Teledermatology to support self-care in Chronic Spontaneous Uticaria

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Abstract

Chronic spontaneous urticaria (CSU) is an autoimmune prompted skin disorder whose hallmarks include the unpredictable onset of hives and itch.1,2 Symptom duration typically exceed 6 weeks, and flares can occur for up to 5 years or longer if untreated,3 impacting potentially any area of the body.4 The absence of obvious triggers and the variation in onset frequency often delays formal diagnosis which on average is ~ 2 years from first presentation.5 Initial standard of care is the use of low through to higher strength antihistamines in first instance, with eventual escalation to prescription anti-inflammatory agents and potentially biologics once patients are under managed care.6 The societal impacts of delays in diagnosis are marked, with data suggesting CSU impacts up to 1% of the population, primarily of working age and with twice the prevalence in women.5 Herein we advocate for the deployment of smartphone imaging and generative AI technology to improve detection and early management of CSU through integrated self-care approaches. Such approaches, embodying the tenets of P4 personalized medicine,7 could have sustained impact on the disease through awareness campaigns, reducing the burden on the dermatology community and facilitating earlier access to curative therapeutic interventions.

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Viewpoint

Title: Teledermatology to support self-care in Chronic Spontaneous Uticaria

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Abstract: Chronic spontaneous urticaria (CSU) is an autoimmune prompted skin disorder whose hallmarks include the unpredictable onset of hives and itch.[1,2] Symptom duration typically exceed 6 weeks, and flares can occur for up to 5 years or longer if untreated,[3] impacting potentially any area of the body.[4] The absence of obvious triggers and the variation in onset frequency often delays formal diagnosis which on average is ~ 2 years from first presentation.[5] Initial standard of care is the use of low through to higher strength antihistamines in first instance, with eventual escalation to prescription anti-inflammatory agents and potentially biologics once patients are under managed care.[6] The societal impacts of delays in diagnosis are marked, with data suggesting CSU impacts up to 1% of the population, primarily of working age and with twice the prevalence in women.[5] Herein we advocate for the deployment of smartphone imaging and generative AI technology to improve detection and early management of CSU through integrated self-care approaches. Such approaches, embodying the tenets of P4 personalized medicine,[7] could have sustained impact on the disease through awareness campaigns, reducing the burden on the dermatology community and facilitating earlier access to curative therapeutic interventions.

Keywords: Dermal imaging, Chronic spontaneous urticaria, diagnosis, teledermatology, self care

Introduction:
Dermatological conditions are estimated to afflict nearly 2 billion people globally, yet because of historical shortages of expert dermatologists the majority of cases are addressed by general practitioners, resulting in lowered diagnostic accuracy and delays in patients receiving optimized care. Chronic Spontaneous Uticaria (CSU) is representative of this conundrum, with patients typically addressing symptoms periodically and episodically with anti-histamine agents which provide short term relief from symptoms but do not address root cause. With powerful disease modifying prescription agents now available it becomes imperative that patients' symptomatic presentations are documented then adequately assessed to allow escalation as soon as practicable. Given the rich structural and topological elements associated with symptoms (hives, itch), there is natural interest in the use of imaging technologies coupled with computational tools to improve diagnosis. In one recent teledermatological study involving over 16,000 cases, a deep learning system was deployed on photographic images and demonstrated high diagnostic accuracy.[8] The rapid evolution of mobile health technologies has now resulted in standardized methods for sharing of personal health images using smartphone technologies and has resulted in dedicated support apps for CSU such as CRUSE.[9] A key to the long term deployment of and adherence to these solutions lies at the intersect of behavioral and social sciences,[10] and we explore tactics herein which may lead to more widespread adoption.

Discussion:
The impact of digital health on modern medicine is being witnessed in multiple areas most dramatically where patients obtain medical related information on symptoms and potential

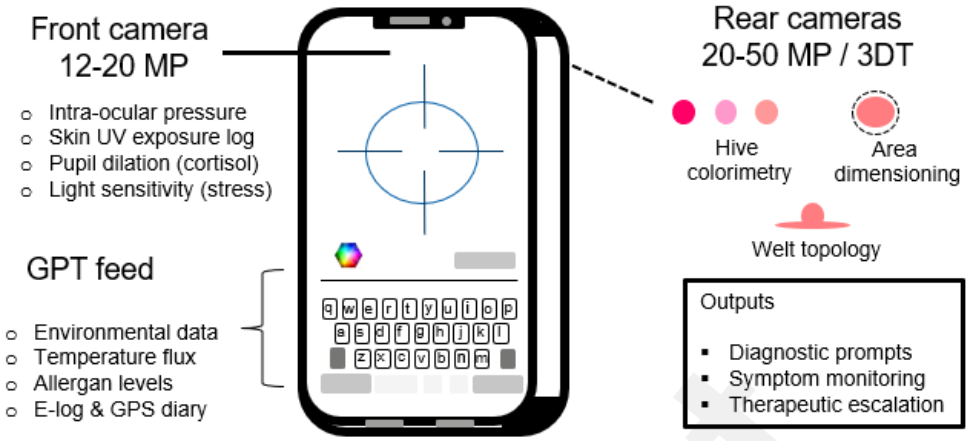


Figure 1. Specimen CSU relevant passive & active monitoring

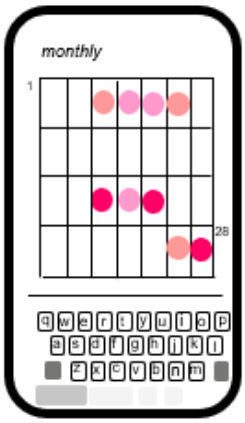
remedies.[11] Though quality and validity of this information varies greatly, there is increased awareness surrounding skin related diseases together with methods, typically using smartphone cameras, to assess visual characteristics to aid diagnosis.[12] In the case of CSU, some of the visible hallmarks are hives and welts whose appearance, locations, dimensions and topology are potentially useful indicators in diagnosis, self-care, and outcomes assessments (Figure 1).[4] Although some way off from providing clinical grade characterization, these features could be useful in (i) raising awareness and prompting a patient to seek medical care (ii) serving as time-stamped reference points to track disease progression and (iii) confirming any observed treatment effects e.g. from topical adjuvants, over the counter symptomatic agents or prescribed disease modifying therapies. If used with precision and guidance, such information could become a key component in the patients electronic health record, in the same manner as patient recorded outcomes or self-assessment questionnaires have utility as part of a patients composite case history. To achieve desired medical grade standard will require active dialog with professional dermatological societies, including standardized formats, rules and metrics for image capture and storage, procedures to validate images against controls, verification and authentication that it is associated with the patient, and informed consenting for upload and sharing of data.[13] Nonetheless rapid progress is being observed and there is every reason to believe that such approaches will be embraced by the medical community and become integral components of telehealth based care of dermatological conditions in the future.

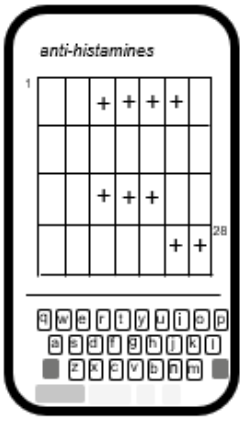
While these efforts progress, there is need to consider additional aspects of self-care which can help improve adherence to best practices and promote lifelong engagement with patients beyond addressing visual symptoms. A key to this approach is to consider behavioral and environmental factors which impact the patient on a perpetual basis, to drive engagement at multiple touch points. Ideally these can be achieved using a single device, and it turns out that the modern smartphone offers multiple options in this regard. For example, staple environmental factors including allergen levels in the atmosphere, ambient temperature, barometric pressure and relative humidity are all potential contributing factors in triggering immune responses.[14] Precision data, linked to GPS coordinates, can be provided on a real time basis to smartphones, and AI /GPT based alerts could be directed to the patient – e.g. on entering an area with high levels of specific pollens. This could be of additional relevance if recent dermatological images of CSU related features (Figure 1) are stored on the smartphone and used to prompt alerts – e.g. need for symptomatic therapy dose escalation. There may also be potential for pre-emptive action to avoid disease triggering. The environmental based data could alert a patient to reconsider an action (e.g. walking in a particular area) but the front camera of the smartphone could also be of utility. The sensors of this camera could be engaged automatically (e.g. unlocking via retina scan) and have the ability to measure numerous features including intraocular pressure[15] and pupil dilation.[16] Both of these metrics correlate with elevated levels of plasma cortisol, which itself is a biomarker for stress and a potential trigger for CSU.[17] Likewise, light sensitivity and heightened UV exposure to facial

skin are also potential immune-mediated triggers and could be detected and measured through the front camera sensor (Figure 1).[18] Taken in sum, there are multiple opportunities to frame CSU patient self-management through the medium of the smartphone and in doing so provide an effective mechanism for risk avoidance, real-time education, and longitudinal disease monitoring.

Integrating into managed care:

To successfully implement a smartphone based tracking tool into managed care for CSU patients will require careful consideration of the patient-provider interface. Whether managed by a specialist dermatologist or primary care physician, there are a number of common scoring tools available including the Urticaria Activity Score (UAS), Urticaria Control Test (UCT), and Chronic Urticaria





Symptom	Daily	Weekly	Occasional	Impacting work?
Hives			X	
Itch		X		
Sleep loss	X			X
Fatigue	X			
Anxiety	X			X
Depression		X		
Angioedema			X	

Figure 2. Combining images & medication log with activities of daily living data to assess control

Quality of Life Questionnaire (CU-Q2oL).[19] These scales can provide key insights to disease history and impact and inform treatment plans. This said, their deployment is not widespread or uniform, as there is a natural tendency for providers to treat presented visual symptoms, initially with anti-histamines. Since a high percentage of patients are refractory to antihistamine treatment administered at the standard dose, there is potential for patients to disengage from care resulting in impact to quality of life. The envisioned app could provide, on demand, a digital log of any visual symptoms, a patient provided log of impact on quality of life, and potentially a log of medication history from which to assess impact of both therapeutics themselves and dosage (Figure 2). Such digital records could also serve to inform insurer and payer claims by offering accurate insight to impact on quality of life, potentially supporting decisions on dose escalations or the need to consider switching to alternate or higher efficacy medications to control symptoms and co-morbidities.[20] Although patient reported outcomes constitute components of existing diagnostic tools,[19] there may be potential for higher levels of engagement if provisioned on the patients personal device, in an app which also imports personal images and medication logs. There may also be the potential to keep patients engaged in their care in the absence of flares/symptoms e.g. by careful design of features in the app which celebrate ‘days clear of symptoms’ through prompts. Clearly if approached appropriately, there is potential for such an app to strengthen the interactions between patient and provider, based on longitudinally captured data and where the patient becomes more pro-active in care of their condition. More specifically, given the limited time available for typical patient-physician consults, the availability of this digital data could help maximize productivity and drive to improved outcomes.

The road to implementation:

The evolution of digital tools for patient self-management continues apace and in the case of CSU, the smartphone offers high potential to become a core component and contributor to patients EHR’s. In order to realize the myriad benefits and opportunities outlined herein the following are anticipated next steps:

- Alignment between CSU patient advocacy groups and technology developers to optimize existing tools and design next generation apps and SDK's which can be customized around the individual patient
- Discussion with medical professional societies on required features, sensors, and SaMD grade algorithms needed in devices and patients on which features would be of highest relevance to them
- Development of standardized frameworks for data capture, storage, and sharing respectful of GDPR's
- The development of additional teledermatology media for patients (blogs, resources, apps) and the medical community (scholarly journals, scientific conferences)

It is anticipated that many of the features and concepts outlined could be offered through patient support networks provisioned by developers of symptomatic and disease modifying therapies, typically through native apps or web portals. However, a key to the approach advocated herein is to more fully engage the patient on their terms, through their lived experiences in a highly personalized manner. The combination of smartphone sensors coupled with powerful generative AI features, both of which are trained and evolved around the individual patient themselves has a high probability of achieving this goal and we encourage the dermatology community to embrace this vision with enthusiasm.

Potential conflicts of interest: The authors are employees of Novartis Pharmaceuticals. Views expressed are those of the authors and Novartis Pharmaceuticals had no influence on the content of the submitted manuscript. References cited were selected using search engines (SciFinder, Google Scholar) on the basis of scientific relevance, with priority afforded to most recent exemplars. Generative AI was not used in any portion of the manuscript.

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