



**University of Dundee**

## **Transmitted irradiance not as expected in enclosed handheld Minimal Erythema Dose (MED) device**

Eadie, Ewan; Valentine, R.; Thompson, G.; Campbell, K.; Moseley, H.

*Published in:*  
Photodermatology, Photoimmunology & Photomedicine

*DOI:*  
[10.1111/phpp.12267](https://doi.org/10.1111/phpp.12267)

*Publication date:*  
2016

*Document Version*  
Peer reviewed version

[Link to publication in Discovery Research Portal](#)

### *Citation for published version (APA):*

Eadie, E., Valentine, R., Thompson, G., Campbell, K., & Moseley, H. (2016). Transmitted irradiance not as expected in enclosed handheld Minimal Erythema Dose (MED) device. *Photodermatology, Photoimmunology & Photomedicine*, 32(5-6), 304-306. DOI: 10.1111/phpp.12267

### **General rights**

Copyright and moral rights for the publications made accessible in Discovery Research Portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from Discovery Research Portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain.
- You may freely distribute the URL identifying the publication in the public portal.

### **Take down policy**

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

## Transmitted Irradiance Not As Expected in Enclosed Handheld Minimal Erythema Dose (MED) Device

Journal:	<i>Photodermatology, Photoimmunology &amp; Photomedicine</i>
Manuscript ID	PHOTO-LE-06-16-0177.R1
Manuscript Type:	Letter to the Editor
Date Submitted by the Author:	n/a
Complete List of Authors:	Eadie, Ewan; NHS Tayside, The Photobiology Unit Valentine, Ronan; University of Dundee, The Photobiology Unit Thompson, Grace; University of St Andrews, School of Physics and Astronomy Campbell, Kevin; NHS Tayside, The Photobiology Unit Moseley, Harry; University of Dundee, The Photobiology Unit
Keywords:	minimal erythema dose, MED, phototherapy, phototest, ultraviolet

SCHOLARONE™  
Manuscripts

Only

"This is the peer reviewed version of the following article: Eadie, E., Valentine, R., Thompson, G., Campbell, K. and Moseley, H. (2016), Transmitted Irradiance Not As Expected in Enclosed Handheld Minimal Erythema Dose (MED) Device. *Photodermatol. Photoimmunol. Photomed.* Accepted Author Manuscript. which has been published in final form at [doi:10.1111/php.12267](https://doi.org/10.1111/php.12267),. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Self-Archiving."

1  
2  
3 Title Page  
4

5  
6 Transmitted Irradiance Not As Expected in Enclosed Handheld Minimal Erythema Dose (MED)  
7

8 Device  
9

10  
11 Word count: 1,083  
12

13  
14 Table count: 0  
15

16  
17 Figure count: 2  
18  
19  
20  
21

22  
23 Authors: E. Eadie<sup>1</sup>, R. Valentine<sup>2</sup>, G. Thompson<sup>3</sup>, K. Campbell<sup>4</sup>, H. Moseley<sup>2</sup>  
24

25  
26 Institutions:  
27

28  
29 <sup>1</sup> NHS Tayside, Photobiology Unit, Ninewells Hospital and Medical School, Dundee, DD1 9SY  
30

31  
32 <sup>2</sup> University of Dundee, Photobiology Unit, Ninewells Hospital and Medical School, Dundee, DD1 9SY  
33

34  
35 <sup>3</sup> University of St Andrews, School of Physics & Astronomy, St Andrews, KY16 9SS  
36

37  
38 <sup>4</sup> Photonet, NHS Scotland, Photobiology Unit, Ninewells Hospital and Medical School, Dundee, DD1  
39

40 9SY  
41

42  
43 Corresponding Author:  
44

45  
46 Ewan Eadie, Photobiology Unit, Ninewells Hospital and Medical School Dundee, DD1 9SY.  
47

48 [Ewan.eadie@nhs.net](mailto:Ewan.eadie@nhs.net)  
49  
50  
51  
52

53  
54 Funding Sources: None  
55

56  
57 Conflict of Interest: None  
58  
59  
60

1  
2  
3 Summary Statement  
4  
5

6 What's already known about this topic?  
7

- 8 • The MED produced by a handheld semiautomated device produces a similar but lower MED  
9 than the traditional template test method.  
10
- 11 • The ultraviolet B irradiance from a handheld MED device varies with internal temperature.  
12  
13  
14  
15

16 What does this study add?  
17

- 18 • The internal temperature of the handheld MED device varies along the length of the lamp  
19 resulting in a non-uniform lamp irradiance.  
20
- 21 • Non-uniform lamp irradiance results in transmitted irradiances that are different from  
22 claimed values.  
23
- 24 • The claimed 1.26 dose progression can be used if the first and second aperture are  
25 disregarded.  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 Text:

4  
5  
6 Dear Sir / Madam

7  
8  
9 In 2014 Turner and Goulden demonstrated that the ultraviolet B (UVB) irradiance from a Handheld  
10  
11 Minimal Erythema Dose (MED) device varied depending upon the internal temperature of the  
12  
13 device<sup>1</sup>. The Handheld MED device in question consisted of a single PL-S 9W/01/2P narrowband UVB  
14  
15 fluorescent lamp located inside a plastic handheld enclosure. On the treatment surface of the device  
16  
17 there were 10 apertures, each one containing attenuating foil to deliver a range of doses for a fixed  
18  
19 exposure time. The link between temperature and irradiance led the investigators to recommend a  
20  
21 shorter warm-up time for the device than had been previously advised.  
22

23  
24  
25 The transmitted irradiance from each aperture in a handheld MED device depends upon two  
26  
27 variables – the transmission properties of the attenuating foil and the UV output from the section of  
28  
29 lamp located directly below the aperture. Since fluorescent lamp output varies with temperature,  
30  
31 the claimed transmitted irradiance through each window will only be valid if internal temperature is  
32  
33 constant along the length of the tube.  
34

35  
36  
37 In the Turner and Goulden study, the irradiance from a single (fully open) aperture was monitored  
38  
39 and compared to the temperature from a single internal temperature probe. We sought to expand  
40  
41 on the previous study and determine if internal temperature varied consistently at different points  
42  
43 in a handheld MED device. We investigated the impact this would have on the narrowband UVB  
44  
45 irradiance delivered to the patient.  
46

47  
48 Temperature of the MED device was monitored by two methods. An infrared camera (FLIR T420bx,  
49  
50 FLIR, Portland, USA) was used to produce a thermal image of the ultraviolet lamp at multiple time  
51  
52 points. Then three measurement points on the MED device were defined; Aperture 1 the base of the  
53  
54 fluorescent tube corresponding to the fully open aperture, Aperture 3 the middle of the fluorescent  
55  
56 tube corresponding to the aperture with a nominal transmission of 63% and Aperture 5 the tip of  
57  
58  
59  
60

1  
2  
3 the fluorescent tube corresponding to the aperture with a nominal transmission of 40%. These three  
4  
5 points are represented quantitatively with a PicoLog USB TC-08 Thermocouple Data Logger for  
6  
7 temperature and an IL1400A radiometer with UV SEL005 detector and TLST 7mm diffuser for  
8  
9 irradiance. Measurements were made during the first ten minutes after the device was switched on  
10  
11 with a subsequent ten minute switch off, repeated multiple times.  
12

13  
14 Thermal imaging and quantitative measurement showed that the base of the fluorescent tube, and  
15  
16 in particular the area covered by aperture 1 (Figure 1a), reached a much higher temperature than  
17  
18 the middle or the tip of the fluorescent tube (Figure 1a). Therefore the irradiance along the length of  
19  
20 the fluorescent tube was not uniform, which in turn meant that the transmitted irradiance at the  
21  
22 first and second aperture were lower than stated (Figure 2a).  
23

24  
25 In this instance, using the stated transmission results in an incorrectly low MED, potential under-  
26  
27 treatment and increased phototherapy visits. Our findings are corroborated by our own experience  
28  
29 (handheld MED tester results 57% of traditional MED template method) and a study by Lynch et al  
30  
31 (handheld MED 67% of traditional method)<sup>2</sup>.  
32  
33

34  
35 However Figure 2b shows that if Apertures 1 and 2 are discarded the transmitted irradiances will  
36  
37 follow the expected 1.26 progression. From our own experience, when we compensated for the  
38  
39 measured transmitted irradiances, we found the handheld MED tester result to be 82% of the  
40  
41 traditional MED template method. This agrees well with the 88% found by Otman et al<sup>3</sup>.  
42  
43

44  
45 Our study demonstrates a need for caution and independent dosimetry prior to the use of handheld  
46  
47 MED devices. The devices can be used with the anticipated 1.26 dose progression if the first and  
48  
49 second aperture are ignored.  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

## References

1. Turner D, Goulden V. Determination of the optimum operating point for a handheld minimal erythema dose device. *Br J Dermatol* 2014; **170**: 996-97.
2. Lynch M, Carroll F, Kavanagh A., Honari, B. et al. Comparison of a semiautomated hand-held device to test minimal erythema dose before narrowband ultraviolet B phototherapy with the conventional method using matched doses. *J Eur Acad Dermatol Venereol* 2014; **28**:1696-1700.
3. Otman SGH, Edwards C, Gambles B. et al. Validation of a semiautomated method of minimal erythema dose testing for narrowband ultraviolet B phototherapy. *Br J Dermatol* 2006; **155**: 416-21.

For Review Only

1  
2  
3 Figure Legends  
4  
5

6 Figure 1 a) Thermal imaging of handheld MED device during its warm-up phase. Images were  
7  
8 acquired at two minute intervals from two to ten minutes. After ten minutes patient testing would  
9  
10 take place. White dots on the image at ten minutes indicate the location of each of the device  
11  
12 apertures. The temperature at aperture 1 is higher than all other apertures, explaining the lower  
13  
14 irradiance observed at this location. b) Quantitative results from thermopiles corroborating the  
15  
16 information from thermal imaging.  
17  
18

19 Figure 2 a) Measured (dashed diamond) transmitted irradiance from each of the handheld MEDs ten  
20  
21 apertures. Claimed (solid square) transmitted irradiance if the output was normalised to Aperture  
22  
23 10. This clearly shows the lower than expected irradiance at Aperture 1 and 2, which corresponds  
24  
25 with the higher temperature shown in Figures 1a and b. b) If Apertures 1 and 2 are discarded and  
26  
27 Aperture 3 is treated as the 100% aperture then the measured dose progression is similar to the  
28  
29 claimed 1.26 dose progression.  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



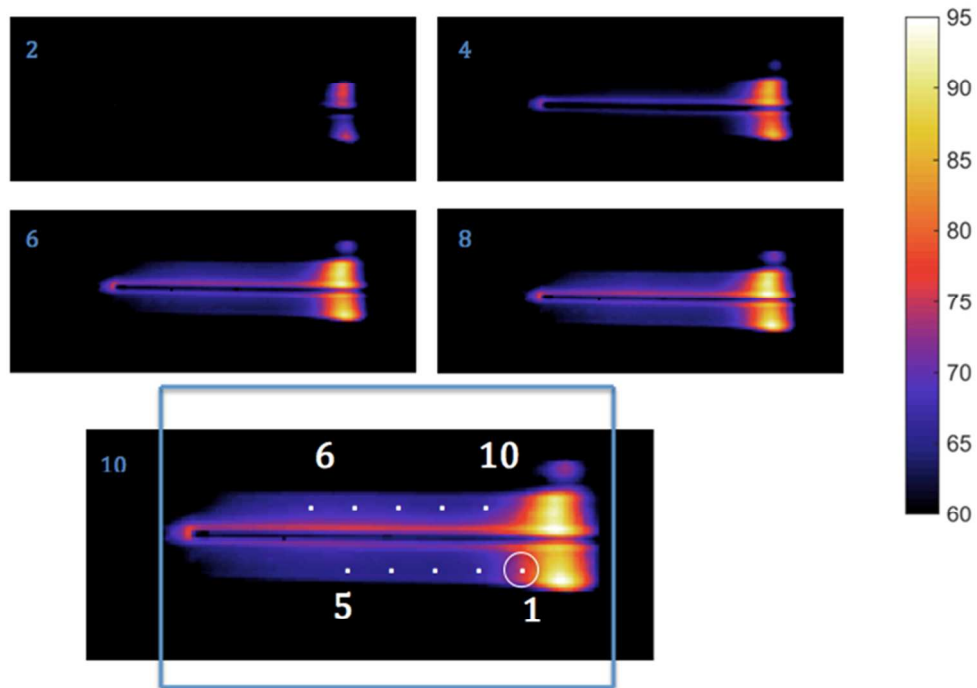


Figure 1 a) Thermal imaging of handheld MED device during its warm-up phase. Images were acquired at two minute intervals from two to ten minutes. After ten minutes patient testing would take place. White dots on the image at ten minutes indicate the location of each of the device apertures. The temperature at aperture 1 is higher than all other apertures, explaining the lower irradiance observed at this location. b) Quantitative results from thermopiles corroborating the information from thermal imaging.

Figure 1a

254x190mm (96 x 96 DPI)

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

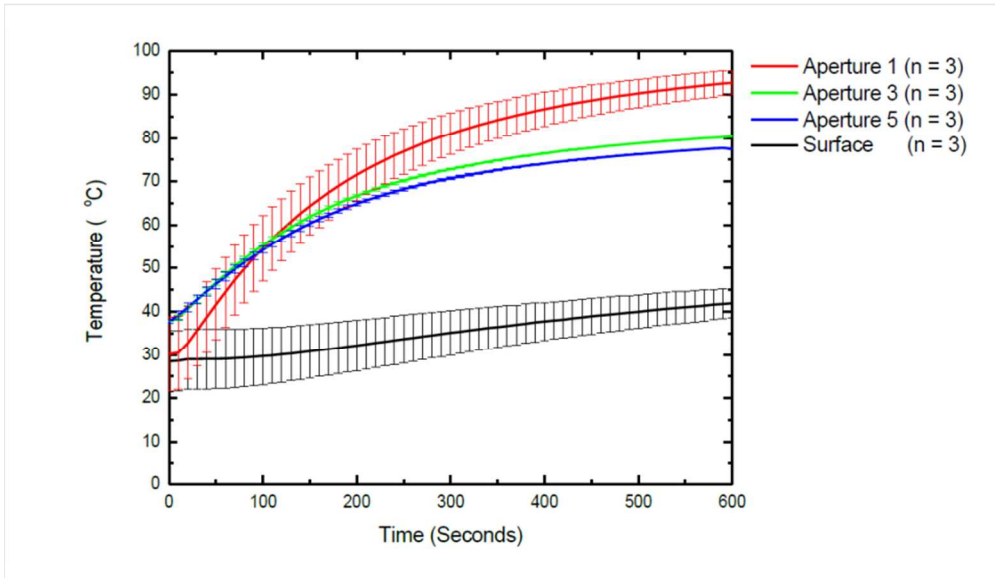


Figure 1 a) Thermal imaging of handheld MED device during its warm-up phase. Images were acquired at two minute intervals from two to ten minutes. After ten minutes patient testing would take place. White dots on the image at ten minutes indicate the location of each of the device apertures. The temperature at aperture 1 is higher than all other apertures, explaining the lower irradiance observed at this location. b) Quantitative results from thermopiles corroborating the information from thermal imaging.

Figure 1b  
254x190mm (96 x 96 DPI)

only

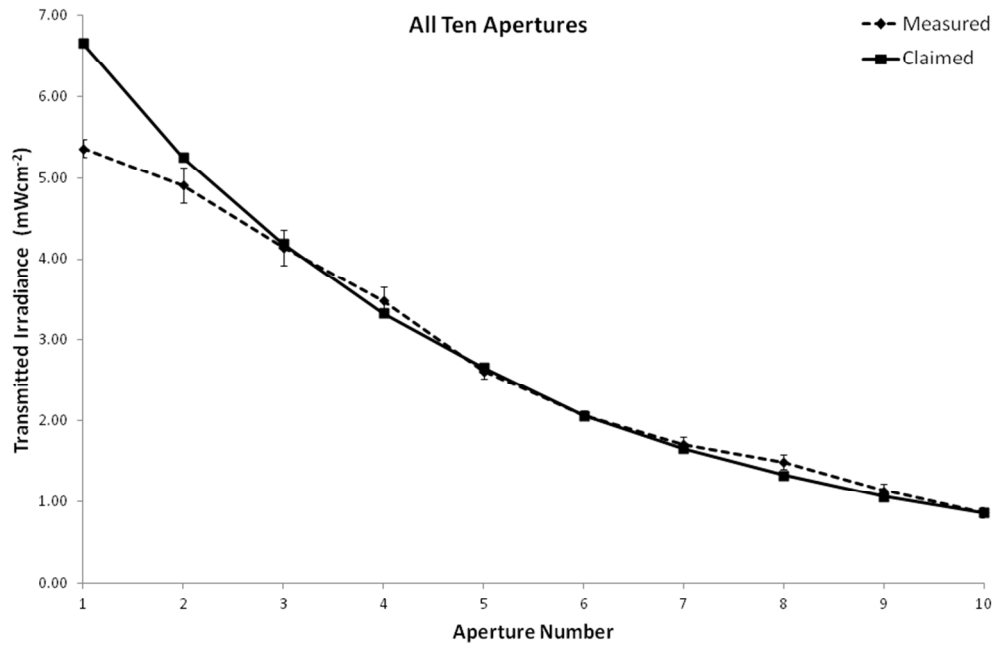


Figure 2 a) Measured (dashed diamond) transmitted irradiance from each of the handheld MEDs ten apertures. Claimed (solid square) transmitted irradiance if the output was normalised to Aperture 10. This clearly shows the lower than expected irradiance at Aperture 1 and 2, which corresponds with the higher temperature shown in Figures 1a and b. b) If Apertures 1 and 2 are discarded and Aperture 3 is treated as the 100% aperture then the measured dose progression is similar to the claimed 1.26 dose progression.

Figure 2a  
254x190mm (96 x 96 DPI)

only

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

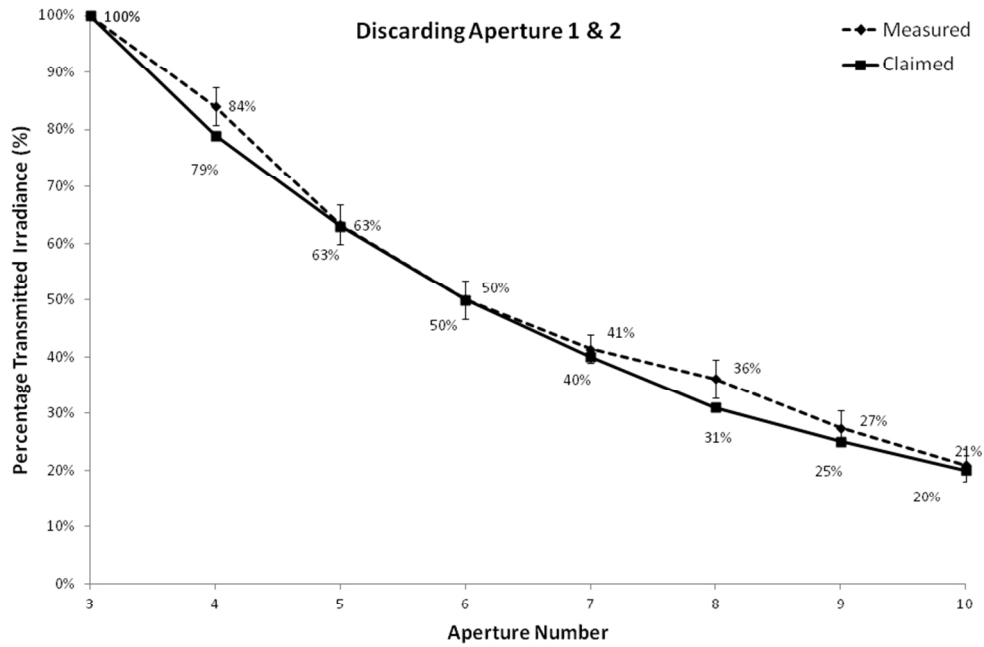


Figure 2 a) Measured (dashed diamond) transmitted irradiance from each of the handheld MEDs ten apertures. Claimed (solid square) transmitted irradiance if the output was normalised to Aperture 10. This clearly shows the lower than expected irradiance at Aperture 1 and 2, which corresponds with the higher temperature shown in Figures 1a and b. b) If Apertures 1 and 2 are discarded and Aperture 3 is treated as the 100% aperture then the measured dose progression is similar to the claimed 1.26 dose progression.

Figure 2b

254x190mm (96 x 96 DPI)

only

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60