (%)]	3 (11.1)	9 (33.3)	7 (26)	0 (0)	8 (29.6)	27 (100)

aged 3–36 years close to that reported by Mahmood *et al.* [7] from Iraq whose patients aged 3–42 years. Most PWS cases in this series were females (14/15). This is similar to Mahmood *et al.* [7] who had nine females of 10 cases. In contrast, Cordoro *et al.* [9] found no sex predilection. Nearly half of PWS lesions (47%) were located in the maxillary region, whereas one-third of the lesions (n=5, 33.3%) were located in ophthalmic or ophthalmic and maxillary regions. Similar finding was observed by Cordoro *et al.* [9]. Unlike hemangioma, PWS never resolve spontaneously [2,5,7], and hence, therapy is needed. Being vascular selective, KTP laser (532 nm) has been considered an initial treatment choice for PWS and has been primarily studied for resistant and residual cases [9]. In this series, we observed that despite more laser treatment sessions, patients with PWS had less satisfactory results when compared with other vascular lesions. Mahmood *et al.* [7], on the contrary, achieved better results (70% good–excellent results).

Hemangiomas are present in up to 3% of newborns and commonly present around 2 weeks after birth [2]. Most hemangiomas begin to slowly involute by 1 year of age [2,10]. In the present study, all hemangiomas (n=8) were infantile (<2 years); five developed within 2 weeks. They were located in prominent parts of the face (nose, lips, cheek, and chin). After an average of 4.25 treatment sessions, almost all patients (7/8) achieved good to excellent results.

The development of telangiectasia is connected to significant sun exposure, hormonal factors, or

Figure 6

(a) A pretreatment photograph of a 50-year-old man with perialar telangiectasia. (b) A post-treatment photograph of the same patient after four sessions of potassium titanyl phosphate laser treatment showing excellent result.

Figure 7

(a) A pretreatment photograph of a 10-month-old girl with upper lip hemangioma. (b) A post-treatment photograph after three sessions of potassium titanyl phosphate laser treatment showing excellent result.

Figure 8

(a) A pretreatment photograph of a 12-year-old girl with port-wine stain. (b) A post-treatment photograph after seven sessions of potassium titanyl phosphate laser treatment showing poor result.

Table 7 Post-therapy complications

Complications	*n* (%)
Pain	10 (37)
Edema	16 (59)
Erythema	16 (59)
Blistering	22 (82)
Hypopigmentation	2 (7)
Atrophic scars	3 (11)

genetic predisposition [3]. KTP laser produces energy pulses with small spot sizes and therefore can be used in the treatment of smaller vessels such as facial telangiectasias. The target vessels are not ruptured during treatment; thus, much less purpura is noticed thereafter [3,4]. In this series, there were four cases of telangiectasia (three males), aged 11–50 years, located in the nose (n=3) and forehead (n=1). They responded

very well to laser therapy; all achieved good–excellent results after an average of four sessions.

Regarding complications, the commonest was blistering (n=22, 82%), whereas the least was hypopigmentation (n=2, 7%). Only light-skinned patients were enrolled in this study. At the wavelength of 532 nm, there is significant energy absorption by melanin, which makes patients with dark skin (Fitzpatrick IV–VI) unsuitable for treatment with KTP laser, as they would develop long-lasting dyspigmentation if they were to receive such therapy [3–5].

Conclusion

KTP laser seems to be a safe and effective therapy for facial telangiectasia and hemangioma but is less satisfactory for PWS.

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Conflicts of interest

There are no conflicts of interest.

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