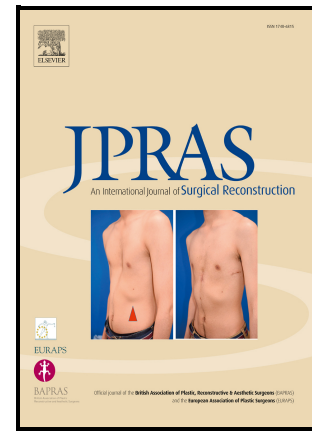


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Quantifying the clinical and economic burden of desquamating dermatological conditions: implications for a supraregional burns centre

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Abstract

Introduction: This study sought to identify the spectrum of desquamating skin diseases referred for tertiary burns care and quantify the care requirements and expense associated with caring for these patients within the burns service.

Methods: Patient records were identified with non-burn induced skin loss between 2016 and 2022. Data was extracted from inpatient records, operative notes, dressing clinic records. A cost analysis was conducted using figures from the National Schedule of National Health Service Costs and our own unit-specific costs.

Results: 20 patients were identified, with a median age of 46.5 and median TBSA of 30%. The mean length of stay was 21.2 days with 8/20 patients requiring intensive care. Overall mortality was 30%, rising to 50% if patients required ITU admission. Patients had a mean of

1.5 procedures under general anaesthesia and a mean operative time of 169 minutes per patient. Post-operatively, a mean of 8.3 dressing changes were required per patient (range 1-21). 75% of patients were referred as suspected toxic epidermal necrolysis syndrome (TENS) yet, only 32% of patients histologically had TENS (32%), with linear IgA disease, pemphigus vulgaris, and bullous lupus comprising the other diagnoses. Cost analysis predicted a total cost to the unit of £1,422,106.

Conclusion: Desquamating dermatological diseases are life-threatening conditions with exhaustive care requirements. Our experiences highlight the importance of awareness of the range of desquamating skin conditions beyond TENS to enable optimum management, and the need to ensure adequate financial provisions to accommodate the care requirements mandated by these patients.

Key words: Burns, desquamation, dermatology, service provision

Introduction

As the largest organ in the body, the skin plays a multitude of essential roles in mediating homeostasis, immunity and providing a sense of identity. As such, disruptions in the integrity of the skin present challenges for multidisciplinary clinical teams in Burns, Plastic Surgery and Dermatology alike. Whilst the mechanism of skin loss may differ between the patients under each of these specialties, there are overarching management principles in massive skin loss that may encourage shared care between services ¹.

Dermatological conditions in which there is skin loss may manifest with similar needs to burns patients, presenting similar physiological challenges, dressing requirements and a need for extensive multidisciplinary input ². As such, burns and plastic surgery may be called upon with a view to facilitating or even leading the management of patients with these conditions. Desquamating dermatological skin conditions differ to burns in their aetiology but share the potential to be severe, debilitating and potentially fatal ^{3,4}.

The demand for inpatient care for these patients has major implications for burns surgeons, many of whom will be required to lead the management of their inpatient care, particularly where Level 3 care is mandated ². As a burns service there are additionally cost implications associated with the intensive care, operative and dressing burdens to manage their skin loss ⁵. Moreover, these conditions confer diagnostic and management challenges: the clinical features of erythema, blistering and desquamation are shared features of many dermatological conditions whilst the underlying pathogenesis can vary widely ^{3,6}. Therefore,

when faced with desquamating conditions, it is important to appreciate the scope of pathologies that underpin these presentations and have an awareness of the different investigations that may be warranted to elucidate an underlying aetiology.

In the context of a cohort of desquamating dermatological conditions referred to our centre, the aim of this article is therefore to explore the breadth of desquamating skin conditions that may require input from the burns team and to estimate the financial implications that might ensue from managing their care. Guidance as to how these patients can be appropriately investigated and managed is provided based on the experiences and reflections of cases from our centre and the literature.

Methods

Study Design

A retrospective cohort study was designed in which data pertaining to dermatological skin conditions was extracted between the years of 2016 and 2022 from a supraregional Burns Centre: The Welsh Centre for Burns & Plastic Surgery, Morriston Hospital, UK.

Data extraction

Patients falling under the care of the Burns team between the years of 2016 and 2022 were identified using clinical records, extracting patients with diagnoses of non-burns dermatological conditions. Data pertaining to the initial working diagnosis, histological diagnosis, length of stay, intensive care admission, number of procedures and dressings, mortality and total body surface area (TBSA) were extracted from clinical records.

Cost Analysis

The National schedule of NHS costs is an open access, aggregation of costs ensued from inpatient and outpatient care records within the National Health Service. Costs associated with inpatient burns care and intensive care stays were extracted from this archive, and average values used where multiple entries were present. For specific burns related care events, estimated values for operative costs and burns dressings costs were acquired from a 2009 study from our centre and adjusted for inflation ⁵. When calculating inpatient stay, the number

of days in intensive care were subtracted from the total length of stay to acquire the duration of stay in a ward environment.

Statistical Analysis

Data was assessed for normality and a mean or median was acquired accordingly. To ascertain the spread of data, the range, standard deviation and interquartile range are presented. Statistical analysis was conducted using GraphPad Prism software (Version 9.5.0).

Results

Patient Demographics and Clinical Implications

A total of 20 patients were identified between the years of 2016 and 2022. The mean number of cases per year was 2.86, with an increase in the number referred for specialist burns care increased from 2016 to 2022 (Figure 1).

The median age of the patients was 46.5 (IQR: 21.75-66.25), and the median TBSA affected by desquamation was 30% (IQR: 9.5-62).

There was a mean length of stay of 21.2 days (Range 2-53) for patients with desquamating skin conditions, of which 8 patients (40%) were admitted to intensive care (ITU) and kept in isolated rooms for infection control optimisation. All patients admitted to ITU had an initial working diagnosis of TENS. The mean duration of stay in ITU was 23.3 days (range 2-32 days) and 14.6 days in a ward environment (range 5-53).

There was a 30% in-hospital mortality associated with this patient cohort, which was expectedly higher in those requiring admission to intensive care in which a 50% mortality was observed. The primary causes of death were multi-organ failure (50%), aspiration pneumonia (25%) and sepsis (25%), with dermatological condition listed on the death certificates as either the leading or a contributing cause of death.

Patients in this cohort had a mean of 1.5 procedures under general anaesthetic each (range 0-11), with a mean operative time of 168.7 minutes per patient. The nature of these procedures were debridement and cleaning of the desquamated skin and application of dressings. The primary reasons for warranting surgical intervention were in cases of extreme desquamation or necrosis (where debridement was necessary), for the application of Biobrane®, and where infection was suspected. Dressing changes were subsequently managed in isolated side rooms where possible. There was a mean of 4.3 dressing changes recorded per patient (range 1-21), however detailed dressings data was unavailable for 3 patients.

Clinical and Histological Diagnosis

Of the patients admitted under the care of the burns team, 75% were referred with an initial working diagnosis of Toxic Epidermal Necrolysis Syndrome (TENS) or Stevens Johnson Syndrome (SJS, Figure 2). Tissue biopsies were performed in 14/20 cases (70%), of which only 32% actually confirmed a diagnosis of TENS. Of the cases where a drug reaction was felt to underlie the pathogenesis of TENS, co-trimoxazole was the most common precipitant ($n=2$), followed by piperacillin-tazobactam and carbamazepine. Figure 2 outlines the other histological diagnoses confirmed by biopsy, which included pemphigus vulgaris, pemphigus paraneoplastica, pyoderma gangrenosum, bullous lupus, linear IgA dermatosis, acute exanthematous pustulosis and staphylococcal scalded skin syndrome, highlighting the extensive variety of dermatological conditions that may clinically emulate TENS and SJS (Figure 3).

Cost Analysis

A cost analysis was conducted to determine the economic burden of providing burns level care for patients with desquamation (Table 1). Costings were categorised by year and on the basis of requiring ward or ITU level care, the number of general anaesthetic procedures required in an operating theatre environment (debridement and dressings) and subsequent dressing changes. The majority of dressings used acutely were Jelonet® (70% of cases) or Mepilex®. For more extensive cases of desquamation such as TENS; Bactigras®, Biobrane® and Acticoat® were used as adjuncts to Jelonet® in the management of these patients.

Expectedly, the most expensive intervention was ITU level care, with a mean cost of £91,392.68 per patient for a mean duration of 23 days and a total estimated cost of £731,141.41 over the 6-year period. There was no correlation between TBSA and duration of ITU stay however ($R^2 = 0.03$). The next most costly intervention was theatre under general anaesthetic, for which dermatology patients required an average of 168.7 minutes of operative time, costing approximately £37,599 per patient and a total of £496,310 over 6 years. Inpatient ward-based care incurred a mean cost per patient of 14,121.30 for a mean duration of 14.6 days, totalling 146,691.41 over the 6-year period. Dressing changes for these patients incurred an average cost of £1,239.56 per patient for a mean of 4.3 dressings per patient, totalling £25,163.11 over the 6-year study period.

In total, the anticipated costs incurred to the burns service for caring for patients with desquamating skin conditions was found to be £1,422,106.40, equating to £71,105 per patient. Of note, as the number of patients being referred for burns care has increased in South Wales over the last 6 years, so too have the annual costs associated with the care of these patients:

£567,743.69 in 2022 compared to 160,427.28 in 2016 (Table 2). The care requirements for dermatological skin loss patients are extensive, and as such have implications for commissioning and budgeting within the burns service.

Discussion

In this study, we have highlighted the breadth of dermatological conditions that may be referred for care under the burns service. A stark finding is that whilst 75% of referrals are initially felt to reflect TENS clinically, the disease processes underlying extensive desquamation are significantly more diverse. This presents challenges to burns surgeons, who are not conventionally trained to detect the nuances between dermatological conditions and may not necessarily be familiar with the investigations and management of rarer desquamating conditions such as bullous lupus or pemphigus paraneoplastica, for example. Moreover, there are some desquamating skin conditions with which a more sinister aetiology may underpin the desquamation. Where TENS and SJS are commonly precipitated by medications, especially antibiotics and certain antiepileptics, pemphigus paraneoplastica is a condition that arises in the context of an occult or confirmed malignancy⁷. Paraneoplastic pemphigus is a rare but severe form of pemphigus, arising in approximately 5% of patients with internal malignancies, the most common of which are lymphoproliferative diseases such as non-Hodgkin lymphoma and chronic lymphocytic leukaemia⁸. This particular diagnosis has a poor prognosis, with a mortality of 70-90%, and requires treatment of the underlying malignancy to be curative, but may be supportively managed with corticosteroids and monoclonal antibodies such as rituximab^{7,8}. In contrast, desquamating skin conditions such as staphylococcal scalded skin syndrome have a low mortality of 1-3%, and rather than immunosuppression, requires prompt treatment with intravenous antibiotic therapy⁹. There is as such an urgent need to be able to rapidly detect, diagnose and treat desquamating skin conditions, placing additional demands on the knowledge required of burns specialists. In particular, the importance of acquiring an early tissue diagnosis through incision or punch biopsy is reinforced in these patients, plus the need to engage with the wider multidisciplinary team including intensivists, anaesthetists and especially dermatologists is paramount.

In addition to the increasing demands on clinical decision making, the care requirements of these patients are complex, mirroring the physiological insults of a burn injury with regard to impaired thermoregulation, insensible losses and immunocompromise, compounded by an underlying pathological process that may be driven by autoimmunity, malignancy or infection. It is an unsurprising finding, therefore, that the duration of stay of these patients was typically in excess of two weeks in a burns ward and up to 53 days in an ITU environment. Moreover, where the severity of a burn is typically determined at or within the initial few days post-injury,

dermatological skin loss may evolve, recur and progress despite surgical intervention and supportive therapy. This may be particularly prominent in pathologies such as pyoderma gangrenosum and pemphigus vulgaris, and as such lengthy admissions and recurrent treatments should be anticipated in the care of these patients ^{10,11}.

With prolonged hospital stays and intensive care requirements comes significant costs, and this was certainly demonstrated through the cost analysis performed in this study. The most costly intervention was intensive care, and owing to the TBSA and relapsing and remitting course of many of these conditions, the duration of intensive care admission was often lengthy, with a mean duration of 23 days and a total cost of £687,046 over the 6 year period. Coupled to the demands for frequent dressing changes and intervention under general anaesthesia (debridement and dressing), our mean estimate is approximately £64,00 per patient. With the increasing frequency of referrals observed in our unit over the past 6 years, the annual cost in 2022 was almost half a million pounds to care for these patients. These costs have significant implications for resource allocation and funding for burns services. In the UK, the costs associated with the management of burns patients, have been reported as ranging from £12,553 to £71,000 per patient in high income countries ^{5,12,13}, meaning the cost of care for dermatological patients in this study is comparable to the published figures of burns patients. There are fewer studies pertaining to the costs of caring for desquamating dermatological conditions, however studies from Thailand and the Netherlands have offered cost estimates equating to £1,600 - £36,000 ^{14,15}. Our costs were significantly higher than these estimates, perhaps owing to the severity of cases that are referred for our input, with a mean TBSA of 30% in this study, but also reflecting differences in treatment strategies, the use of intensive care admission and costing methodology used in these studies.

The reason for the increase in referrals observed in our unit is likely to be multifactorial. The last decade has seen a sequential closure of dermatology inpatient beds, leading to a loss of specialised inpatient wound care expertise should these patients require hospitalisation ¹. It is unsurprising that general medical wards may be overwhelmed by the skillset and time demands of adequately caring for patients with extensive cutaneous disorders, and as such the onus appears to be shifting towards burns specialists for the management of not only patients with TENS and SJS but indeed a multitude of desquamating dermatological conditions. As such, as burns surgeons, our clinical and diagnostic skillset must adapt to meet the increasing demands on our services and formalised joint management between dermatology and burns must be implemented to ensure the best and most cost-effective outcomes can be achieved for these patients. Furthermore, it must be ensured that adequate

financial provisions are instated to support the lengthy and complex care these patients require.

Conclusions

This study has demonstrated the broad range of dermatological conditions referred as desquamation to burns specialists and highlighted the importance of acquiring the correct histological diagnosis early to expedite appropriate management. Mortality in these cases is high, and lengthy and the need for extensive debridement and dressings should be anticipated when accepting these patients under the care of the burns service. There are significant cost implications associated with the care of these patients, which warrants consideration when planning and allocating resources within healthcare settings.

Conflict of Interest Statement

None to declare

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Ethical approval: Not required

Patient consent: Written informed consent has been acquired for all images used in this study to be used for publication

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Table 1: Cost Analysis for inpatient ward stay, intensive care stay, theatre management and dressing changes incurred over the 6-year study period (2016-2022)

Item	Year	Mean per patient (days)	Number of patients	Cost per day (£)	Total cost (£)
Ward stay	2016	7	2	669.06	9,366.84
	2017				
	2018	5	1	703.97	3,519.85
	2019				
	2020	19	2	722.68	27,461.84
	2021	15.5	2	741.38	22,982.78
	2022	26.25	5	808.84	106,160.25
	Mean	14.6	1.0	729.19	14,124.30
	Total	128	12		169,491.56
	Year	Mean per patient (days)	Number of patients	Cost per day (£)	Total cost (£)
ITU stay	2016	27	1	4092	110,484.00
	2017	32	1	4201.79	134,457.28
	2018	17	2	4305.92	146,401.28
	2019				
	2020				

Theatre	2021	17.3	3	4354.73	226,010.49
	2022	23	1	4947.32	113,788.36
	Mean	23.3	1.0	4380.35	91,392.68
	Total	128	8		731,141.41
	Year	Mean per patient (minutes)	Number of patients	Cost per minute (£)	Total cost (£)
	2016	240	1	155.73	37,375.20
	2017	120	1	159.16	19,099.20
	2018	180	2	163.1	58,716.00
	2019				
	2020	40	1	167.44	6,697.60
	2021	72	3	171.77	37,102.32
	2022	360	5	187.4	337,320.00
	Mean	168.7	1.0	167.43	37,599.27
	Total	128	13		496,310.32
Dressing change	Year	Mean per patient	Number of patients	Cost per dressing change (£)	Total cost (£)
	2016	7.0	2	228.66	3,201.24
	2017	n/a	1	234.12	0.00
	2018	1.0	2	239.92	479.84
	2019	1.0	1	244.22	244.22
	2020	5.3	3	246.29	3,940.64
	2021	5.4	5	252.67	6,822.09
	2022	6.3	6	275.66	10,475.08
	Mean	4.3	1.0	245.93	1,239.56
	Total	128	20		25,163.11
	Grand Total				1,422,106.40

Table 2: Annual costing associated with desquamating dermatological patient care between 2016-2022.

Year	Total Cost
2016	160427.28
2017	153556.48
2018	209116.97
2019	244.22
2020	38100.08
2021	292917.68
2022	567743.69
Total	1422106.40

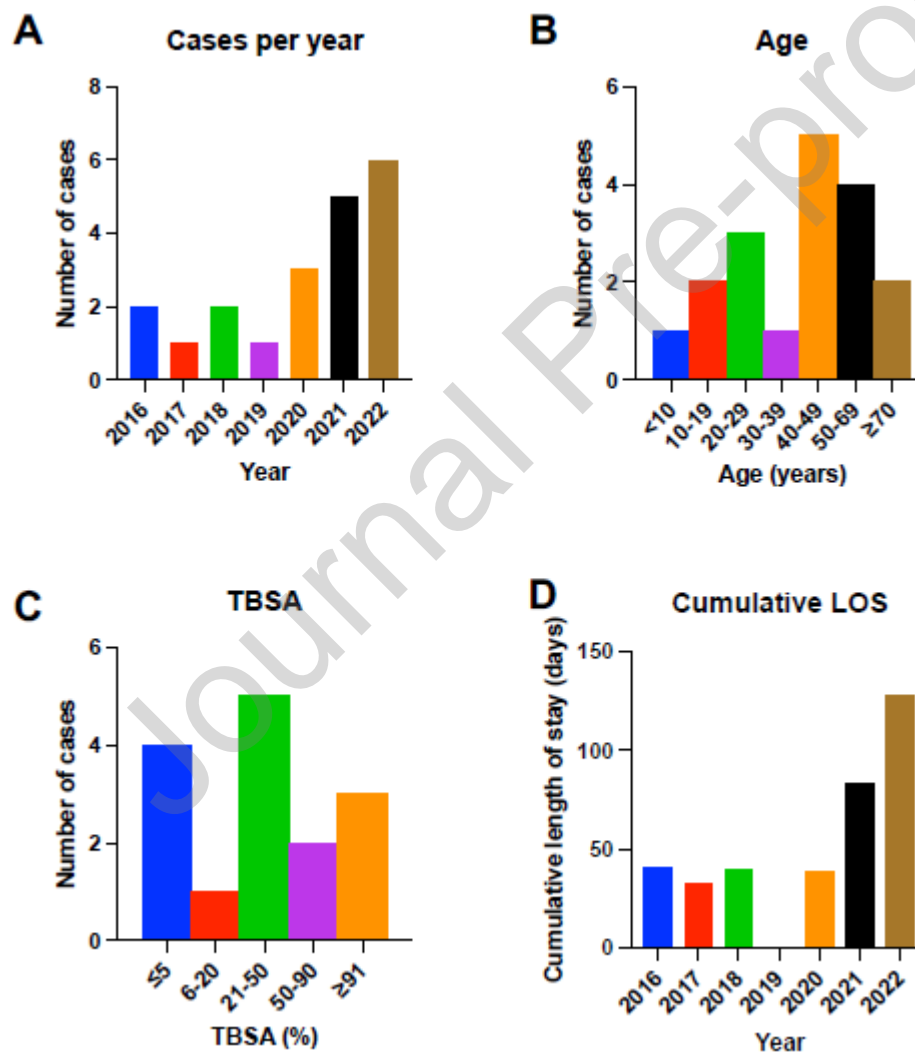
Figure Legends:

Figure 1: Demographics of patients admitted between 2016 and 2022 with desquamating skin diseases. A) Total number of cases referred per annum. B) Age distribution of patients referred with desquamation are presented over the 6 year period. C) The range of estimated total body surface area (TBSA) is presented through the 6 year period. D) The cumulative

length of stay for each year is presented to reflect the number of days allocated to dermatology patients per annum.

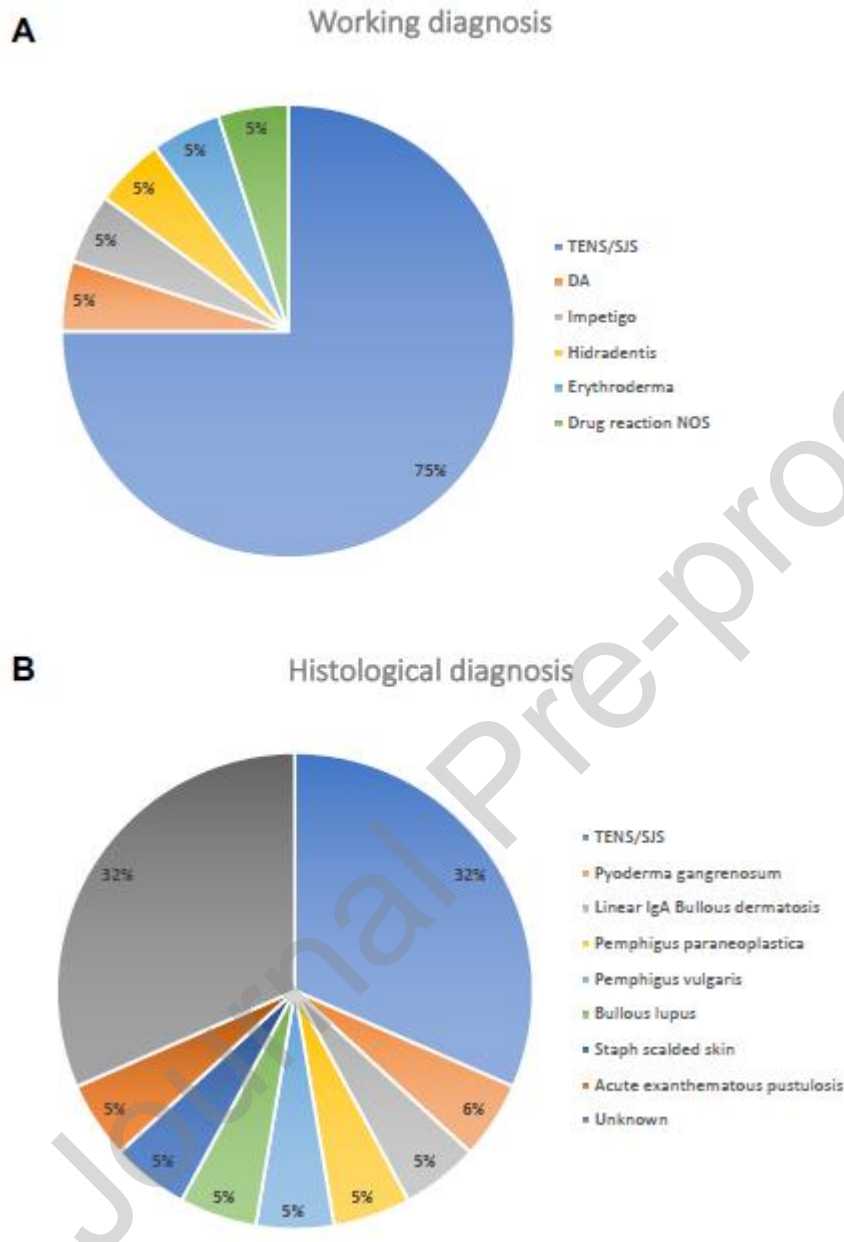


Figure 2: Pie charts to demonstrate A) the proportion of patients referred with a working diagnosis of Toxic Epidermal Necrolysis Syndrome (TENS), Stevens Johnson Syndrome (SJS), Dermatitis artefacta (DA), and other dermatological conditions compared to B) the actual histological diagnoses post biopsy.



Figure 3: Clinical photographs of desquamating dermatological conditions needing burns input. (A-B) Photos of a 6 month old child initially diagnosed with impetigo (B) with extensive torso desquamation (A-B) and a final diagnosis of Staphylococcal scalded skin syndrome. (C) Cutaneous facial erosions initially suspected to be dermatitis artefacta, histologically confirmed as pyoderma gangrenosum. (D-E) Blistering patches of desquamation affecting the upper (D) and lower (E) limbs initially thought to reflect TENS or dermatitis herpetiformis, diagnosed histologically as linear IgA bullous dermatosis. (F-G) Extensive erythema and desquamation in a lady with Toxic Epidermal Necrolysis Syndrome. (H) Patches of desquamation affecting the anterior and posterior torso and upper limbs reflecting Stevens Johnson Syndrome.