RESEARCH/Original Article

Journal of Telemedicine and Telecare
0(0) 1–7

DOI: 10.1177/1357633X20904901
journals.sagepub.com/home/jtt
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Teledermatology in paediatrics: Health-care impact on the early treatment of infantile haemangiomas

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Abstract

Introduction: Teledermatology can solve diagnostic and therapeutic problems in paediatrics, for example in infantile haemangiomas (IHs) requiring early treatment with propranolol. This study aims to assess the impact of teledermatology following its implementation in a health area of Spain, specifically analysing its effectiveness in reducing the age of first propranolol treatment for IH.

Methods: This was a descriptive study of paediatric teledermatology from 2015 to 2018, studying age, sex, diagnosis, time and mode of resolution. All IHs referred via teledermatology were analysed, and age at propranolol initiation was compared to the period prior to implementation (2008–2014). We also analysed IHs according to referral pathways (teledermatology vs. conventional pathways).

Results: We included 432 consultations (47.7% boys). The main diagnoses were IH, erythematous-desquamative diseases and infections. Concordance in diagnosis between paediatricians and dermatologists was good, and 48.12% of cases consulted via teledermatology were resolved remotely. Response time was 2.81 days on average. Children younger than two months of age showed the highest proportion of in-person visits. In 2015–2018, children with IHs began treatment with propranolol at a mean age of 4.5 months (1.9 months in those referred via teledermatology vs. 5.6 months in those using conventional referral pathways). In 2008–2014, the mean age at referral was 7.1 months. These differences were significant.

Discussion: Teledermatology is a fast and effective tool to resolve paediatric cases, enabling a significant decrease in the age of treatment in infants with IH.

Keywords

Teledermatology, paediatrics, infantile haemangioma

Date received: 21 August 2019; Date accepted: 21 September 2019

Introduction

Teledermatology allows specialists to perform remote clinical evaluation of cutaneous lesions using telemedicine techniques. Deferred teledermatology is the most common form of communication between primary-care physicians and dermatologists, and in recent years this modality has extended to other areas of health care, including paediatrics.[1–5]

One of the main purposes of teledermatology is to increase diagnostic efficiency and decrease hospital visits, but interest in this approach goes beyond the mere provision of health-care services. According to the World Health Organization (WHO),[6] together

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with the diagnostic, treatment and prevention functions associated with teledermatology, it promotes continuous communication and education amongst health professionals.[7–9]

In our health area, teledermatology was first implemented in primary health care in 2008. However, it was not until 2014 that it was extended to paediatrics for the purpose of quickly referring children with infantile haemangiomas (IHs) to their dermatologist in order to weigh options for early treatment, since in 24% of these cases, this could avoid local, aesthetic and functional complications, as well as the involvement of vital organs.[10,11]

Since 2008, when the efficacy of propranolol was established, this drug has become the first-line treatment for IHs for which it is indicated.[12] The early proliferative stage is the most appropriate time to initiate treatment.[13] As the haemangioma reaches 80% of its size at three months of age, and the stage of rapid growth occurs before eight weeks of age,[14,15] the first weeks and months of life are critical. Yet, patients are referred to specialist consultations at an average age of five months or more,[10,11,16] when the haemangioma has already reached its maximum size and caused most of its associated complications. In our setting, the implementation of teledermatology was thought to favour faster referrals and earlier treatment in patients with IH. Following an information and training programme on IH, teledermatology was implemented at the end of 2014 in the paediatric services of our health area, expanding the use of this tool not only to improve care for patients with IH but also to enable paediatricians to consult with dermatologists on other topics.

Methods

This study took place in the Health Department of Alicante General Hospital, in the Valencian Region of Spain, and had two aims: to assess the impact of teledermatology as a tool for paediatric consultation in the 2015–2018 period; and to analyse patients suspected of having IH and referred via teledermatology, specifically assessing whether this modality was effective in reducing the age of propranolol initiation.

To achieve the first objective, we performed a descriptive retrospective study of all paediatric teledermatology consultations. For the second objective, we designed an observational study comparing age at propranolol initiation during two periods: before (2008–2014) and after (2015–2018) implementation of the programme. For patients treated in the latter period, we also compared age at treatment initiation in those referred via teledermatology versus other means.

For the first objective, included patients were all paediatric patients referred through teledermatology for the first four years of implementation (January 2015–December 2018). For the second objective, we included all patients with IH who were treated with propranolol from 2008 – when the drug first started being used for IH – to December 2018.

Teledermatology consultations were undertaken with specific software housed in a hospital server with access restricted to authorised professionals in order to maintain the confidentiality of the consultations. Paediatricians submitted the case at hand, providing basic data from the clinical history and attaching various clinical images. The dermatologist responded to each teleconsultation, indicating the diagnosis and the best treatment plan to follow. The consultations could be resolved remotely, with the specialist proposing a solution without having to see the child, or patients could be referred for an in-person visit in a paediatric dermatology clinic.

Variables collected were age (months), sex, response time (days), diagnosis established by the paediatrician and dermatologist and resolution of the teleconsultation (remote vs. in-person). In patients with a diagnosis of IH, we recorded all cases treated with propranolol and the age at treatment initiation, along with cases receiving treatment with topical timolol.

Diagnoses were grouped in 10 categories: (a) IH, (b) non-IH vascular malformation, (c) changes in skin pigmentation (e.g. melanocytic nevi, hypo- and hyperpigmentation), (d) infectious pathologies, (e) eczemas and erythematous-desquamative diseases (e.g. contact dermatitis, atopic dermatitis, psoriasis, pityriasis rosea), (f) inflammatory diseases (e.g. exanthemas, granuloma annulare, non-specific erythema), (g) benign tumours, (h) diseases of the skin annexes (e.g. acne, alopecia, nail alterations), (i) other diagnoses and (j) no specific diagnosis.

Data were recorded in a Microsoft Excel database and then imported into IBM SPSS Statistics for Windows v22 (IBM Corp., Armonk, NY) for analysis. Results of the descriptive study are expressed as absolute and relative frequencies. To compare groups, we used the chi-square statistic for categorical variables and Student's *t*-test for quantitative variables. *p*-Values of <0.05 were considered statistically significant. To assess diagnostic concordance, we used Cohen's kappa coefficient. Our hospital's ethics committee approved the study.

Results

Teledermatology in paediatrics

Data from 432 teleconsultations were obtained of which 47.7% ($n = 206$) were in boys. The mean age of the study population was 51.46 months (4.28 years), and 188 (43.6%) were younger than a year old. Table 1 shows the distribution of the sample by age group.

Table 1. Characteristics of patients diagnosed via paediatric teledermatology.

Variable	Total ($N = 432$)
Sex, *n* (%)	
Male	206 (47.7)
Female	226 (52.3)
Mean age in months (*SD*)	51.46 (±54.7)
Mean age years (*SD*)	4.28 (±4.55)
Age groups, *n* (%)	
≤2 months	82 (19)
3–12 months	106 (24.5)
13–72 months (1–6 years)	109 (25.2)
73–132 months (7–11 years)	89 (20.6)
133–168 months (12–14 years)	46 (10.6)
Response time in teledermatology, days (*SD*)	2.81 (±2.93)
>7 days, *n* (%)	36 (8.3)
≤7 days, *n* (%)	396 (91.7)
≤1 day, *n* (%)	170 (39.4)
Diagnoses, *n* (%)	
Haemangiomas	99 (22.7)
Vascular anomalies	31 (7.1)
Erythematous-desquamative diseases	88 (20.1)
Infections	66 (15.1)
Pigmentation changes	58 (13.3)
Inflammatory disease	28 (6.4)
Benign tumours	18 (4.1)
Skin annex pathology	290 (6.9)
Other	6 (1.4)
No diagnosis	9 (2.1)
Resolution of teledermatology consultation, *n* (%)	
Remote	208 (48.1)
In-person	224 (51.9)

SD: standard deviation.

Mean response time in teledermatology was 2.81 days (standard deviation (SD) = 2.93 days, range 0–14 days); 396 (90.6%) of the responses took seven days or less, and 170 (39.4% of the total) took less than one day. Of the 36 consultations answered after seven days, 94% were resolved within 14 days.

The preliminary diagnoses given by the paediatricians were, in order of frequency: IH ($n = 107$; 24.5%), erythematous-desquamative diseases ($n = 78$; 17.8%), infections ($n = 69$; 15.8%) and pigmentation changes ($n = 61$; 14%). In 25 (5.7%) cases, paediatricians did not record the diagnostic suspicion in the teleconsultation form, indicating only an isolated lesion or symptom.

With regard to the (definitive) diagnoses given by dermatologists, these followed the same order of frequency and consisted mainly of IH ($n = 99$; 22.7%), erythematous-desquamative diseases ($n = 88$; 20.1%), infections ($n = 66$; 15.1%) and pigmentation changes ($n = 58$; 13.3%). The dermatologist was unable to establish a diagnosis in only nine (2.1%) patients.

Table 2. Concordance between paediatricians' and dermatologists' diagnoses.

Diagnostic concordance, paediatrician/dermatologist	Simple concordance, % (*n*/*N*)	Cohen's kappa[a]
Total	*82.4 (356/432)*	*0.793*
Haemangioma	97.2 (420/432)	0.924
Vascular malformation	97.7 (422/432)	0.815
Pigmentation changes	95.6 (413/432)	0.815
Infection	93.8 (405/432)	0.763
Erythematous-desquamative diseases	95.4 (412/432)	0.851
Inflammatory condition	97.0 (419/432)	0.739
Benign tumour	96.1 (415/432)	0.352
Skin annex pathology	98.1 (424/432)	0.842

[a]Strength of concordance: $\kappa = 0.81$–1.00: very good; $\kappa = 0.61$–0.80: good; $\kappa = 0.41$–0.60: moderate; $\kappa = 0.21$–0.40: weak; $\kappa \leq 0{:}20$: poor.

In 356/432 cases, the paediatrician's and dermatologist's diagnoses were similar, for a simple concordance rate of 82.4% and a kappa value of 0.793 (good concordance). The only group of diseases for which the diagnostic correlation was very low was tumour pathologies; in the rest, concordance was good or very good, with the highest levels observed in diagnoses of IH ($\kappa = 0.924$; Table 2).

A total of 207 (48.1%) teleconsultations were resolved virtually, while 224 (51.9%) required an in-person assessment. Excluding IHs, the proportions of remote resolution of cases and hospital referrals were similar: 50.6% and 49.4%, respectively.

The pathologies in which a large percentage of referrals were avoided comprised erythematous-desquamative diseases (62.1%), infections (61.5%) and pigmentation changes (53.4%), while hospital referrals were still the dominant mode of diagnostic resolution for vascular malformations (87.5%), tumours (77.8%) and IHs (59.6%). Significant differences between remote and in-person assessments were observed only for vascular malformations ($p < 0.001$) and erythematous-desquamative pathologies ($p = 0.002$).

Hospital referrals decreased with the patient's age, as 244 (34%) of the children aged one year or older were referred to hospital compared to 188 (66%) infants (<12 months). The youngest age group (<2 months) was also the group most frequently referred to the clinic (71.8%). In both cases, this difference was significant ($p = 0.001$).

The IHs referred via teledermatology ($n = 99$) were more frequent in girls ($n = 60$; 60.6%) than in boys. Mean age at consultation was 8.25 months ($SD = 21.9$ months). This group included 10 cases of haemangiomas in children older than 12 months of age. If we exclude this subgroup, the mean age of

referral for children with IH was 5.3 months, and 78.8% of these were referred before their first birthday, at a mean age of three months. In 52 cases, the children were younger than 2 months of age. Additionally, of the 82 patients referred before reaching two months of age, 52 (63.4%) were IH, and 15 (18.3%) were vascular malformations. Dermatologists responded in less than a week in 87 (87.9%) cases, and in less than 24 hours in 34 (44.4%) cases. The mean response time was 3.16 days ($SD = 3.87$ days). Forty (40.4%) cases were resolved remotely, while the other 59 (59.6%) required an in-person visit. Half of the referred IHs (49/99; 50.5%) were not treated, 28.3% (28/99) received topical timolol and 22.7% (21/99) were treated with oral propranolol (Table 3).

Teledermatology in IH

Between 2008 and 2018, 131 patients with IH were treated with propranolol: 44 (33.7%) boys and 94 (66.4%) girls. The mean age at treatment initiation was 5.6 months ($SD = 5.6$ months). Of these, 60 (45.8%) were attended from 2008 to 2014 (before implementation of teledermatology); the mean age at treatment initiation was 7.1 months (28.2% were aged two months old or less). From 2015 to 2018, when paediatricians could submit teledermatology queries, 71 (54.2%) patients were treated: 21 (29.6%) of these were the subject of teledermatology consultations, while 50 (70.4%) were referred by other means. The mean age at treatment initiation in this period was 4.5 months ($SD = 6$ months), and 28 (71.8%) began treatment before two months of age. In this second study period, the mean age of patients referred via teledermatology was 1.9 months ($SD = 1.5$ months), and 71.4% of patients were aged two months or younger. Infants referred through other pathways were aged 5.6 months on average, and just 26% were aged two months or younger. These differences were statistically significant (Table 4).

Table 3. Characteristics of teledermatology consultations in patients with infantile haemangioma.

Variable	Participants (N=99)
Boys, *n* (%)	39 (39.42%)
Girls, *n* (%)	60 (60.6%)
Mean age in months (±*SD*)	8.25 (±21.9)
Age group, *n* (%)	
≤2 months	52 (52.5)
3–12 months	37 (37.4)
>12 months	10 (10.1)
Teledermatology response time, mean (±*SD*) days	3.16 (±3.87)
>7 days, *n* (%)	12 (12.1)
≤7 days, *n* (%)	87 (87.9)
≤1 day, *n* (%)	34 (44.4)
Mode of resolution in teledermatology cases, *n* (%)	
Remote	40 (40.4)
In-person	59 (59.6)
Treatment, *n* (%)	51 (49.5)
Oral propranolol	21 (22.7)
Topical timolol	28 (28.28)

Discussion

Telemedicine, in its real-time and deferred variants, is a tool of undisputed utility,[17–21] and in paediatric dermatology, it entails evident advances at both the health-care level (early diagnosis and treatment, patient-centred focus)[2,4,22,23] and training level.[1,7] Mobile applications have even been used to share images with children's parents.[24–27]

Our study, like others,[3] focused on the deferred modality (storage and subsequent submission) in order to avoid interfering with paediatricians' normal routine and also to evaluate response times by specialised dermatologists.[28] This telemedicine model favours excellent cooperation between primary and specialised care, reducing wait times, enhancing the fluidity of communication between health-care levels and producing very positive impacts on quality of care.[29]

The total number of consultations we included was similar to those reported in some other studies[3,28] but higher than in most. Distribution by sex was also quite

Table 4. Haemangiomas treated with propranolol before (2008–2014) and after (2015–2018) implementation of teledermatology.

				2015–2018		
Total, $N = 131$	2008–2014, $N = 60$ (45.8%)	2015–2018, $N = 71$ (54.2%)	*p*	Telederm., $N = 21$ (29.6%)	No telederm., $N = 50$ (70.4%)	*p*
Mean (±*SD*) age at treatment initiation in months						
5.6 (±5.6)	7.1 (±4.9)	4.5 (± 6)	0.008	1.9 (±1.5)	5.6 (±6.8)	*0.015*
Treatment initiated at ≤2 months of age, *n* (%)						
39 (29.8%)	11 (28.2%)	28 (71.8%)	*0.004*	15 (71.4%)	13 (26%)	*<0.001*

similar.[2,22] We did not take into account patients' ethnicity, unlike some other authors.[1]

Our patients' average age was lower than that of other study populations,[1,3,4] and because we classified patients into age groups (a departure from methods reported elsewhere), our data demonstrated that 43.5% of the patients were infants younger than one year old, and 19% were younger than two months old (in just over half of these, the diagnosis was IH). The clearly significant difference in comparison with other diagnoses ($p < 0.001$) reflects primary-care paediatricians' awareness of this condition and their efforts to refer patients to specialists promptly – a key goal of paediatric teledermatology. We also noticed that the age group generating the fewest remote consultations was adolescents (10.6%), in consonance with the same trend seen in in-person visits. We analysed the distribution of consultations according to season, an analysis we did not see in other studies, observing a slight decrease in summer, coinciding with the summer holidays, and a slight increase in spring, perhaps attributable to increased incidence of infectious pathologies or exacerbations of erythematous-desquamative dermatoses.

We consider the dermatologist's response time in telematic consultations to be a very relevant variable, reported only by Paradela[28] ($M = 2.07$ days; $SD = 2.20$ days), with figures that are very similar to ours ($M = 2.81$; $SD = 2.9$ days). Overall, 91.7% of the responses were sent within a week, and 39.4% were sent within a day, which obviously favours the necessary good relationship between primary and specialised care. The summer saw a non-significant increase in the response time – to a mean of 3.95 days ($SD = 4$ days) – while fewer total consultations also took place in this season, in fitting with a holiday period.

The data obtained in relation to the most frequent diagnoses given, both by paediatricians and by remote dermatologists, show a high proportion of IH in paediatric dermatology diagnoses. This is unsurprising, as the reasons for implementing teledermatology in the first place resided in efforts to control this pathology. The frequency of the other conditions is consistent with those reported elsewhere, with some discrete differences according to how diagnoses are grouped.[2–4,28] Broadly speaking, the reasons for teleconsultation generally coincided with those for in-person visits.[30,31]

Concordance between the initial diagnoses made by paediatricians and the definitive diagnoses made by dermatologists was quite good, especially in diagnoses of haemangioma ($\kappa = 0.924$). Low concordance was only apparent for tumoural pathologies. Our results differ from other studies showing much lower paediatrician–dermatologist concordance, which Batalla[3] estimated at 56%, Chen[2] at 48% and Paradela[28] at 39%. Regarding the mode of resolution of teledermatology consultations, in-person visits were slightly more frequent for haemangiomas (52%), as the early evaluation of these lesions was the reason behind implementing teledermatology. If we exclude this diagnosis, the proportion of cases resolved remotely is 50.6% compared to 49.4% requiring a hospital visit. These results are consistent with other studies.[3] The pathologies that are predominantly resolved remotely include erythematous-desquamative diseases (62.1%), followed by infections (61.5%), which is also similar to the study by Batalla,[3] the only other one that studied the mode of resolution by diagnosis. Tumour pathologies most frequently required in-person visits (77.85%), probably due to the need to consider surgical solutions, as also reported by these authors.[3]

The higher referral rates for in-person visits in our series is justified, in the case of haemangiomas (59.6%), by the objective of the programme and, in the case of vascular malformations (87.1%), by the need for an adequate differential diagnosis. Furthermore, we observed that independently of diagnosis, infants younger than 12 months of age – and within this group, those younger than two months of age – were more likely to be referred to hospital ($p < 0.001$ in both cases). This could be because the pathologies affecting this age group require greater diagnostic confirmation.

We highlight the high percentage of children younger than 12 months of age with IH (78.8%), who are sent early (3 months) for assessment, as well as 81.7% of children younger than two months old presenting with IH or vascular malformations, the latest pathologies included in the differential diagnosis for IH in this age group. This result indicates a high level of awareness among paediatricians regarding the need to refer infants rapidly who are suspected of having IH.

The second objective of our study is more novel, in that it evaluates the specific clinical impact of teledermatology on the age of treatment initiation in children with IH. To our knowledge, this topic has not been specifically studied before, although authors have proposed the possible utility of teledermatology for favouring an early approach to serious pathologies, including IH.[32,33] Nowadays, the consensus is that early treatment for IH with propranolol, when indicated, is crucial for achieving optimal functional and aesthetic results and for avoiding complications.[10,13,15] Because they routinely examine babies at 15 days, one month and two months of age, paediatricians are the professionals best situated for early detection and referral of suspected cases to dermatology services, where specialists can identify the IHs that are most amenable to treatment. Teledermatology allows a fluid relationship between both parties.

Analysing the IHs treated with propranolol, we showed that in our paediatric health area, implementing teledermatology was effective in reducing the age of treatment initiation. In light of the results obtained

(Table 4), of the 131 IHs treated in 2008–2018, there was a significant difference in the age of treatment initiation, from 7.1 months in the pre-teledermatology period (2008–2014) to 4.5 months after implementation (2015–2018). Furthermore, in this last period, we observed that age at treatment initiation in children referred via teledermatology (1.9 months) was lower – and below the gold standard cut-off of two months – compared to those referred through conventional pathways (5.6 months). Another result of note was that 28 (28.3%) children received topical timolol, an emerging treatment option for some moderate-risk IHs that avoids systemic treatments.[34,35]

Limitations of our study include the assumption that the dermatologist's remote diagnosis was true, rather than the diagnosis made by the paediatrician. We do not believe this greatly affected the results obtained, given the high concordance (82.4%). In addition, we did not evaluate other aspects of this modality, such as parents' or paediatricians' satisfaction. However, this was not one of our study aims. The most important limitation of the study is the non-random allocation to study groups in the pre- and post-implementation analysis, which could have introduced bias in the comparison between groups.

In conclusion, pathologies consulted via teledermatology showed a similar distribution to those using conventional referral pathways. Remote consultations avoided the need for in-person hospital visits in about half the cases overall, but more in cases of erythematous-desquamative diseases and infections and in older patients. We highlight the speed of the dermatologist's response as key in ensuring a fluid and effective relationship between health-care levels. The rate of diagnostic agreement between paediatricians, the remote dermatologist and the specialist making the in-person diagnosis was high. We confirm that teledermatology has contributed to a reduction in age at propranolol initiation. We consider that using this modality as a routine tool in primary paediatric care could be beneficial for improving patient outcomes.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The authors received no financial support for the research, authorship and/or publication of this article.

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