



Tracking digital ulcers in systemic sclerosis – a feasibility study assessing lesion area in patient-recorded smartphone photographs

DOI:

[10.1136/annrheumdis-2017-212829](https://doi.org/10.1136/annrheumdis-2017-212829)

Document Version

Accepted author manuscript

[Link to publication record in Manchester Research Explorer](#)

Citation for published version (APA):

Dinsdale, G., Moore, T., Manning, J., Murray, A., Atkinson, R., Ousey, K., Dickinson, M., Taylor, C., & Herrick, A. (2018). Tracking digital ulcers in systemic sclerosis – a feasibility study assessing lesion area in patient-recorded smartphone photographs. *Annals of the rheumatic diseases*, 77(9). <https://doi.org/10.1136/annrheumdis-2017-212829>

Published in:

Annals of the rheumatic diseases

Citing this paper

Please note that where the full-text provided on Manchester Research Explorer is the Author Accepted Manuscript or Proof version this may differ from the final Published version. If citing, it is advised that you check and use the publisher's definitive version.

General rights

Copyright and moral rights for the publications made accessible in the Research Explorer 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.

Takedown policy

If you believe that this document breaches copyright please refer to the University of Manchester's Takedown Procedures [<http://man.ac.uk/04Y6Bo>] or contact uml.scholarlycommunications@manchester.ac.uk providing relevant details, so we can investigate your claim.



Tracking digital ulcers in systemic sclerosis – a feasibility study assessing lesion area in patient-recorded smartphone photographs

Journal:	<i>Annals of the Rheumatic Diseases</i>
Manuscript ID	annrheumdis-2017-212829.R1
Article Type:	Letter
Date Submitted by the Author:	15-Jan-2018
Complete List of Authors:	Dinsdale, Graham; University of Manchester, Division of Musculoskeletal & Dermatological Sciences, University of Manchester, Salford Royal NHS Foundation Trust, Manchester Academic Health Science Centre Moore, Tonia; Salford Royal NHS Foundation Trust Manning, Joanne; Salford Royal NHS Foundation Trust Murray, Andrea; University of Manchester, Division of Musculoskeletal & Dermatological Sciences, University of Manchester, Salford Royal NHS Foundation Trust, Manchester Academic Health Science Centre Atkinson, Ross; University of Manchester, Wounds Research Group, Division of Nursing, Midwifery & Social Work, School of Health Sciences Ousey, Karen; University of Huddersfield, Institute of Skin Integrity and Infection Prevention Dickinson, Mark; University of Manchester, Photon Science Institute Taylor, Christopher; University of Manchester, Centre for Imaging Sciences, Division of Informatics, Imaging & Data Sciences Herrick, Ariane; University of Manchester, Division of Musculoskeletal & Dermatological Sciences, University of Manchester, Salford Royal NHS Foundation Trust, Manchester Academic Health Science Centre; Manchester University NHS Foundation Trust, NIHR Manchester Musculoskeletal Biomedical Research Centre, Manchester Academic Health Science Centre
Keywords:	Systemic Sclerosis, Outcomes research, Patient perspective

Tracking digital ulcers in systemic sclerosis – a feasibility study assessing lesion area in patient-recorded smartphone photographs

Graham Dinsdale¹, Tonia Moore², Joanne Manning², Andrea Murray¹, Ross Atkinson³, Karen Ousey⁴, Mark Dickinson⁵, Christopher Taylor⁶, Ariane L Herrick^{1,7}

1. Division of Musculoskeletal & Dermatological Sciences, University of Manchester, Salford Royal NHS Foundation Trust, Manchester Academic Health Science Centre, Manchester, UK.
2. Salford Royal NHS Foundation Trust, Salford, UK.
3. Wounds Research Group, Division of Nursing, Midwifery & Social Work, School of Health Sciences, University of Manchester, Manchester, UK.
4. Institute of Skin Integrity and Infection Prevention, University of Huddersfield, Huddersfield, UK.
5. Photon Science Institute, School of Physics and Astronomy, University of Manchester, Manchester, UK.
6. Centre for Imaging Sciences, Division of Informatics, Imaging & Data Sciences, University of Manchester, Manchester, UK.
7. NIHR Manchester Musculoskeletal Biomedical Research Centre, Manchester University NHS Foundation Trust, Manchester Academic Health Science Centre, Manchester, UK.

Corresponding author: Dr Graham Dinsdale, Clinical Sciences Building, Salford Royal Hospital, Stott Lane, Salford, M6 8HD. Email: graham.dinsdale@manchester.ac.uk

Key message: Patient-recorded photographs of digital ulcers are feasible, and photographic measurements may help monitor healing.

Author contribution statement:

GD responsible for study design, data collection, data analysis, and editing and approval of manuscript.

TM, JM responsible for data collection, and editing and approval of manuscript.

AM responsible for study design, data analysis, and editing and approval of manuscript.

RA, KO, MD, CT, AH responsible for study design, and editing and approval of manuscript.

1
2
3 Competing interests:
4

5 All authors declare no conflicts of interest.
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

Confidential: For Review Only

1
2
3 Sir,

4
5
6 Systemic sclerosis (SSc)-related digital ulcers (DU) are painful, and disabling[1-3], and digital ulcer
7
8 burden is often the primary outcome measure in clinical trials of SSc-related digital vasculopathy[4].
9
10 This is despite several studies showing a lack of agreement between rheumatologists as to what
11
12 constitutes a DU[5-8].

13
14
15 Objective outcome measures of SSc-related DUs for tracking change over time are therefore
16
17 urgently required for clinical practice and research studies. The application of digital planimetry to
18
19 clinical DU photographs has shown the possibility of fine-grained measurement of DU characteristics
20
21 (area)[9]. Our aims were to: (1) demonstrate the feasibility of patients with SSc-related DUs/digital
22
23 lesions photographing their lesions using smartphone cameras, and (2) use digital planimetry-style
24
25 software analysis on images collected from patients to measure and track lesion area as a marker of
26
27 healing or progression.

28
29
30 Patients with SSc-related digital lesions (judged to be ulcers by an experienced clinician) were asked
31
32 to photograph their lesion(s) daily, using their own smartphone, for a maximum of 35 days. All
33
34 patients gave written, informed consent. All patients were taking vasodilators, and 1 was on
35
36 immunosuppressant therapy (methotrexate). The patients received normal clinical wound care
37
38 throughout the study period, after which images were collected in-person, and stored securely for
39
40 further analysis (see Figure 1 for examples).

41
42
43 Time and date stamps were extracted for each patient image sequence to accurately describe
44
45 chronology. Images were loaded into custom digital planimetry software[9] and initially calibrated
46
47 using a fixed-size object (often the finger width) to allow comparison between images in the
48
49 sequence. For each image, the lesion area was measured by fitting an elliptical shape to the outline
50
51 of the lesion by a single observer (Figure 1). Using the calibration information, areas from each
52
53 image were finally normalised to the area measured in the first image in the sequence.
54
55
56
57
58
59
60

1
2
3 Image sequences were collected from four patients describing a total of seven lesions (one patient
4 with three lesions, one patient with two lesions, two patients with one lesion). The median (range)
5 sequence duration was 29 (13-35) days, and for number of images recorded/day 0.63 (0.31-1.00).
6
7

8
9 The relative area time course for each lesion is shown in Figure 2. On average, lesion areas had, by
10 study's end, reduced to 56% of the area measured on day 1, with six out of seven lesions reducing in
11 size over the time course.
12
13
14

15
16 This pilot study confirms that it is feasible for patients to monitor their own lesions over an extended
17 period (weeks) by taking photographs with their smartphone camera. Photographs were taken on
18 approximately 2 out of every 3 days during the study period, suggesting patients were highly
19 engaged in the process. Collected photographs were of analysable quality.
20
21
22
23

24
25 This study therefore suggests a potential new tool for monitoring of lesion status/healing, both in
26 the clinical setting, and as an outcome measure in clinical trials of SSc-related digital vasculopathy.
27
28 Further work involving larger numbers of patients is now required to validate measurements
29 produced, and to improve data collection by integrating imaging into a smartphone application.
30
31
32
33

34 35 36 37 Funding

38
39
40 This work was supported by MIMIT (Manchester: Integrating Medicine and Innovative Technology).
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

References

1. Amanzi L, Braschi F, Fiori G, et al. Digital ulcers in scleroderma: staging, characteristics and sub-setting through observation of 1614 digital lesions. *Rheumatology (Oxford)* 2010;49(7):1374-82.
2. Matucci-Cerinic M, Krieg T, Guillevin L, et al. Elucidating the burden of recurrent and chronic digital ulcers in systemic sclerosis: long-term results from the DUO Registry. *Ann Rheum Dis* 2016;75(10):1770-6.
3. Hughes M, Herrick AL. Digital ulcers in systemic sclerosis. *Rheumatology (Oxford)* 2017;56(1):14-25.
4. Galluccio F, Allanore Y, Czirjak L, et al. Points to consider for skin ulcers in systemic sclerosis. *Rheumatology* 2017;56(suppl_5):v67-v71.
5. Herrick AL, Roberts C, Tracey A, et al. Lack of agreement between rheumatologists in defining digital ulceration in systemic sclerosis. *Arthritis Rheum* 2009;60(3):878–82.
6. Baron M, Chung L, Gyger G, et al. Consensus opinion of a North American Working Group regarding the classification of digital ulcers in systemic sclerosis. *Clin Rheumatol* 2014;33(2):207–14.
7. Hughes M, Roberts C, Tracey A, et al. Does the clinical context improve the reliability of rheumatologists grading digital ulcers in systemic sclerosis? *Arthrit Care Res* 2016;68(9):1340-5.
8. Suliman YA, Bruni C, Johnson SR, et al. Defining skin ulcers in systemic sclerosis: systematic literature review and proposed World Scleroderma Foundation (WSF) definition. *J Scleroderma Relat Disord* 2017;2(2):115-120.
9. Simpson V, Hughes M, Wilkinson J, et al. Quantifying digital ulcers in systemic sclerosis: Reliability of digital planimetry in measuring lesion size. *Arthrit Care Res* 2017;Jun2:doi: 10.1002/acr.23300. [Epub ahead of print].

1
2
3 Figure legends
4
5
6
7

8
9 Figure 1. Selected examples of DU/lesion images taken from 3 sequences. Sequences demonstrate
10 the varying quality of images captured by patients (particularly the bottom sequence where there
11 are focus issues), although all were acceptable for further quantitative analysis. Top (L to R): days 1,
12 24, and 35; Middle (L to R): days 1, 4, and 12; Bottom (L to R): days 2, 7 and 18. Lesions are
13 represented by sequences 4, 5 and 6 in Figure 2 (top to bottom respectively). Top right image
14 includes example of fitted ellipse shape (yellow outline) from software analysis.
15
16
17
18
19
20
21
22
23
24

25 Figure 2. Relative area time course plots for each of 7 digital lesions. Dashed red lines indicate 100%
26 area, relative to the area measured on day 1. Lesion areas all reduced except for lesion 3 (top right).
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 **Tracking digital ulcers in systemic sclerosis – a feasibility study assessing lesion area in patient-**
4 **recorded smartphone photographs**
5

6 Graham Dinsdale¹, Tonia Moore², Joanne Manning², Andrea Murray¹, Ross Atkinson³, Karen Ousey⁴,
7 Mark Dickinson⁵, Christopher Taylor⁶, Ariane L Herrick^{1,7}
8
9

- 10
11 1. Division of Musculoskeletal & Dermatological Sciences, University of Manchester, Salford
12 Royal NHS Foundation Trust, Manchester Academic Health Science Centre, Manchester, UK.
13
14 2. Salford Royal NHS Foundation Trust, Salford, UK.
15
16 3. Wounds Research Group, Division of Nursing, Midwifery & Social Work, School of Health
17 Sciences, University of Manchester, Manchester, UK.
18
19 4. Institute of Skin Integrity and Infection Prevention, University of Huddersfield, Huddersfield,
20 UK.
21
22 5. Photon Science Institute, School of Physics and Astronomy, University of Manchester,
23 Manchester, UK.
24
25 6. Centre for Imaging Sciences, Division of Informatics, Imaging & Data Sciences, University of
26 Manchester, Manchester, UK.
27
28 7. NIHR Manchester Musculoskeletal Biomedical Research Centre, Manchester University NHS
29 Foundation Trust, Manchester Academic Health Science Centre, Manchester, UK.
30
31
32
33

34 Corresponding author: Dr Graham Dinsdale, Clinical Sciences Building, Salford Royal Hospital, Stott
35 Lane, Salford, M6 8HD. Email: graham.dinsdale@manchester.ac.uk
36
37

38
39
40 Key message: Patient-recorded photographs of digital ulcers are feasible, and photographic
41 measurements may help monitor healing.
42
43

44
45 Author contribution statement:

46 GD responsible for study design, data collection, data analysis, and editing and approval of
47 manuscript.
48

49
50 TM, JM responsible for data collection, and editing and approval of manuscript.
51

52 AM responsible for study design, data analysis, and editing and approval of manuscript.
53

54 RA, KO, MD, CT, AH responsible for study design, and editing and approval of manuscript.
55
56
57
58
59
60

1
2
3 Competing interests:

4
5 All authors declare no conflicts of interest.
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

Confidential: For Review Only

1
2
3 Sir,

4
5 Systemic sclerosis (SSc)-related digital ulcers (DU) are painful, and disabling[1-3], and digital ulcer
6
7 burden is often the primary outcome measure in clinical trials of SSc-related digital vasculopathy[4].

8
9 This is despite several studies showing a lack of agreement between rheumatologists as to what
10
11 constitutes a DU[5-8], ~~suggesting that subjective expert grading is insufficient for nuanced~~
12
13 ~~monitoring of DU healing.~~

14
15
16 Objective outcome measures of SSc-related DUs for tracking change over time are therefore
17
18 urgently required for clinical practice and research studies. The application of digital planimetry to
19
20 clinical DU photographs has shown the possibility of fine-grained measurement of DU characteristics
21
22 (area)[9]. Our aims were to: (1) demonstrate the feasibility of patients with SSc-related DUs/digital
23
24 lesions photographing their lesions using smartphone cameras, and (2) use digital planimetry-style
25
26 software analysis on images collected from patients to measure and track DU-lesion area as a marker
27
28 of healing or progression.

29
30
31 Patients with SSc-related DUs-digital lesions (judged to be ulcers by an experienced clinician) were
32
33 asked to photograph their lesion(s) daily, using their own smartphone, for a maximum of 35 days. All
34
35 patients gave written, informed consent. All patients were taking vasodilators, and 1 was on
36
37 immunosuppressant therapy (methotrexate). The patients received normal clinical wound care
38
39 throughout the study period, after which images were collected in-person, and stored securely for
40
41 further analysis (see Figure 1 for examples).

42
43
44 Time and date stamps were extracted for each patient image sequence to accurately describe
45
46 chronology. Images were loaded into custom digital planimetry software[9] and initially calibrated
47
48 using a fixed-size object (often the finger width) to allow comparison between images in the
49
50 sequence. For each DU-image, the lesion area was measured by fitting an elliptical shape to the
51
52 outline of the DU-lesion by a single observer (~~see top-right panel-Figure 1-for example of fitted~~
53
54
55
56
57
58
59
60

1
2
3 | ellipse). Using the calibration information, areas from each image were finally normalised to the area
4 measured in the first image in the sequence.
5
6
7

8 Image sequences were collected from four patients describing a total of seven lesions (one patient
9 with three lesions, one patient with two lesions, two patients with one lesion). The median (range)
10 sequence duration was 29 (13-35) days, and for number of images recorded/day 0.63 (0.31-1.00).
11
12 The relative area time course for each lesion is shown in Figure 2. On average, lesion areas had, by
13
14 study's end, reduced to 56% of the area measured on day 1, with six out of seven lesions reducing in
15
16 size over the time course.
17
18
19
20

21 | This pilot study confirms that it is feasible for patients to monitor their own ~~ulcers-lesions~~ over an
22 extended period (weeks) by taking photographs with their smartphone camera. Photographs were
23 taken on approximately 2 out of every 3 days during the study period, suggesting patients were
24
25 highly engaged in the process ~~and willing to complete the study task~~. Collected photographs were of
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

32 | This study therefore suggests a potential new tool for monitoring of DU-lesion status/healing, both
33 in the clinical setting, and as an outcome measure in clinical trials of SSC-related digital vasculopathy.
34
35

36 | Further work involving larger numbers of patients is now required to validate measurements
37 produced, and to improve data collection by integrating imaging into a smartphone application.
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

44 Funding

45
46
47 This work was supported by MIMIT (Manchester: Integrating Medicine and Innovative Technology).
48
49
50
51
52
53
54
55
56
57
58
59
60

References

1. Amanzi L, Braschi F, Fiori G, et al. Digital ulcers in scleroderma: staging, characteristics and sub-setting through observation of 1614 digital lesions. *Rheumatology (Oxford)* 2010;49(7):1374-82.
2. Matucci-Cerinic M, Krieg T, Guillevin L, et al. Elucidating the burden of recurrent and chronic digital ulcers in systemic sclerosis: long-term results from the DUO Registry. *Ann Rheum Dis* 2016;75(10):1770-6.
3. Hughes M, Herrick AL. Digital ulcers in systemic sclerosis. *Rheumatology (Oxford)* 2017;56(1):14-25.
4. Galluccio F, Allanore Y, Czirjak L, et al. Points to consider for skin ulcers in systemic sclerosis. *Rheumatology* 2017;56(suppl_5):v67-v71.
5. Herrick AL, Roberts C, Tracey A, et al. Lack of agreement between rheumatologists in defining digital ulceration in systemic sclerosis. *Arthritis Rheum* 2009;60(3):878–82.
6. Baron M, Chung L, Gyger G, et al. Consensus opinion of a North American Working Group regarding the classification of digital ulcers in systemic sclerosis. *Clin Rheumatol* 2014;33(2):207–14.
7. Hughes M, Roberts C, Tracey A, et al. Does the clinical context improve the reliability of rheumatologists grading digital ulcers in systemic sclerosis? *Arthrit Care Res* 2016;68(9):1340-5.
8. Suliman YA, Bruni C, Johnson SR, et al. Defining skin ulcers in systemic sclerosis: systematic literature review and proposed World Scleroderma Foundation (WSF) definition. *J Scleroderma Relat Disord* 2017;2(2):115-120.
9. Simpson V, Hughes M, Wilkinson J, et al. Quantifying digital ulcers in systemic sclerosis: Reliability of digital planimetry in measuring lesion size. *Arthrit Care Res* 2017;Jun2:doi: 10.1002/acr.23300. [Epub ahead of print].

Figure legends

Figure 1. Selected examples of DU/lesion images taken from 3 sequences. Sequences demonstrate the varying quality of images captured by patients (particularly the bottom sequence where there are focus issues), although all were acceptable for further quantitative analysis. Top (L to R): days 1, 24, and 35; Middle (L to R): days 1, 4, and 12; Bottom (L to R): days 2, 7 and 18. Lesions are represented by sequences 4, 5 and 6 in Figure 2 (top to bottom respectively). Top right image includes example of fitted ellipse shape (yellow outline) from software analysis.

Figure 2. Relative area time course plots for each of 7 DUs/digital lesions. Dashed red lines indicate 100% area, relative to the area measured on day 1. DU-Lesion areas all reduced except for lesion 3 (top right).

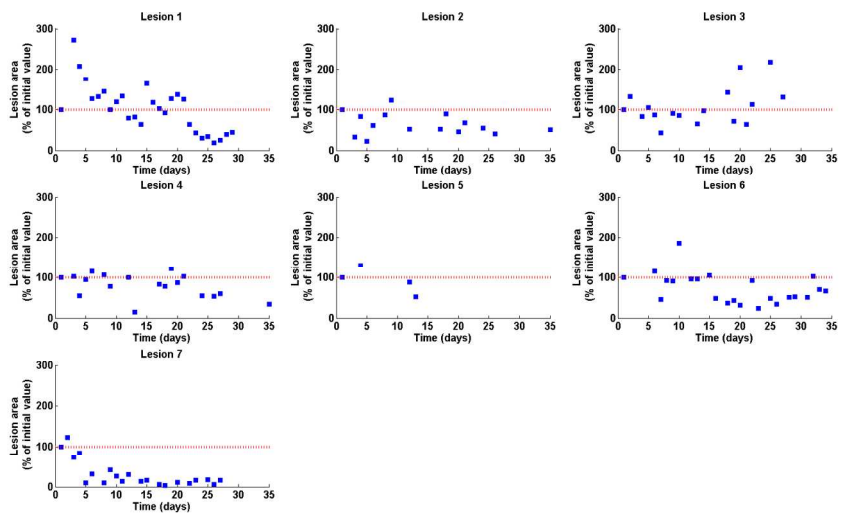


Figure 2. Relative area time course plots for each of 7 digital lesions. Dashed red lines indicate 100% area, relative to the area measured on day 1. Lesion areas all reduced except for lesion 3 (top right).

162x91mm (300 x 300 DPI)

Or Review Only



Figure 1. Selected examples of DU/lesion images taken from 3 sequences. Sequences demonstrate the varying quality of images captured by patients (particularly the bottom sequence where there are focus issues), although all were acceptable for further quantitative analysis. Top (L to R): days 1, 24, and 35; Middle (L to R): days 1, 4, and 12; Bottom (L to R): days 2, 7 and 18. Lesions are represented by sequences 4, 5 and 6 in Figure 2 (top to bottom respectively). Top right image includes example of fitted ellipse shape (yellow outline) from software analysis.

113x120mm (300 x 300 DPI)

1
2
3 Professor Josef S Smolen,
4
5 Editor, Annals of the Rheumatic Diseases
6
7

8
9 15th January 2018
10

11
12 Dear Professor Smolen,
13

14 Manuscript: **annrheumdis-2017-212829**
15

16
17 Title: **Tracking digital ulcers in systemic sclerosis – a feasibility study assessing lesion area in**
18 **patient-recorded smartphone photographs**
19

20
21
22 Thank you for your email of 5th January 2018. We are pleased at the interest in our manuscript and
23 appreciate the reviewers' comments. Our response is detailed below:
24
25

26
27 *Comments to Author:*
28

29 *Reviewer: 1*
30

31 *Comments to the Author*
32

33 *the present letter has the aim to report on the feasibility of SSc patients with DU to photograph*
34 *their lesions with a smartphone camera, and on the possibility to use digital planimetry-style*
35 *software to analyse the collected images.*
36

37 *major problems:*
38

39 *1: the number of DU is really low to draw any conclusion. The authors should add some more case*
40 *with different kind of ulcers*
41

42 *2.the pictures of DU from 3 different cases are unclear. Are these ulcers? I see scabs and healing how*
43 *do the authors define an ulcer. I have difficulties in seeing the bottom of the ulcer.*
44

45 *3.did the authors classify DU before asking the patient to take pictures?*
46

47 *4.were patients on treatment, immunosuppressant and/or vasodilating?*
48

49 *the authors ought to work on details and provide a substantially strengthened version of the paper.*
50
51

52
53
54 Authors' response
55
56
57
58
59
60

1
2
3 1: We appreciate that only a small number of digital lesions are included in our analysis. However,
4 we would stress the pilot nature of our study and that the primary objective of this work was to
5 assess the feasibility of (1) patients capturing their own images, and (2) captured images being of
6 sufficient quality that they can be further analysed as described. We think that, despite the small
7 numbers of lesions included, we have sufficiently demonstrated both aspects of this feasibility to
8 encourage further work in larger studies (now emphasised in the last sentence).
9

10
11 2: We are acutely aware of the difficulties of defining digital ulcers. For the purposes of this work we
12 included lesions that had been classed as a digital ulcer (DU) by the treating physician for
13 clinical/treatment purposes (this point has now been added in the revised manuscript) , but did not
14 specify any further restrictive criteria such as depth or specific characteristics. We are primarily
15 interested in monitoring healing using our described methods – a lesion, regardless of its status as a
16 DU, will still need to be carefully monitored for healing/progression. In order to remove potential for
17 confusion we have altered a number of references to “digital ulcers” or “DUs” to refer instead to
18 “digital lesions” or “lesions”. These changes are marked on the revised manuscript.
19
20

21 3: As above (point 2), ulcers/lesions were included following diagnosis by the treating physician. No
22 further classification was applied to the lesions, once included.
23

24 4: We have added details of the treatments (immunosuppressants and vasodilators) that the
25 patients were taking to the manuscript.
26
27
28
29

30 *Reviewer: 2*

31 *Comments to the Author*

32
33 *The authors developed a new patient-reported smartphone photograph technic and analysis to*
34 *follow the healing/worsening of digital ulcers in systemic sclerosis. The basic of a special digital*
35 *planimetry technic for quantifying digital ulcers in systemic sclerosis has already published recently*
36 *(Reference 9).*
37
38

39 *This work demonstrated the feasibility of a self-management patient photographing method to*
40 *follow their lesions using smartphone cameras. The digital planimetry-style software used in it*
41 *proved to be adequate. Correct and accurate method and demonstration.*
42

43 *After testing on a larger patient number it can be a pontential new tool both in the daily practice and*
44 *for clinical trials also.*
45

46 *Excellent methodological work but it does not fit into the original concept of the ARD.*
47
48
49

50
51 *Authors' response*

52
53 As Reviewer 2 states, we have previously published our work on digital planimetry as applied to
54 photographs of digital ulcers in systemic sclerosis (reference 9 in the manuscript). However, the
55 work in the current manuscript is concerned with 2 novel aspects: (1) the feasibility of patients
56
57
58
59
60

1
2
3 capturing images themselves using a smartphone camera (the photographs in the previous study
4 were taken by a medical photographer in the hospital), and (2) whether images taken by the
5 patients (with all the potential quality control issues that may occur) were then able to be measured
6 using digital planimetry techniques.
7

8 We agree with the reviewer that further work in a larger study is now required and (as mentioned in
9 response to Reviewer 1) have added in our last sentence '...involving larger numbers of patients'.

10
11 We would contend the point that this work does not fit into the original concept of ARD. Indeed, in
12 the "Instructions to authors" section on the ARD website the first sentence describing the "Letter"
13 format for manuscripts states: "Short clinical or laboratory observations (eg preliminary or
14 confirmatory data) may be presented as a Letter to the Editor". We would suggest that that this
15 manuscript is both "preliminary" (early stage/pilot work) and "confirmatory" (applies an analysis
16 method to a new data set).
17
18

19 We have made a small number of other changes (all tracked) to keep within the word count.
20

21 We hope that our responses have addressed the reviewers' comments satisfactorily, and we look
22 forward to hearing from you.
23
24
25

26
27 Yours Sincerely,
28
29
30
31

32
33 Graham Dinsdale (on behalf of all authors)
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