Check for updates

Contact Dermatitis

WILEY

CONTACT DERMATITIS

ORIGINAL ARTICLE OPEN ACCESS

High Diagnostic Yield of Testing With a Diabetes Device Screening Series in Patients With Suspected Allergic Reactions to Glucose Sensors, Insulin Patch Pumps and Insulin Infusion Sets

Norbertus A. Ipenburg[1] | Emma M. van Oers[2] | Anton C. de Groot[1] | Mounir Yaâkoubi[2] | Thomas Rustemeyer[1]

[1]Dermato-Allergology and Occupational Dermatology, Amsterdam University Medical Center, Amsterdam, the Netherlands | [2]Amsterdam University Medical Centers, Amsterdam, the Netherlands

Correspondence: Anton C. de Groot (antondegroot@planet.nl)

Received: 9 July 2026 | **Revised:** 11 September 2026 | **Accepted:** 13 October 2026

Keywords: adhesive extract | allergic contact dermatitis | colophonium | diabetes | dicyclohexylmethane-4,4′-diisocyanate | glucose sensor | insulin pump | isobornyl acrylate | patch testing | screening series

ABSTRACT

Background: Patch testing in patients with dermatitis from diabetes devices is challenging because device composition is nearly always undisclosed, relevant allergens are incompletely known, and many suspected allergens are not commercially available.

Objectives: To evaluate the diagnostic yield of a dedicated diabetes device screening series, supplemented with a (meth)acrylate series and testing of patients' own device adhesives and adhesive extracts, in patients with suspected allergic contact dermatitis to glucose sensors, insulin patch pumps, or infusion sets.

Materials and Methods: We performed a retrospective patch test study of 100 patients referred to a tertiary referral centre for suspected allergic reactions to diabetes devices.

Results: Seventy-one patients reacted to one or more allergens in the diabetes device screening series; in 50 (70.4%), at least one reaction was clinically relevant. The most frequent relevant allergens were colophonium and its related substances abietic acid and hydroabietyl alcohol, isobornyl acrylate, dicyclohexylmethane-4,4′-diisocyanate, and *N,N*-dimethylacrylamide. The (meth) acrylate series had no clear additional diagnostic value. Testing with patients' own device adhesives and extracts frequently identified allergic reactions to devices not recognised by the results of the screening series alone.

Conclusion: The combined approach identified relevant contact allergies in most patients with suspected allergic contact dermatitis to diabetes devices.

Abbreviations: 2,4-DTBP, 2,4-di-*tert*-Butylphenol; 2-PEA, 2-Phenoxyethyl acrylate; AA, Abietic acid; BA, Butyl acrylate; BDDMA, 1,4-Butanediol dimethacrylate; BEMA, Benzyl methacrylate; BHT, Butylated hydroxytoluene; Bis-GMA, Bisphenol A-glycidyl methacrylate; Bis-MA, Bisphenol A dimethacrylate; BUMA, Butyl methacrylate; CEA, Carboxyethyl acrylate; COL, Colophonium; DCMDI, Dicyclohexylmethane-4,4′-diisocyanate; DDM, 4,4′-Diaminodiphenylmethane; DMAA, *N,N*-Dimethylacrylamide; DMAEMA, Dimethylaminoethyl methacrylate; DPGDA, Dipropylene glycol diacrylate; DPMDI, Diphenylmethane 4,4′-diisocyanate; DUDMA, Diurethane dimethacrylate; EA, Ethyl acrylate; ECA, Ethyl 2-cyanoacrylate; EGDMA, Ethylene glycol dimethacrylate; EPA, Epoxy acrylate; FSL, FreeStyle Libre; HA, Hydroabietyl alcohol; HCPK, Hydroxycyclohexyl phenyl ketone (1-benzoyl cyclohexanol); HDDA, 1,6-Hexanediol diacrylate; HEMA, 2-Hydroxyethyl methacrylate; HMME, Hydroquinone monomethyl ether (4-methoxyphenol); HPMA, Hydroxypropyl methacrylate; IBOA, Isobornyl acrylate; IBOMA, Isobornyl methacrylate; IPDI, Isophorone diisocyanate; MBPA, 2,2'-Methylenebis(6-*tert*-butyl-4-methylphenol) monoacrylate; MMA, Methyl methacrylate; PEEA, Phenoxypoly(ethyleneoxy)ethyl acrylate; TEGDMA, Triethylene glycol dimethacrylate; THFMA, Tetrahydrofurfuryl methacrylate; TMPTMA, Trimethylolpropane trimethacrylate; TPGDA, Tripropylene glycol diacrylate.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2026 The Author(s). *Contact Dermatitis* published by John Wiley & Sons Ltd.

1 | Introduction

Continuous glucose monitors, patch pumps and insulin infusion sets have substantially improved diabetes care. They enable more precise glucose monitoring and insulin delivery, reduce the burden of disease management, and may contribute to better glycaemic control and quality of life [1, 2]. However, the increasing and prolonged use of these devices has also been accompanied by skin problems in a considerable proportion of users, including irritant contact dermatitis, pressure-related skin damage and allergic contact dermatitis (ACD) [3–5].

ACD to diabetes devices is diagnosed by patch testing, but this is often challenging. The chemical composition of devices is never fully disclosed, relevant allergens are incompletely known, many suspected allergens are not commercially available as patch test preparations, and the composition of the devices may be changed without notice [3, 6, 7]. In addition, for newly suspected allergens, reliable test concentrations and vehicles are often lacking. As a result, relevant contact allergies may remain undetected when only standard patch test series are used [6–8].

The diagnostic yield may be improved by using a dedicated screening series containing allergens previously identified in diabetes devices, supplemented where appropriate by additional allergens and by testing patients' own devices [6–8]. We recently developed such a diabetes device screening series for use in patients referred with suspected ACD to glucose sensors, patch pumps, or insulin infusion sets.

The aims of this study were to evaluate the diagnostic yield of this diabetes device screening series; to assess whether additional testing with a (meth)acrylate series identified further relevant allergies; and to investigate the added value of testing patients' own products, including the optimal choice of test materials.

2 | Materials and Methods

2.1 | Patients

This retrospective study was conducted at the Department of Dermato-Allergology and Occupational Dermatology of Amsterdam University Medical Center among patients seen between June 2024 and March 2026 for standard clinical care. Consecutive patients with diabetes mellitus who were referred for patch testing because of suspected ACD to glucose sensors, insulin pumps, or insulin infusion sets were included. As Amsterdam University Medical Center is a tertiary referral centre, patients were referred by dermatologists, internists, diabetologists, or other secondary care medical specialists; referrals from general practitioners were not accepted. Medical histories were obtained using a standardised questionnaire administered by a resident or dermatologist 2–4 weeks before the patch test appointment.

2.2 | Patch Tests

Patients were patch tested with the European baseline series (EBS), our Diabetes Device Screening series (DDS series), a (meth)acrylate series, a series of acetone extracts of the adhesives and housing from nine diabetes devices, adhesives and adhesive extracts from devices brought in by patients, and personal products used in conjunction with diabetes devices, such as additional adhesives, tapes, skin cleansing products, underpatches, barrier sprays, and barrier wipes. Not all patients could be tested with all materials; this is specified in the Results section.

The European baseline series was purchased from SmartPractice Europe (Allergeaze; www.smartpracticeeurope.com). The DDS series consisted of 25 compounds, including colophonium from the EBS and two concentrations of the allergen isobornyl acrylate. The compounds, concentrations, and suppliers are listed in Table 1. Of these, eight were obtained from Allergeaze, five from Chemotechnique Diagnostics (www.chemotechnique.se), and 12 were prepared in-house.

The DDS series was based on 21 allergens that had been reported to be present in one or more diabetes devices, either by chemical analysis or according to information provided by the manufacturer, and had been implicated in cases of ACD caused by these devices. 4,4′-Diaminodiphenylmethane was added as a screening agent for allergy to diphenylmethane-4,4′-diisocyanate [9]. Hydroquinone monomethyl ether was added because it is often present in acrylate raw materials from Sigma-Aldrich to prevent spontaneous polymerisation; for example, 2-carboxyethyl acrylate contains 900–1100 ppm hydroquinone monomethyl ether as an inhibitor [10].

The (meth)acrylate series consisted of 15 acrylates and methacrylates. The series is smaller than the (meth)acrylate series used for other patients [11], as some allergens in the larger series were already present in the DDS series. The allergens, test concentrations, and suppliers are listed in Table 1. 2-Hydroxypropyl methacrylate, benzyl methacrylate, epoxy acrylate, and trimethylolpropane trimethacrylate were not tested throughout the entire study period; this is specified in the Results section.

The device extract series comprised five glucose sensors (Dexcom G6, Dexcom G7, FreeStyle Libre 3, Guardian 4, and Simplera Sync), two patch pumps (Omnipod 5 and TouchCare SmartOne Nano 200 U), and two infusion sets (Ypsomed Orbit Soft and Ypsomed Inset) (Table 1).

Patch testing was performed using Van der Bend patch test chambers (Van der Bend, Brielle, The Netherlands), fixed with Omnifix elastic (Paul Hartmann BV, Nijmegen, The Netherlands). The occlusion time was 48 h. Reactions were read on day (D)2, with a second reading on D3, according to European Society of Contact Dermatitis (ESCD) criteria [12]. D7 readings were not routinely performed; however, all patients were instructed on two occasions to contact the department if new reactions developed after the final reading. Written informed consent was obtained from all participants.

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 | Composition of the diabetes device, (meth)acrylate and device extract series.

Test series + allergens	Abbreviation	Concentration[a]	Provider
Diabetes device series			
Abietic acid	AA	10.0%	A
Butyl acrylate	BA	0.1%	A
Butylated hydroxytoluene	BHT	2.0%	A
2,4-di-*tert*-Butylphenol	2,4-DTBP	1.0%	S-A (I-H)
Carboxyethyl acrylate	CEA	0.1%	S-A (I-H)
Colophonium[b]	COL	20.0%	A
4,4′-Diaminodiphenylmethane	DDM	0.5%	A
Dicyclohexylmethane-4,4′-diisocyanate	DCMDI	1.0%	S-A (I-H)
N,N-Dimethylacrylamide	DMAA	0.3%	S-A (I-H)
Diphenylmethane 4,4′-diisocyanate	DPMDI	0.5%	S-A (I-H)
Dipropylene glycol diacrylate	DPGDA	0.1%	TCI (I-H)
Ethyl acrylate	EA	0.1%	C
Ethyl 2-cyanoacrylate	ECA	5.0%	C
1,6-Hexanediol diacrylate	HDDA	0.1%	C
Hydroabietyl alcohol	HA	10.0%	A
Hydroquinone monomethyl ether	HMME	1.0%	S-A (I-H)
Hydroxycyclohexyl phenyl ketone (1-benzoylcyclohexanol)	HCPK	5.0%	S-A (I-H)
Isobornyl acrylate	IBOA	0.1%	A
	IBOA	0.3%	S-A (I-H)
Isophorone diisocyanate	IPDI	1.0%	C
2,2′-Methylenebis(6-*tert*-butyl-4-methylphenol) monoacrylate	MBPA	1.5%	FS (I-H)
Methyl methacrylate	MMA	2.0%	A
2-Phenoxyethyl acrylate	2-PEA	0.1%	S-A (I-H)
Phenoxypoly(ethyleneoxy)ethyl acrylate	PEEA	0.1%	S-A (I-H)
Tripropylene glycol diacrylate	TPGDA	0.1%	C
(Meth)acrylate series			
Benzyl methacrylate	BEMA	2.0%	S-A (I-H)
Bisphenol A dimethacrylate	Bis-MA	2.0%	C
Bisphenol A-glycidyl methacrylate	Bis-GMA	2.0%	C
1,4-Butanediol dimethacrylate	BDDMA	2.0%	C
n-Butyl methacrylate	BUMA	2.0%	C
N,N-Dimethylaminoethyl methacrylate	DMAEMA	0.2%	C
Diurethane dimethacrylate	DUDMA	2.0%	C
Epoxy acrylate	EPA	0.5%	C
Ethylene glycol dimethacrylate	EGDMA	2.0%	C
2-Hydroxyethyl methacrylate	HEMA	2.0%	C
2-Hydroxypropyl methacrylate	HPMA	2.0%	C

(Continues)

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 | (Continued)

Test series + allergens	Abbreviation	Concentration[a]	Provider
Isobornyl methacrylate	IBOMA	2.0%	S-A (I-H)
Tetrahydrofurfuryl methacrylate	THFMA	2.0%	C
Triethylene glycol dimethacrylate	TEGDMA	2.0%	C
Trimethylolpropane trimethacrylate	TMPTMA	2.0%	S-A (I-H)
Device extract series			
Dexcom G6 (Dexcom Inc.)		Acetone extract	I-H
Dexcom G7 (Dexcom Inc.)		Acetone extract	I-H
Guardian 4 (Medtronic MiniMed Inc.)		Acetone extract	I-H
Omnipod 5 (Insulet Corporation)		Acetone extract	I-H
Simplera Sync (Medtronic MiniMed Inc.)		Acetone extract	I-H
TouchCare SmartOne Nano 200 U (Medtrum Technologies Inc.)		Acetone extract	I-H
Ypsomed Orbit Soft (Ypsomed AG)		Acetone extract	I-H
FreeStyle Libre 3 (Abbott Diabetes Care Ltd.)		Acetone extract	I-H
Ypsomed Inset (Unomedical a/s)		Acetone extract	I-H

Abbreviations: A = Allergeaze, www.smartpracticeeurope.com; C = Chemotechnique, www.chemotechnique.se; FS = Fisher Scientific, www.fishersci.com; I-H = prepared in-house; S-A = Sigma-Aldrich, www.sigmaaldrich.com; TCI = TCI Chemicals, www.tcichemicals.com.
[a]All allergens in the diabetes device screening series and (meth)acrylate series w/w in petrolatum.
[b]Present in the European baseline series.

Positive patch test reactions to allergens in the DDS series were considered clinically relevant when patients had developed dermatitis from the use of devices that had been reported to contain one or more of the allergens to which they reacted [6, 13–15]. An alphabetical list of all allergens and related chemicals identified in diabetes devices, including the devices in which they have been detected, is provided in Table S1.

Before the DDS series and the device extract series were introduced, patch testing with the new allergens included in the DDS series and the extracts had shown no allergic or irritant reactions in 20 non-diabetic control patients.

2.3 | Data Collection

Data collected for each patient included the results of the patient history, the MOAHLFA parameters (male sex, occupational contact allergy, atopic dermatitis, and the presence of hand, leg, and face dermatitis and age ≥ 40 years), patch test results, the clinical relevance of positive patch test reactions, and the suspected products responsible for dermatitis. Results of patch testing with materials unrelated to diabetes devices were not included in the data collection, as they were not considered relevant to the purpose and aims of the study.

2.4 | Preparation of Acetone Extracts of Sensors, Pumps and Infusion Sets

Two types of acetone extracts were prepared for patch testing: extracts from nine commonly used diabetes devices and extracts from the patients' own devices. In both procedures, the device materials were extracted in acetone using ultrasonic treatment for 15 min at 30°C in an ultrasonic bath (Elma Schmidbauer GmbH, model S30H), and the resulting extracts were stored at 3°C until use.

For the nine commonly used diabetes devices, the adhesive patch and a piece of the device housing were extracted. For the Ypsomed infusion sets, a section of the cannula was also included. The materials were placed in 100 mL glass Erlenmeyer flasks, 10 mL of acetone was added, and the flasks were hermetically sealed with Parafilm. After ultrasonic extraction, the solid materials were removed with tweezers, and the extracts were transferred to 10 mL amber glass vials.

Patients' own diabetes devices were received by mail one week before the patch test appointment. From sensors, infusion sets, and patch pumps, half of the adhesive patch was removed and placed in amber glass vials for extraction; the remaining half was reserved for direct patch testing. Acetone, 10 mL, was added to each vial, which was then sealed with a white polypropylene plastic lid before ultrasonic extraction. After extraction, the vials were left open at room temperature to allow evaporation to a final volume of approximately 2.5 mL. The vials were then resealed and stored at 3°C.

For patch testing, 20 μL of each extract was applied to the test chamber.

2.5 | Statistical Analyses

Data were analysed descriptively. Categorical variables are presented as numbers and percentages, and continuous variables

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

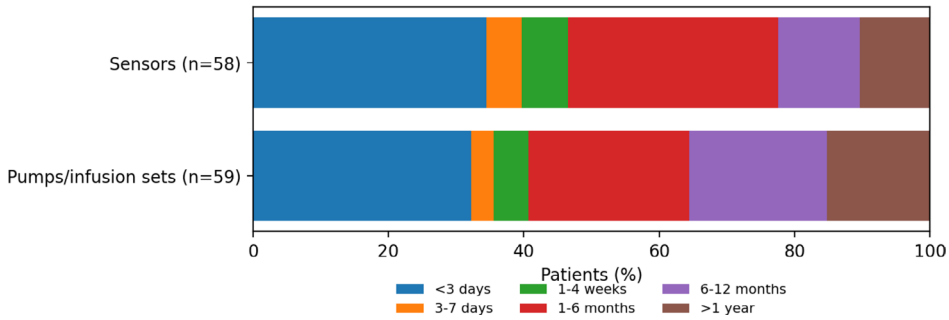


FIGURE 1 | Time from first device use to onset of skin complaints.

as mean, median and range. Associations between selected categorical variables, including MOAHLFA parameters, were analysed with two-sided Fisher's exact tests. Odds ratios (OR) with 95% confidence intervals (CI) were calculated from two-by-two tables. A p-value <0.05 was considered statistically significant.

3 | Results

Between June 2024 and March 2026, 100 patients referred to our department because of suspected allergy to diabetes devices, including glucose sensors, patch pumps, and infusion sets, were investigated.

The study population consisted of 100 patients (74 female and 26 male), aged 5–70 years, with a mean age of 29.8 years; 35 patients (35.0%) had atopic dermatitis. The cohort included 71 adults (58 women and 13 men) and 29 children younger than 18 years (16 girls and 13 boys). The age of the adults ranged from 18 to 70 years, with a mean age of 37.5 years and a median age of 35 years. The children were 5–17 years old, with a mean age of 10.8 years and a median age of 11 years. Sex was not significantly associated with a positive patch test reaction to allergens in the DDS series, with similar positivity rates in males and females (65.4% vs. 73.0%; OR 0.70, 95% CI 0.27–1.82; $p=0.463$). Patients aged <40 years were significantly more likely to have a positive reaction than those aged ≥ 40 years (77.3% vs. 52.0%; OR 3.15, 95% CI 1.22–8.17; $p=0.022$). Atopic dermatitis was also significantly associated with a positive reaction, with higher positivity among patients with atopic dermatitis than among those without (85.7% vs. 63.1%; OR 3.51, 95% CI 1.20–10.26; $p=0.021$). None of the patients had occupational dermatitis, hand dermatitis, leg dermatitis, or face dermatitis.

3.1 | Devices Used Causing Skin Complaints

All patients had used at least one glucose sensor. Eighty patients (80.0%) reported skin complaints attributed to one or more sensors; 37 (46.3%) had reacted to one sensor and 43 (53.8%) to two or more sensors. The most frequently implicated sensors were FreeStyle Libre (FSL) 2, Guardian 4, FSL 3, FSL 1 (the original FSL, termed FSL 1 for clarity), and Dexcom G7. Detailed patient-reported sensor data are provided in Table S2. Fifty-four patients reported one or more sensors that had not caused skin complaints, most commonly FSL 2, Dexcom G6, FSL 1, and FSL 3 (Table S3).

Eighty-five patients had used a patch pump or a pump requiring an infusion set. Skin complaints attributed to at least one pump- or infusion set-related device were reported by 76 patients. Forty-six patients (60.5%) reported complaints from one such device, whereas 30 (39.5%) reported complaints from two or more devices. Patch pumps accounted for 44 patient-device reports, mainly involving Omnipod variants ($n=29$, 65.9%) or Medtrum TouchCare Nano ($n=9$, 20.5%). In addition, many reports concerned infusion-set-related devices. When specified infusion sets and pump systems using known infusion-set families were considered together, most potential infusion set-related reports involved the MiniMed/Medtronic family (68.8%), followed by mylife YpsoPump/Orbit micro-related reports (29.9%). Full details are provided in Table S4.

3.2 | Patient-Reported Clinical Course

Usable data on the interval between a patient's first use of the particular device concerned and the onset of skin complaints attributed to that device were available for 58 patients for glucose sensors and 59 patients for pumps or infusion sets. In both groups, the timing was heterogeneous (Figure 1). Approximately one-third of patients reported onset of skin complaints within 3 days after first use of the particular device concerned (20/58, 34.5% for sensors; 19/59, 32.2% for pumps/infusion sets), whereas delayed onset after more than 1 month was also common (31/58, 53.4% and 35/59, 59.3%, respectively). A considerable portion of patients developed the first skin reactions after more than 6 months (sensors 13/58, 22.4%; pumps/infusion sets 21/59, 35.6%). Full data are shown in Table S5.

Horizontal stacked bars show patient-reported timing of onset after first use of glucose sensors and pumps/infusion sets. Percentages are based on patients with usable answers.

Most patients reported a localised and reproducible pattern of skin reactions. Dermatitis remained limited to the adhesive area in 64/74 patients (86.5%) for sensors and 62/70 patients (88.6%) for pumps/infusion sets. Eczema elsewhere on the body was uncommon (5/75, 6.7% and 6/72, 8.3%, respectively). Symptoms occurred at every or almost every new application in 56/65 patients (86.2%) for sensors and 59/68 patients (86.8%) for pumps/infusion sets (Figure 2).

Following application of a new unit of the same device model that had previously caused skin complaints, recurrent symptoms

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

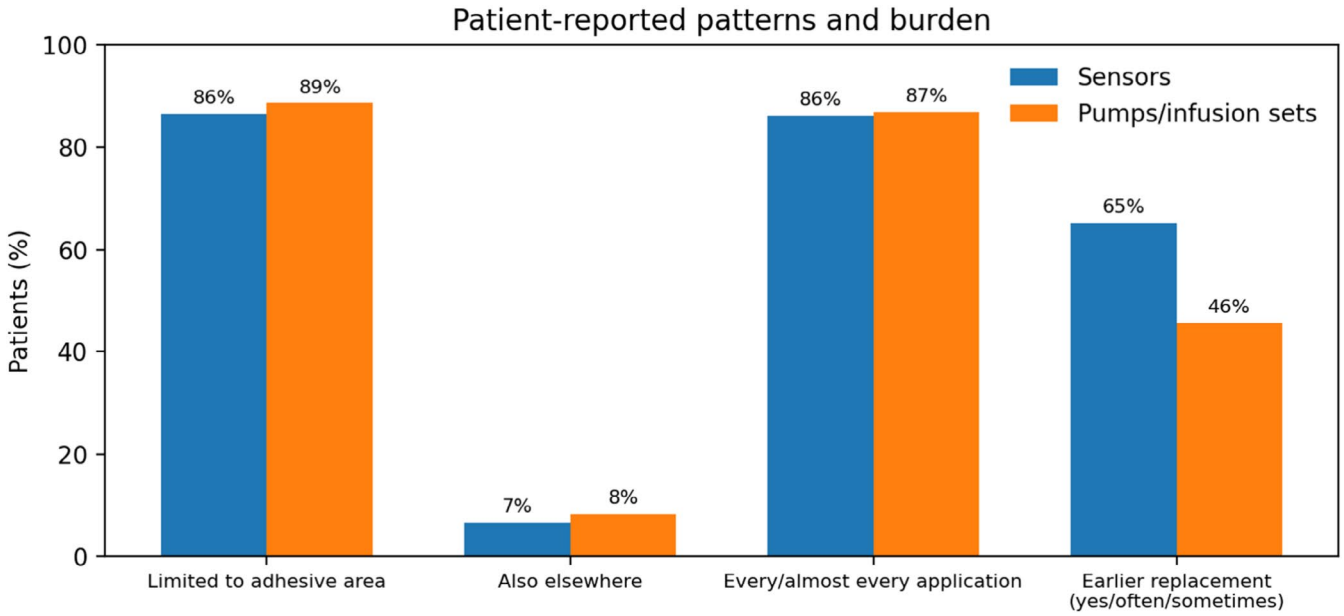


FIGURE 2 | Patient-reported clinical patterns and burden.

most often started within 1–2 days. For sensors, 44/65 patients (67.7%) reported recurrence within 2 days; for pumps/infusion sets, this was reported by 48/65 patients (73.8%). Symptoms recurred within a few hours in 12/65 (18.5%) sensor users and in 13/65 (20.0%) pump/infusion-set users. Full data are shown in Table S6.

Complaints were sufficiently severe to require earlier replacement than scheduled in 39/69 patients (56.5%) using sensors and 28/68 patients (41.2%) using pumps/infusion sets; when occasional or frequent early replacement was also included, these proportions were 45/69 (65.2%) and 31/68 (45.6%), respectively (Figure 2).

Usable data on the patient-reported effect of topical corticosteroids were available for 43 patients for sensor-related complaints and 45 for pump/infusion-set-related complaints. A clearly good effect was reported by only a minority of patients (4/43, 9.3% and 4/45, 8.9%, respectively). Full data are shown in Table S7.

Bars show the proportion of patients reporting localised dermatitis, eczema elsewhere, reproducible symptoms with each or almost each application, and earlier replacement than scheduled. For earlier replacement, yes/often/sometimes were combined.

Underpatches and barrier products were frequently tried, but the reported benefit was limited and often difficult to assess. Among 63 sensor users, 22 named products/types plus underpatches of unknown type were reported; only 10 reports (15.9%) described a good, moderate, or partial beneficial effect (Table S8). Among 52 pump or infusion-set users, 17 named products/types plus underpatches of unknown type were reported; only 3 reports (5.8%) described any beneficial effect (Table S9). Worsening of complaints or complaints caused by the product was reported in 7 sensor-related and 4 pump/infusion-set-related cases. Full product-level details are provided in Tables S10 and S11.

3.3 | Patch Test Results

3.3.1 | Patch Test Results by Series

The results of patch testing with the diabetes device screening (DDS) series are shown in Table 2. Positive reactions were found in 71 of 100 (71%) patients. The highest numbers of positive reactions were observed to colophonium ($n = 31$; 34.1%), isobornyl acrylate (IBOA) (30 reactions; 30%), hydroabietyl alcohol ($n = 29$; 29.3%), dicyclohexylmethane-4,4′-diisocyanate ($n = 22$; 22.2%) and abietic acid ($n = 20$, 20.2%).

The relative frequency of positive reactions to each allergen in the group of 71 patients reacting to one or more allergens in the DDS series is shown in Table 2. These frequencies ranged from 0% for 2,4-di-*tert*-butylphenol, diphenylmethane 4,4′-diisocyanate, and ethyl 2-cyanoacrylate to 42.3% for IBOA and 43.7% for colophonium.

The results of patch testing with the (meth)acrylate series are shown in Table 3. Positive reactions were observed in 28 of 100 patients (28%). Tetrahydrofurfuryl methacrylate and isobornyl methacrylate elicited 15 (15.0%) positive reactions and 1,4-butanediol dimethacrylate 14 (14.0%); the other allergens elicited five positive reactions or less, with ethylene glycol dimethacrylate accounting for five reactions. The relative frequencies of positive reactions to each allergen among the 28 patients who reacted to one or more allergens in the (meth)acrylate series are shown in Table 3. These frequencies ranged from 0% for five allergens to 50.0% for 1,4-butanediol dimethacrylate and 53.6% for tetrahydrofurfuryl methacrylate.

The results of patch testing with the device extract series in 36 patients are shown in Table 4. Ten patients (27.8%) had one or more positive reactions. Positive reactions were observed in 8 patients tested with the Simplera Sync extract (22.2%) and in 7 patients tested with the Guardian 4 extract (19.4%). The remaining extracts elicited three or fewer positive reactions.

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 | Results of patch testing with the diabetes device screening series.

Allergens	*n* tested	*n* positive (%)	% positive in 71 patients reacting to the DDS series	*n* relevant, patients (%)[a,c]	*n* relevant devices[b]	Culprit devices and numbers
Colophonium (European baseline series)	91	31 (34.1%)	43.7%	22 (71.0%)	33	Guardian 4 (*n* = 13); FSL 1 (*n* = 8); Medtronic oval tape (*n* = 4); Dexcom G6 (*n* = 1); Dexcom G7 (*n* = 3); Guardian 3 (*n* = 2); Omnipod (*n* = 2)
Isobornyl acrylate	100	30 (30.0%)[d]	42.3%	23 (76.7%)	42	FSL 1 (*n* = 13); Guardian 4 (*n* = 10); Dexcom G6 (*n* = 6); Dexcom G7 (*n* = 6); Omnipod (*n* = 3); Guardian 3 (*n* = 3); MiniMed Quick-set (*n* = 1)
Hydroabietyl alcohol	99	29 (29.3%)	40.8%	23 (79.3%)	38	Guardian 4 (*n* = 12); Dexcom G7 (*n* = 6); FSL 1 (*n* = 6); Dexcom G6 (*n* = 5); Medtronic oval tape (*n* = 4); Enlite (*n* = 1); Guardian (unspecified) (*n* = 1); Guardian 3 (*n* = 1); Omnipod DASH (*n* = 1); Minimed Extended (*n* = 1)
Dicyclohexylmethane-4,4′-diisocyanate	99	22 (22.2%)	31%	11 (50.0%)	15	FSL 1 (*n* = 8); Dexcom G7 (*n* = 7)
Abietic acid	99	20 (20.2%)	28.2%	13 (65%)	25	Guardian 4 (*n* = 7); FSL 1 (*n* = 7); Medtronic oval tape (*n* = 4); Dexcom G7 (*n* = 2); Omnipod (*n* = 2); Dexcom G6 (*n* = 1); Enlite (*n* = 1); Guardian 3 (*n* = 1)
Butyl acrylate	100	12 (12.0%)	16.9%	0%	0	
1,6-Hexanediol diacrylate	100	12 (12.0%)	16.9%	5 (41.7%)	6	Guardian 4 (*n* = 4); Guardian 3 (*n* = 2)
Phenoxypoly(ethyleneoxy)ethyl acrylate	100	12 (12.0%)	16.9%	0%	0	
2-Phenoxyethyl acrylate	100	10 (10.0%)	14.1%	0%	0	
Dipropylene glycol diacrylate	100	9 (9.0%)	12.7%	1 (11.1%)	1	Omnipod (*n* = 1)
N,N-Dimethylacrylamide	100	8 (8.0%)	11.3%	7 (87.5%)	13	FSL 1 (*n* = 6); Guardian 4 (*n* = 5); Guardian 3 (*n* = 1); Omnipod (*n* = 1)
Ethyl acrylate	100	6 (6.0%)	8.5%	0%	0	
Carboxyethyl acrylate	100	5 (5.0%)	7.0%	0%	0	
Hydroxycyclohexyl phenyl ketone	100	5 (5.0%)	7.0%	2 (40%)	4	Guardian 4 (*n* = 2); Dexcom G7 (*n* = 1); MiniMed Quick-set (*n* = 1)
Isophorone diisocyanate	100	5 (5.0%)	7.0%	2 (40%)	3	Guardian 4 (*n* = 2); FSL 1 (*n* = 1)
Tripropylene glycol diacrylate	100	5 (5.0%)	7.0%	1 (20%)	1	Omnipod (*n* = 1)
2,2′-Methylenebis(6-*tert*-butyl-4-methylphenol) monoacrylate	100	4 (4.0%)	5.6%	1 (25%)	1	Dexcom G6 (*n* = 1)

(Continues)

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 | (Continued)

Allergens	*n* tested	*n* positive (%)	% positive in 71 patients reacting to the DDS series	*n* relevant, patients (%)[a,c]	*n* relevant devices[b]	Culprit devices and numbers
4,4′-Diaminodiphenylmethane	100	3 (3.0%)	4.2%	0%	0	
Butylated hydroxytoluene	100	1 (1.0%)	1.4%	1 (100%)	1	FSL 3 ($n=1$)
Hydroquinone monomethyl ether	100	1 (1.0%)	1.4%	0%	0	
Methyl methacrylate	100	1 (1.0%)	1.4%	0%	0	
2,4-di-*tert*-Butylphenol	100	0 (0%)	0%		0	
Diphenylmethane 4,4′-diisocyanate	98	0 (0%)	0%	0%	0	
Ethyl 2-cyanoacrylate	92	0 (0%)	0%	0%	0	

Abbreviation: FSL: FreeStyle Libre.

[a]The number shown for each allergen in this column indicates the number of patients who had suffered skin reactions from one or more devices that are known to contain the allergen involved.

[b]The number shown for each allergen in this column indicates the total number of devices known to contain the allergen used by the patients and causing skin reactions (specified in the last column). Example with Isobornyl acrylate: Of 100 patients tested with isobornyl acrylate, 30 had a positive patch test. Of these, 23 (76.7%) had suffered from skin reactions to one or more devices known to contain isobornyl acrylate, involving a total of 42 devices (specified in the last column).

[c]Percentage of the number of patients with a positive reaction for each allergen.

[d]26 positive reactions to IBOA 0.1%, 27 to IBOA 0.3% (tested in 98/100 patients); 30 patients had positive reactions to IBOA 0.1%, 0.3% or both.

3.3.2 | Patch Test Results by Patients

Table 5 provides the following information for all 100 participants: sex, age, positive patch test reactions in the DDS, (meth)acrylate and device extract series, positive reactions to personal products, and the products causing dermatitis.

Seventy-one of 100 patients (71.0%) had one or more positive reactions to allergens in the DDS series; the number of positive reactions per patient ranged from 1 to 14. Of these 71 patients, 18 (25.4%) reacted to a single allergen, another 18 (25.4%) reacted to two allergens, 12 (16.9%) to three, 9 (12.7%) to four, and 14 patients (19.7%) to five or more allergens. Of the 30 patients reacting to IBOA, 15 (50.0%) co-reacted to isobornyl methacrylate (IBOMA) in the (meth)acrylate series.

Twenty-eight patients had positive reactions in the (meth)acrylate series, ranging from 1 to 8 reactions per patient. All 28 individuals also had one or more positive reactions in the DDS series, and only one patient, who reacted to tetrahydrofurfuryl methacrylate, had no positive reaction to any (meth)acrylates in the DDS series. Fifteen patients had positive reactions to IBOMA; all also reacted to IBOA in the DDS series.

3.4 | Clinical Relevance of Positive Patch Tests and Culprit Devices Causing Dermatitis

Using the conservative definition specified in the Methods, positive reactions were classified as clinically relevant only when the patient had developed dermatitis from a device previously reported to contain the corresponding allergen. Colophonium and its derivatives hydroabietyl alcohol and abietic acid were counted as one allergen. The devices involved and the implicated relevant allergens they contain are shown in the last column of Table 5, 'Products causing dermatitis'.

Fifty of the 71 patients (70.4%) reacting to the DDS series had clinically relevant reactions to one or more allergens in one to four devices they had used, involving a total of 80 devices. Details of these devices causing dermatitis are shown in Table S12. Six patients had dermatitis from a patch pump (5 Omnipod, 1 Omnipod DASH) and 2 from an infusion set (MiniMed Quickset and Minimed Extended). The large majority of implicated devices were sensors (72 of 80, 90.0%). The most frequently involved sensors were Guardian 4 ($n=20$), FSL1 ($n=18$), Dexcom G7 ($n=12$) and Dexcom G6 ($n=10$).

The allergens that caused ACD by their presence in these devices are specified in the Table S13. The most frequently implicated allergens were IBOA in 42 devices, hydroabietyl alcohol ($n=38$), colophonium ($n=33$), abietic acid ($n=25$), dicyclohexylmethane-4,4′-diisocyanate ($n=15$), and *N,N*-dimethylacrylamide ($n=13$) (Table S13). This table also specifies the devices causing dermatitis from the presence of each allergen.

The relative frequency of clinically relevant reactions for each allergen, the total number of devices in which the allergen was present, and the nature of the culprit devices are shown in Table 2. For IBOA, for example, 30 positive patch test reactions were observed, representing 30.0% of all patients tested and

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 3 | Results of testing with the (meth)acrylate series.

Allergens	*n* tested	*n* positive (%)	% positive in group of 28 patients allergic to the (meth)acrylate series	*n* without positive reactions to (meth) acrylates in the DDS series
Tetrahydrofurfuryl methacrylate	100	15 (15.0%)	53.6%	1
Isobornyl methacrylate	100	15 (15.0%)	53.6%	0
1,4-Butanediol dimethacrylate	100	14 (14.0%)	50.0%	0
Ethylene glycol dimethacrylate	100	5 (5.0%)	17.9%	0
2-Hydroxyethyl methacrylate	100	4 (4.0%)	14.3%	0
Triethylene glycol dimethacrylate	100	3 (3.0%)	10.7%	0
N,*N*-Dimethylaminoethyl methacrylate	100	3 (3.0%)	10.7%	0
2-Hydroxypropyl methacrylate	72	2 (2.8%)	7.1%	0
Bisphenol A-glycidyl methacrylate	100	2 (2.0%)	7.1%	0
Diurethane dimethacrylate	100	2 (2.0%)	7.1%	0
n-Butyl methacrylate	100	1 (1.0%)	3.6%	0
Benzyl methacrylate	59	0 (0.0%)	0%	0
Bisphenol A dimethacrylate	100	0 (0.0%)	0%	0
Epoxy acrylate	56	0 (0.0%)	0%	0
Trimethylolpropane trimethacrylate	59	0 (0.0%)	0%	0

42.3% of the 71 patients with positive reactions to the DDS series. Of these 30 reactions, 23 (76.7%) were clinically relevant. These 23 patients had used 42 IBOA-containing devices that had caused dermatitis; the device names and numbers are specified in the last column, 'Culprit devices and numbers'.

3.5 | Testing With Personal Products

A total of 355 personal products were tested in 87 patients who had submitted such products. These are specified in Table S14. The number of products ranged from 1–14 per patient, with a median of 3 and an average of 4.1. The products tested included 210 device adhesives or tapes and 70 corresponding adhesive or tape extracts.

Positive reactions to personal products are shown in Table 5. Reactions to one or more personal products were observed in 43 of the 87 patients in whom such products had been tested (49.4%). In these 43 patients, the number of positive reactions to personal products ranged from 1 to 5 per patient. In total, 70 positive reactions to personal products were recorded. Most were to device-related products (61 reactions in 40 patients), whereas nine reactions in eight patients were to other personal products used in relation to diabetes-device wear. The most frequently positive device-related products were Guardian 4 adhesive, Medtronic Oval Tape, Simplera Sync adhesive, Guardian 4 adhesive extract and Mylife Orbit Micro YpsoPump adhesive. Full details of positive reactions to personal products are shown in Table S15.

In 38 of the 43 patients (88.4%) with one or more positive reactions to personal products, testing of these products yielded at least one product-level finding that had not been identified through the DDS-based assessment of culprit products. Overall, 58 of the 70 positive personal product-reactions (82.9%) represented new product-level information, whereas 12 reactions (17.1%) confirmed products that had already been assigned as culprit products. Among device-related products, 49 of 61 positive reactions (80.3%) identified a product not listed in the Products causing dermatitis column of Table 5. All nine positive reactions to other personal products used in relation to device wear represented additional (new) findings. Full details of the added value of testing personal products over testing with the DDS series alone are provided in Table S16.

Among the 40 patients with at least one positive reaction to a device-related personal product, 18 had been tested with both an adhesive and an extract of the same adhesive, yielding 26 paired patient-device comparisons. In 7 comparisons, both tests were negative. In the remaining 19, both were positive in five, only the adhesive in eight, and only the extract in six. Details are shown in Table S17.

3.6 | Patterns of Co-Reactivities

Reactions to colophonium (COL) and its related compounds abietic acid (AA) and hydroabietyl alcohol (HA) occurred

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 4 | Results of patch testing with the device extract series.

Devices extracts	*n* tested	*n* positive (%)	*n* clinically relevant[a]	Co-reaction to extract of personal device[b]
Simplera Sync	36	8 (22.2%)	0	5
Guardian 4	36	7 (19.4%)	2	2
Omnipod 5	36	3 (8.3%)	0	2
Dexcom G6	36	1 (2.8%)	0	
TouchCare SmartOne Nano 200U	36	1 (2.8%)	0	
Dexcom G7	36	0 (0.0%)	0	
Ypsomed Orbit Soft	36	0 (0.0%)	0	
FreeStyle Libre 3	36	0 (0.0%)	0	
Ypsomed Inset	36	0 (0.0%)	0	

[a]The number shown for each extract in this column indicates the number of patients who had suffered skin reactions from the device in question and who reacted to one or more allergens known to be present in the device.
[b]The number shown for each extract indicates the number of patients that also reacted to an extract made from the same brand and type of personal product used by the patient. Example for Guardian 4: Of 36 patients tested with an extract made by us from a Guardian 4, 7 (19.4%) had a positive reaction to it. Of these 7, 2 had developed skin reactions from Guardian 4 caused by one or more allergens to which the patient reacted. Of patients who were also tested with an extract of their personal Guardian 4, 2 also reacted to this extract.

in 43 patients (Table S18). Of these, 17 patients (39.5%) had a single reaction (COL, $n=7$; HA, $n=9$; AA, $n=1$), 15 patients (34.9%) reacted to two allergens, and 11 patients (25.6%) reacted to all three allergens. Of the 30 patients reacting to IBOA in the DDS series, 15 (50.0%) co-reacted to IBOMA in the (meth)acrylate series. All 15 patients reacting to IBOMA also reacted to IBOA.

4 | Discussion

4.1 | Clinical Burden of Allergic Reactions to Diabetes Devices

The patient-history data underline the clinical burden of allergic reactions to diabetes devices, at least in this group of patients referred to a tertiary care facility. Most patients reported a localised and reproducible dermatitis pattern, usually confined to the adhesive area and recurring with every or almost every new application. This clinical pattern is highly compatible with ACD, although irritant dermatitis and mechanical factors may also have contributed in some patients.

The burden of device-related dermatitis was further reflected by the need for premature device replacement. Many patients, particularly sensor users, reported having to replace devices earlier than scheduled because of skin complaints. Topical corticosteroids were reported to have a clearly good effect in only a small minority of evaluable patients, and underpatches or barrier products had limited or uncertain benefit in many cases. Moreover, some patients reported worsening of complaints or new complaints caused by these products. These findings suggest that symptomatic treatment or barrier measures are often insufficient when the underlying problem is ACD.

4.2 | Yield of the Diabetes Devices Screening Series and Relevance

The main findings of this study are that the diabetes device screening series had a high diagnostic yield in patients referred with suspected ACD to diabetes devices, that clinically relevant reactions were identified in a large proportion of patients, and that ACD to diabetes devices was associated with a broad range of allergens, dominated by colophonium and related compounds, IBOA, dicyclohexylmethane-4,4′-diisocyanate, and *N*,*N*-dimethylacrylamide.

Overall, 71 of 100 patients reacted to one or more allergens in the DDS series. This high proportion probably reflects the strict selection of patients referred to our tertiary referral centre, but it also supports the diagnostic value of the currently selected allergens in the DDS series, which include all allergens reported as a cause of ACD from diabetes devices up to early 2024. More than 70% of the patients with positive reactions to the DDS series had reactions that were considered clinically relevant because they had developed dermatitis from devices previously reported to contain one or more of the allergens to which they reacted. This classification should be interpreted with some caution. The presence of the relevant allergen was not confirmed in the exact device used by each individual patient at the time of sensitisation or elicitation, and device compositions may change over time [16]. Therefore, these reactions are best regarded as very likely clinically relevant rather than definitively proven in every case.

For the remaining positive patch test reactions, no obvious clinical relevance could be assigned. However, relevance was scored conservatively: reactions were considered relevant only when dermatitis had occurred from a device known to contain the corresponding allergen. Most patients had used more than one sensor, pump, or infusion set, and it is therefore conceivable that some reactions classified as of unknown relevance were in fact related to exposure from devices for which the relevant chemical information is not publicly available. In addition, a number of patients had used various devices over the years. It is conceivable that some had forgotten to mention that they had used a particular device or forgotten to report that certain products had caused skin complaints. Any relevant reactions to such products would then be missed.

Seven patients had positive reactions to IBOA, for which no relevance could be established. There have been a few case reports of ACD from IBOA present in products other than diabetes devices: a hospital wristband [17], a home nail glue [18], glue to

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 5 | Results of patch tests and products causing dermatitis in 100 patients.

Pat. nr.	Sex and age	Positive patch tests				Products causing dermatitis[b]
		Diabetes device screening series[a]	(Meth)acrylateseries	9 Extracts	Personal products	
1	F 28			NT		
2	F 39	AA; DCMDI		NT		
3	F 15	AA; HA; IPDI; DMAA; COL	HEMA	NT	Medtronic oval tape	Guardian 4 (AA, COL, HA, DMAA, IPDI) Medtronic oval tape (AA, COL, HA)
4	F 10	HA; COL		NT	Dexcom G7 adhesive	Dexcom G7 (COL, HA)
5	F 22			NT		
6	F 13	DDM; HA; COL		NT	Guardian 4 adhesive extract; Simplera Sync adhesive extract	Guardian 4 (COL, HA)
7	M 7			NT		
8	F 37	MBPA; BA; DCMDI; IBOA; PEEA	BDDMA; IBOMA; THFMA	NT	Ypsopump orbit micro adhesive	Dexcom G6 (MBPA, IBOA)
9	F 52			NT		
10	F 11	DCMDI		NT	Guardian 4 adhesive	
11	F 26	AA; DCMDI; HA; COL	THFMA	NT		Dexcom G7 (AA, COL, HA, DCMDI)
12	F 22	AA; HCPK; IBOA; COL		NT	FSL 2 adhesive; Skin Tac	Omnipod (AA, COL, IBOA)
13	F 8	CEA; DCMDI; IBOA	BDDMA; IBOMA; THFMA	NT	Mylife Orbit Micro YpsoPump adhesive; Mylife Orbit Soft YpsoPump adhesive	
14	F 23	AA; HA; COL		NT		
15	F 33			NT	Kaleido infusionset adhesive	
16	M 24	HA; HCPK; IBOA; PEEA		NT	FSL3 adhesive extract; MiniMed extended adhesive	Minimed Extended (HA)[c]
17	F 31	IBOA		NT		
18	F 35	AA; COL		NT	Skin Tac wipe	FSL1 (AA, COL) Omnipod (AA, COL)
19	M 23	COL		NT	Simplera sync adhesive	Guardian 3 (COL) Guardian 4 (COL)

(Continues)

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 5 | (Continued)

Pat. nr.	Sex and age	Positive patch tests				Products causing dermatitis[b]
		Diabetes device screening series[a]	(Meth)acrylateseries	9 Extracts	Personal products	
20	F 36	DCMDI; IBOA; DMAA			Guardian 4 adhesive; Guardian 4 hard plastic	FSL1 (IBOA, DMAA, DCMDI) Guardian 3 (IBOA) Guardian 4 (IBOA, DMAA) Omnipod (IBOA, DMAA)
21	F 26	HDDA; BA				
22	F 30					
23	F 27	HA				Dexcom G6 (HA) Guardian 4 (HA)
24	F 59	HDDA; 2-PEA; AA; BA; CEA; DPGDA; EA; HA; HCPK; IBOA; DMAA; PEEA; TPGDA; COL	BDDMA; Bis-GMA; DUDMA; EGDMA; HEMA; IBOMA; TEGDMA; THFMA	NT	Medtronic oval tape	FSL1 (AA, COL, HA, IBOA, DMAA) Guardian 4 (AA, COL, HA, HDDA, IBOA, DMAA, HCPK) MiniMed Quick-Set (IBOA, HCPK) Medtronic oval tape (AA, COL, HA)
25	M 14	IBOA		NT	Medtronic extended infusion set adhesive; Medtronic oval tape; Minimed mio advance infusion set adhesive	Guardian 4 (IBOA)
26	F 14	HDDA		NT		
27	M 28			NT		
28	F 24	HA; COL		Guardian 4[d]; Simplera Sync	Guardian 4 adhesive extract; Medtronic Oval Tape extract	Dexcom G7 (HA, COL)
29	F 59	HDDA; 2-PEA; AA; BA; CEA; DCMDI; DPGDA; EA; DMAA; IBOA; PEEA; COL	BDDMA; Bis-GMA	NT	Simplera sync adhesive and adhesive extract	FSL1 (AA, COL, IBOA, DMAA, DCMDI) Guardian 3 (AA, COL, HDDA, IBOA) Guardian 4 (AA, COL, HDDA, IBOA, DMAA)
30	M 19	AA; DCMDI; EA; HA; IBOA	BUMA; IBOMA	Guardian 4; Simplera Sync	Accu-Chek SmartGuide adhesive; Simplera Sync adhesive	Dexcom G6 (AA, HA, IBOA) Dexcom G7 (AA, HA, IBOA, DCMDI) FSL1 (AA, HA, IBOA, DCMDI)
31	F 65	DPGDA; HDDA; TPGDA	BDDMA; HPMA; DMAEMA; THFMA			Omnipod (DPGDA, TPGDA)
32	F 29			NT		
33	F 15	AA; HA; COL		NT	Medtronic oval tape	Guardian 4 (AA, COL, HA) Medtronic oval tape (AA, COL, HA)

(Continues)

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 5 | (Continued)

Pat. nr.	Sex and age	Positive patch tests				Products causing dermatitis[b]
		Diabetes device screening series[a]	(Meth)acrylateseries	9 Extracts	Personal products	
34	M 36	HA; COL		NT	FSL1 adhesive	Dexcom G6 (HA, COL)
35	F 37			NT		
36	M 9	BHT; DCMDI; HA		NT	Simplera sync adhesive and sensor thread	FSL3 (BHT)
37	M 44			NT		
38	F 24	CEA; DCMDI; HA; HCPK; IBOA; IPDI; DMAA; PEEA	IBOMA	NT	Cavilon spray; Guardian 4 adhesive; needle of Guardian 4; Simplera needle and adhesive	Dexcom G7 (HA, IBOA, DCMDI, HCPK) FSL1 (HA, IBOA, DMAA, DCMDI, IPDI) Guardian 3 (HA, IBOA) Guardian 4 (HA, IBOA, DMAA, IPDI, HCPK)
39	M 40			NT		
40	F 26	MBPA; HA	DMAEMA	NT		Dexcom G6 (HA)
41	F 13			NT	FSL3 adhesive	
42	F 51	AA; HA; COL		NT	Medtronic extended adhesive; Medtronic oval tape; Guardian 4 adhesive extract; Simplera Sync adhesive extract	FSL1 (AA, COL, HA) Guardian 4 (AA, COL, HA) Medtronic oval tape (AA, COL, HA)
43	F 11	2-PEA; AA; BA; DCMDI; HA; IBOA; COL	BDDMA; IBOMA; THFMA; TEGDMA	NT	Skin Tac wipe; extract Skin Tac wipe; extract Ypsomed pomp orbit micro	FSL1 (AA, COL, HA, IBOA, DCMDI) Guardian 4 (AA, COL, HA, IBOA)
44	F 24	IBOA; 2-PEA	BDDMA; DUDMA	NT		Guardian 4 (IBOA)
45	M 14	AA; HA; COL		Simplera Sync		FSL 1 (AA, HA, COL)
46	F 63	BA; DPGDA; EA; DMAA; HDDA; PEEA	BDDMA; THFMA	NT		Guardian 3 (HDDA)
47	M 59	HA; HCPK		NT	Accu-Chek adhesive; skin barrier wipe	Omnipod DASH (HA)[d]
48	F 41	AA; DCMDI; COL		NT	FSL1 adhesive extract	
49	M 7	HA		NT	FSL3 adhesive	Dexcom G6 (HA) Dexcom G7 (HA) Guardian (unspecified) (HA)

(Continues)

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 5 | (Continued)

Pat. nr.	Sex and age	Positive patch tests				Products causing dermatitis[b]
		Diabetes device screening series[a]	(Meth)acrylateseries	9 Extracts	Personal products	
50	F 48	DCMDI; COL				FSL1 (COL, DCMDI)
51	F 20			Dexcom G6		
52	F 51	DDM; IBOA; COL	HPMA	NT	Accu-chek Solo adhesive	FSL1 (COL, IBOA)
53	F 26	HDDA; 2-PEA; BA; DCMDI; DPGDA; HA; HMME; MMA; PEEA; TPGDA	DMAEMA; EGDMA; HEMA; THFMA	NT		
54	F 5	AA; DCMDI; HA; IPDI		Guardian 4; Simplera Sync	FSL3 adhesive	Enlite (AA, HA)
55	F 13	IBOA	IBOMA		Ypsopump orbit micro 2.0 adhesive and extract	Dexcom G6 (IBOA)
56	F 21				Kaleido pump adhesive and adhesive extract	
57	F 12					
58	F 41					
59	M 14	IBOA; COL	BDDMA; IBOMA; THFMA			
60	F 64	COL		Guardian 4; Omnipod 5; Simplera Sync		Guardian 4 (COL)
61	F 38	AA; DCMDI; HA; IBOA; COL		Guardian 4; Omnipod 5; Simplera Sync	Guardian 4 adhesive	Guardian 4 (AA, COL, HA, IBOA)
62	F 19	MBPA; IBOA	IBOMA			Dexcom G7 (IBOA) FSL1 (IBOA)
63	F 39	HDDA; MBPA; 2-PEA; DPGDA; IBOA; TPGDA	EGDMA; HEMA; IBOMA; THFMA		Omnipod 5 adhesive	FSL1 (IBOA)
64	F 23	HDDA; BA; HA; IBOA; PEEA; COL	BDDMA	NT		Guardian 4 (COL, HA, HDDA, IBOA)

(Continues)

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 5 | (Continued)

Pat. nr.	Sex and age	Positive patch tests				Products causing dermatitis[b]
		Diabetes device screening series[a]	(Meth)acrylateseries	9 Extracts	Personal products	
65	M 12	DCMDI		Simplera Sync; TouchCare SmartOne Nano 200U		Dexcom G7 (DCMDI)
66	F 11	HA				
67	M 6			NT	Dexcom G7 adhesive; Omnipod 5 adhesive	
68	F 34					
69	F 17	BA; DCMDI; IBOA; DMAA	BDDMA; IBOMA; THFMA			Dexcom G6 (IBOA) Dexcom G7 (IBOA, DCMDI) FSL1 (IBOA, DMAA, DCMDI)
70	F 33	DDM; AA; IPDI; COL		NT		
71	F 45	DCMDI; COL				
72	M 26					
73	M 59	IBOA	IBOMA	NT		FSL1 (IBOA)
74	F 35	IBOA		NT		
75	F 61			Guardian 4; Omnipod 5; Simplera Sync		
76	M 7	HDDA; 2-PEA; BA; CEA; DCMDI; DPGDA; EA; IBOA; PEEA; TPGDA	BDDMA; EGDMA; TEGDMA; THFMA	NT	Cavilon spray	Dexcom G7 (IBOA, DCMDI)
77	M 55					
78	F 54			NT		
79	F 41	IBOA	IBOMA			FSL1 (IBOA) Omnipod (IBOA)
80	F 39	AA; DCMDI; HA; COL		NT	FSL 2 adhesive	
81	F 18	AA; HA; COL		NT		
82	F 70					

(Continues)

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 5 | (Continued)

Pat. nr.	Sex and age	Positive patch tests				Products causing dermatitis[b]
		Diabetes device screening series[a]	(Meth)acrylateseries	9 Extracts	Personal products	
83	F 28	2-PEA; HA; PEEA; COL	THFMA	Guardian 4	Guardian 4 adhesive; Pinotape	Guardian 4 (COL, HA)
84	F 6	IPDI		NT	Dexcom G7 adhesive and extract	
85	F 18	HA; COL		NT	Unspecified Minimed adhesive	Guardian 4 (COL, HA)
86	M 46			NT		
87	M 7	HDDA; 2-PEA; BA; PEEA	BDDMA; EGDMA; THFMA	NT	Guardian 4 adhesive extract	Guardian 4 (HDDA)
88	F 61			NT		
89	M 5	IBOA				Dexcom G6 (IBOA) Dexcom G7 (IBOA) Guardian 4 (IBOA)
90	F 23					
91	M 9	COL; IBOA		NT	FSL 3 adhesive extract; Ypsopump orbit micro adhesive	
92	F 34	DPGDA; IBOA		NT		
93	M 32	AA; COL		NT	Skin glu cleanser	
94	F 39	HDDA; EA		NT		
95	F 15	IBOA	IBOMA	NT		Dexcom G6 (IBOA)
96	F 26	2-PEA; BA; DPGDA; IBOA; DMAA; PEEA	BDDMA; IBOMA; THFMA	NT	Ypsopump orbit adhesive	FSL1 (IBOA, DMAA)
97	F 22	DCMDI		NT		Dexcom G7 (DCMDI) FSL1 (DCMDI)
98	F 64					
99	M 12					
100	F 68					

[a]Includes colophonium 20% pet. from the European baseline series.
[b]Only products causing dermatitis containing allergens to which the patients had positive patch test reactions are mentioned. For colophonium-related allergens, the presence of chemicals other than the one(s) to which the patient reacted was also used for scoring a product as causing dermatitis (which is indicated in footnotes in this Legend below). Products that have caused dermatitis but for which no link could be found with the allergens to which the patient reacted are not mentioned in this column.
[c]Hydroabietyl alcohol (HA) was not found in the Minimed Extended, but the device did contain the related methyl dehydroabietate.
[d]HA itself has not been identified in Omnipod DASH, but the related 'colophonium-related substances' and methyl dehydroabietate.

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

fixate cell phone screen protectors [19] (occupational ACD), a glass fibre coating and UV-cured ink [20] (occupational ACD), and the adhesive of a subcutaneous infusion set for treprostinil to treat idiopathic pulmonary arterial hypertension (2 patients) [21].

Apart from these rare cases, virtually all published cases of IBOA allergy have involved patients sensitised through the use of diabetes devices. Cross-reactivity to IBOA from other (meth)acrylates is considered absent or rare [13, 15, 20], making sensitisation through a cross-reactivity phenomenon unlikely. Taken together, these observations make previous sensitisation through diabetes-device use a plausible explanation for the seven IBOA reactions for which clinical relevance could not be established according to our strict, predefined criteria. This interpretation cannot be confirmed by our data and is therefore not included in the primary relevance analysis. However, if all seven reactions—or at least a large majority—were indeed device-related, the number of patients with relevant reactions would be higher. In the deliberately hypothetical scenario in which all seven were device-related, this number would increase from 50 to 57 patients and from 70.4% to 80.3%. Adding the four patients who reacted to extracts of their own devices and had no other positive patch tests would increase the corresponding estimate to 61 patients (85.9%).The majority of implicated devices were glucose sensors (90.0%). Guardian 4 ($n = 20$), FSL1 ($n = 18$), Dexcom G7 ($n = 12$) and Dexcom G6 ($n = 10$) were most frequently involved and together accounted for 75.0% of culprit devices causing dermatitis. These numbers should not be interpreted as indicating that these devices have a higher intrinsic sensitising potential than other devices. It is conceivable that the implicated devices are also the ones that are most frequently used by patients with diabetes.

4.3 | Co-Reactions

Interestingly, the five allergens for which no reactions could be assigned clinical relevance frequently co-reacted. Twenty patients reacted to at least one of these allergens, and 12 of them reacted to two or more. Co-reactivity was particularly common for butyl acrylate (BA) and phenoxypoly(ethyleneoxy)ethyl acrylate (PEEA), observed together in nine patients, and for 2-phenoxyethyl acrylate (2-PEA) with either BA or PEEA, observed in seven patients each.

In addition, 17 of these 20 patients reacting to 2-PEA, BA, carboxyethyl acrylate (CEA), ethyl acrylate (EA), and/or PEEA also reacted to one or more allergens in the (meth)acrylate series; when one patient who was not tested with this series was excluded, this was 17 of 19 patients. This frequent co-reactivity among each other and with allergens in the (meth)acrylate series may support cross-reactivity or concomitant sensitisation as an explanation for these reactions, although the virtual absence of information on the presence of these allergens in diabetes devices precludes firm conclusions.

A specific observation concerns the association between 2-PEA and IBOA. In the present study, 7 of 10 patients with a positive reaction to 2-PEA were also IBOA-positive, compared with 23 of 90 patients without a reaction to 2-PEA. This association was statistically significant (Fisher's exact test, $p = 0.007$; OR 6.8, 95% CI 1.6–28.5).

In a Belgian study [22], of 14 patients sensitised to IBOA from the use of the FSL1 sensor, 9 (64%) co-reacted to 2-PEA 0.1% pet. Gas chromatography—mass spectrometry (GC–MS) analyses failed to identify 2-PEA in any device. However, IBOA was found to be a contaminant of the in-house prepared PEA patch test preparation [22]. Whether this also applies to the present study is unknown because our test preparation was obtained from a different supplier and was not chemically analysed. Nevertheless, contamination may be a plausible explanation, even more likely than cross-reactivity. IBOA appears to show little, if any, cross-reactivity with other acrylates or methacrylates [13, 20] and there is no obvious structural reason why IBOA would selectively cross-react with 2-PEA but not, or only rarely, with other structurally related (meth)acrylates. Therefore, the frequent concomitant reactivity to 2-PEA and IBOA should be interpreted with caution and may not necessarily indicate true sensitisation to 2-PEA.

Of 30 patients reacting to IBOA in the DDS series, 15 (50%) co-reacted to IBOMA in the (meth)acrylate series. No patients reacted to IBOMA without a positive co-reaction to IBOA, which suggests that the reactions to IBOMA are cross-reactions to IBOA and that IBOMA is not an allergen of any importance itself.

4.4 | Allergens

The allergens most often implicated in clinically relevant reactions were colophonium and related compounds (hydroabietyl alcohol and abietic acid), IBOA, dicyclohexylmethane-4,4′-diisocyanate (DCMDI), and *N*,*N*-dimethylacrylamide (DMAA). Since 2017, IBOA has been recognised as the cause of an epidemic of ACD to the FSL1 sensor [13, 23]. Abbott subsequently removed IBOA from all FSL systems in 2020 [24]. However, IBOA has since been identified in at least twelve other sensors, pumps and infusion sets, including commonly used Dexcom G6 and G7 sensors, Guardian 3 and 4 sensors, MiniMed infusion sets and the Omnipod patch pump (6; Table S1). These devices, together with FSL1, were also those most often responsible for dermatitis in IBOA-sensitised patients in the present study (Table S13). Some patients may have been sensitised by these non-FSL1 devices, but previous sensitisation to IBOA in FSL1 probably contributed to subsequent ACD from other IBOA-containing devices in a number of patients.

This is supported by the rapid onset of dermatitis within 3 days after first application of a device in approximately one-third of patients. Such short latency strongly suggests previous sensitisation to the eliciting allergen, whether IBOA or another allergen.

A considerable number of reactions were also observed to butyl acrylate, 1,6-hexanediol diacrylate (HDDA), phenoxypoly(ethyleneoxy)ethyl acrylate, 2-phenoxyethyl acrylate, and dipropylene glycol diacrylate, but for most, no clinical relevance was established. It remains unclear whether these reactions represent cross-reactions, past or unrecognised exposures, or true

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

reactions to device constituents for which chemical information is currently lacking.

For a comparison with the literature of previous reports of ACD to these and other allergens in diabetes devices, we refer to our review article on diabetes devices [7, 13].

4.5 | Personal Products

Testing with personal products proved to be an important additional diagnostic step. Positive reactions were frequently observed, particularly to adhesives of sensors, pumps, and infusion sets, and to extracts prepared from these adhesives. These results are clinically relevant in themselves because they identify products that individual patients are likely unable to tolerate. In several patients, positive reactions to personal device-related products were the only positive patch test results, underlining that testing with the screening series alone may fail to detect the responsible product in a substantial minority of patients.

Many positive reactions were observed to products that had not been assigned as culprit products on the basis of known allergens detected in the DDS series. This suggests that these products may contain relevant allergens that were not included in the DDS series or in the additional (meth)acrylate series. Therefore, positive reactions to personal products should be regarded not only as clinically useful for the individual patient, but also as a signal that further analytical investigation of these devices is needed.

The paired testing of adhesives and extracts of the same adhesives showed that neither approach was clearly superior. However, testing only one of the two would have missed a relevant number of positive reactions. Whenever sufficient material is available, both the adhesive itself and an extract of the adhesive should therefore be tested.

A further relevant observation is that many patients reacted to multiple devices. This may be explained by the presence of common allergens or chemically related, cross-reacting allergens in different devices. However, it may also reflect independent sensitization to different allergens after sequential use of several devices.

A limitation of testing with personal products, especially extracts, is that irritant reactions cannot be fully excluded. Control testing with extracts was not performed in the present study. Nevertheless, the frequent occurrence of positive reactions to device-related products, their concordance with the patients' clinical histories, and the identification of products not otherwise recognised as culprit devices support the diagnostic value of this approach.

4.6 | Patients With Negative Reactions to the DDS Series

Twenty-nine of the 100 patients included in this study (29%) had no positive reactions to the DDS series. In four of them, however, allergy to one or more personal devices was demonstrated by positive patch test reactions to the adhesives and/or extracts of the sensors or pumps, from which they had developed dermatitis. Thus, 25 patients had no positive reactions to either the DDS series or adhesives/extracts of their own devices.

Several explanations may account for these negative results. First, the skin reactions in these patients may have been irritant rather than allergic. We consider this unlikely in most cases, because the patients reported reproducible dermatitis after repeated application of new devices, many had to remove devices before the intended wear time, and symptoms were sufficiently severe to warrant referral to a tertiary centre.

Second, the responsible allergens may not have been included in either the DDS series or the additional (meth)acrylate series. Unknown or untested allergens are a plausible explanation for negative test results.

Third, some patients may have had weak allergies to one or more allergens included in the DDS series. Such allergies may be insufficient to elicit a positive patch test reaction under standard test conditions, yet still cause dermatitis during prolonged occlusive exposure to device adhesives, particularly sensors that remain on the skin for more than 1 week.

Fourth, test concentrations for some allergens in the DDS series may have been too low to detect weak sensitisation. This possibility is supported by previous observations for several diabetes-device allergens. IBOA was initially tested at 0.1% pet. and is still commercially available only at this concentration. However, in a recent Malmö study, testing with 0.3% identified almost as many additional IBOA-allergic patients as were detected with 0.1% alone [6]. Similar observations have been made for DMAA [8, 25, 26] and 2,2′-methylenebis(6-*tert*-butyl-4-methylphenol) monoacrylate [16, 24, 27].

Colophonium is included in the European baseline series at 20% pet., but testing at 60% has been shown to identify patients who do not react to 20% [28, 29]. Whether sensitised patients were missed in the present study because of suboptimal test concentrations is unknown, but this possibility cannot be excluded.

Finally, the absence of a routine D7 reading has very likely reduced the diagnostic yield [30]. Late readings are particularly important for IBOA and DMAA [6, 26], and may also be relevant for other acrylates, nearly 10% of which have been reported to become positive only at late readings [20]. In the recent Malmö study, one-third of positive reactions to IBOA 0.1% and/or 0.3% were first observed at D7 [6]. If a similar proportion of late IBOA reactions occurred in our cohort, in which 30 patients reacted to IBOA, a substantial number of additional reactions may have been missed. Therefore, the true diagnostic yield of the DDS series is probably higher than the observed 71% when routine D7 readings and optimised test concentrations are used.

4.7 | Comparison With Literature Data

To the best of our knowledge, this is the first published study in which a large cohort of patients referred for suspected ACD to diabetes devices was patch tested with a large, dedicated

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Diabetes device screening series. Previous studies have investigated cohorts of patients with suspected allergic reactions to such devices using the European baseline series, additional series such as the (meth)acrylate and glue series, selected allergens already known to be implicated in ACD to diabetes devices, and, in some cases, pieces of device adhesives or extracts prepared from adhesives or housings. These studies have been discussed in detail [7]. However, most were small, often including fewer than 20 patients, and the number of diabetes-device-related allergens tested was generally limited. Moreover, many studies focused entirely or predominantly on patients with allergic reactions to the FSL1 sensor.

Only two other studies, both from Malmö, Sweden, have patch tested a large screening series specifically designed for diabetes medical devices [6, 26]. In the first study, the Medical device series (MD series), consisting of 35 allergens, was tested in 15 adult patients with suspected allergic reactions to FSL1 [26]. Positive reactions were observed to IBOA in 13 patients and to *N,N*-dimethylacrylamide (DMAA) in four patients. Both are well-established allergens in FSL1 [25]. In addition, one patient reacted to butylated hydroxytoluene (BHT) and 2,4-di-*tert*-butylphenol (2,4-DTBP), and another to colophonium and abietic acid. BHT and 2,4-DTBP are also present in FSL1, whereas the presence of colophonium-like substances was identified only later [31].

In the second Swedish study [6], adults with Type 1 diabetes using diabetes medical devices and followed at two endocrinology departments were invited for patch testing with a novel MD patch test series comprising 58 substances. Of 667 respondents to a preceding questionnaire study [4], 204 accepted the invitation to be patch tested: 114 with skin rashes related to diabetes devices and 90 without such rashes. Overall, 16.2% had positive reactions to allergens identified in diabetes devices. The prevalence was significantly higher among patients with device-related skin rashes than among those without such rashes (28.1% versus 1.1%). Among the 114 patients who had reported skin rashes from sensors or pumps, 32 (28.1%) had one or more positive reactions to 12 allergens. The most frequent reactions were to IBOA ($n = 21$, 18.4%), DMAA ($n = 10$, 8.8%), 2-hydroxyethyl acrylate (2-HEA) 0.1% pet. ($n = 7$, 6.1%), and dicyclohexylmethane-4,4′-diisocyanate (DCMDI) ($n = 6$, 5.3%). Reactions were considered relevant in 30 of the 32 patients [6].

Comparison between the Swedish study and ours is complicated by several factors. First, the study populations differed substantially. Second, the Swedish MD series comprised 58 chemicals, whereas our DDS series consisted of 24 allergens. Of these 24 allergens, 19 were also tested in the Swedish study (Table S19). Third, the Swedish patients were tested in 2021 and 2022, and nearly all had been exposed to FSL1, which was still widely used at that time. Our patients were investigated between June 2024 and March 2026, and many had not been exposed to FSL1 but had instead used newer devices to which the Swedish patients may not have been exposed, such as Dexcom G7, or may have been exposed less frequently, such as Guardian 4.

Bearing these differences in mind, a tentative comparison can still be made. Among the Swedish patients who had experienced device-related dermatitis, 28.1% had positive reactions to the MD series, whereas the corresponding proportion in our cohort was 71%. This much higher percentage can readily be explained by the stricter referral-based selection in our study.

With regard to the specific positive reactions, IBOA was the most frequently reacting allergen in both studies, with positive reactions in 30% of our cohort and 18.4% of the Swedish dermatitis cohort. Other allergens positive in both studies included DCMDI (22% and 5.3%, respectively), DMAA (8% and 8.8%), and HDDA (12.0% and 3.5%). 2-HEA, which caused seven reactions in the Swedish study and was detected in FSL1, was not tested in our study.

A major difference between the two studies concerns the colophonium group of allergens. In our cohort, 43 patients reacted to colophonium (COL), hydroabietyl alcohol (HA), and/or abietic acid (AA), whereas in the Swedish study only two patients reacted to COL and two to HA.

Of the 43 patients in our cohort with positive reactions to COL, AA and/or HA, 30 had reactions considered relevant. The devices most often implicated were Guardian 4, FSL1, Dexcom G7, and Dexcom G6. In the Swedish study, only three patients had reported a rash from Guardian 4 and none from Dexcom G7, which was first released in October 2022. This difference in device exposure may partly explain the discrepancy between the studies. Conversely, 80 patients in the Swedish study had reported a rash from FSL1, which likely contributed to the high number of reactions to IBOA, DMAA, and 2-HEA, but apparently did not result in a comparable number of reactions to the colophonium group of allergens.

In a recent study from Antwerp, Belgium [15], 27 patients with ACD from Guardian sensors were investigated: 7 had reacted to Guardian 3, 22 to Guardian 4, and 2 to both. The patients were not tested with a separate, dedicated diabetes device screening series. However, 15 of the allergens included in our DDS series were also tested in this study, as part of various additional series, including acrylates, plastics and glues, isocyanates, and colophonium derivatives.

Although the comparison concerns only two devices, it is still worthwhile because our study included 21 patients with ACD from Guardian sensors: 20 from Guardian 4, 5 from Guardian 3, and 4 from both. In the Belgian study, the most frequent sensitisers were colophonium and colophonium derivatives, which were positive in 12 of 27 patients (44%), followed by IBOA in 8 of 26 (31%), 1,6-hexanediol diacrylate (HDDA) in 3 of 15 (20%), and *N,N*-dimethylacrylamide (DMAA) in 2 of 25 (8%). These were also the most frequent allergens associated with Guardian 3 and/or Guardian 4 dermatitis in our study: colophonium derivatives in 15 of 21 patients (71.4%), IBOA in 10 of 21 (47.6%), DMAA in 6 of 21 (28.6%), and HDDA in 5 of 21 (23.8%).

4.8 | Implications of the Findings for an Updated Diabetes Device Screening Series

The high diagnostic yield of the DDS series supports the use of a diabetes device-specific screening series in patients with suspected ACD caused by glucose sensors, patch pumps, or infusion

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

sets. The findings of the present study, considered together with evidence published after the start of the study, informed a proposed update of the series. Based on our own findings, methyl methacrylate, which elicited only one positive reaction and is considered an 'older' allergen in diabetes devices, will be moved back to the (meth)acrylate series. Allergens that elicited only one or two positive reactions will be retained in the DDS series for another 2 years, after which their usefulness will be re-evaluated. We have also added two allergens that were reported as causes of ACD from diabetes devices after the start of our study: 2-hydroxyethyl acrylate 0.1% pet. and tetrahydrofurfuryl acrylate 0.1% pet [6].

Other additions are *tert*-butylhydroquinone (BHQ) 1% pet. and *tert*-butylcatechol (TBC) 0.25% pet., which recently elicited positive reactions in patients with ACD to Guardian 3 and Guardian 4 sensors in a Belgian study [15]. These substances were not identified by GC–MS in the devices but were proposed as screening agents for *tert*-butylphenol (TBP) derivatives, including TBP, 2,4-di-*tert*-butylphenol (2,4-DTBP), butylated hydroxytoluene (BHT), and 2,6-di-*tert*-butylbenzoquinone (DBQ) [32]. One or more of these compounds was identified in the housings and/or adhesives of the sensors and/or in the Medtronic oval tape used with the Guardian sensors [15].

In the same study, GC–MS also identified ethylhexyl salicylate, also known as octyl salicylate, and homomenthyl salicylate in the adhesives of the Guardian sensors and in Medtronic oval tape [15]. Patch tests with these salicylates were negative; the test concentration was 5% pet. for octyl salicylate, whereas the concentration used for homomenthyl salicylate was not specified. However, one patient reacted to benzyl salicylate 10% pet. Targeted testing with octyl salicylate and homomenthyl salicylate, which are available from Allergeaze and Chemotechnique at 5% and 10% pet., may therefore be considered in patients with suspected allergic reactions to Guardian 4 sensors.

Our updated DDS series, together with a comparison with the updated Malmö series, is shown in Table S19.

4.9 | Limitations

This study has several limitations. First, it had a retrospective design and was conducted in a tertiary referral centre. The study population is therefore likely to be enriched for patients with severe, persistent or diagnostically difficult skin reactions to diabetes devices, and the results may not be directly generalisable to all users of such devices. Second, not all patients had a complete and uniformly recorded history, and not all patients were tested with all series or with all individual allergens throughout the study period. In addition, D7 readings were not routinely performed. Late reactions, particularly to some acrylates, isocyanates, or other slowly developing allergens, may therefore have been missed.

Third, the clinical relevance of positive reactions to screening-series allergens was based on previously reported chemical compositions of diabetes devices, rather than on chemical analysis of the exact devices used by each individual patient. Device composition may vary between models, batches, or over time, and unpublished components may have been missed. Finally, testing with patients' own products and extracts was not fully standardised, and control testing with extracts was not performed. Therefore, especially for weak positive reactions to extracts, an irritant component cannot be fully excluded.

4.10 | Future Studies

Future research should focus on the chemical analysis of diabetes devices that elicit positive patch test reactions, particularly when these reactions cannot be explained by allergens included in a dedicated diabetes device screening series or additional ([meth]acrylate) series. Adhesives and adhesive extracts should be prioritised, as they frequently yield positive reactions and often identify products that could not otherwise be assigned as culprit products.

Further studies should also determine the optimal way to patch test personal devices. The present findings indicate that testing the adhesive itself and an extract of the adhesive may provide complementary information. Standardised extraction protocols, dilution series, and control testing would help distinguish allergic from irritant reactions, especially for weak positive reactions and reactions to extracts.

Finally, prospective multicentre studies are needed to validate the diagnostic yield of dedicated diabetes device screening series, additional (meth)acrylate testing, and testing with patients' own devices. Such studies should also clarify whether reactions to multiple devices reflect shared allergens, cross-reacting chemicals, or independent sensitisation after sequential exposure to different devices.

Close collaboration between clinicians, analytical chemists, manufacturers and regulatory authorities is encouraged to improve transparency of device composition, to decrease sensitisation risks and to enable safer alternatives for sensitised patients.

Author Contributions

Norbertus A. Ipenburg: conceptualization, investigation, data curation, methodology, writing – review and editing. **Emma M. van Oers:** investigation, data curation, writing – original draft, writing – review and editing. **Anton C. de Groot:** conceptualization, visualization, writing – original draft, writing – review and editing. **Mounir Yaâkoubi:** investigation, data curation, writing – review and editing. **Thomas Rustemeyer:** supervision, writing – review and editing.

Acknowledgements

The authors used ChatGPT model 5.5 (OpenAI, USA), between 15 June 2026 and 6 July 2026. The tool was used to assist with English language editing, organisation and streamlining of the manuscript, statistical analyses based on author-provided data, generation of tables, and preparation of the graphical image/graphical abstract. AI assistance was used in the manuscript text, tables and supplementary tables, the statistical summaries reported in the Results section, the graphical image/graphical abstract, and the responses to the reviewers. All AI-generated output, including text, tables, statistical calculations, and the graphical image, was critically reviewed, checked, edited where necessary, and approved by the authors. Statistical outputs were verified against the original datasets by the authors, and all scientific interpretations,

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

conclusions, and clinical relevance assessments were made by the authors. To maintain privacy and compliance requirements, no directly identifiable human subject data were entered into the AI tool. The data provided to the tool was fully anonymized before use and contained no names, initials, dates of birth, addresses, patient numbers, or other direct identifiers. The use of AI did not replace author responsibility for the accuracy, integrity, and originality of the manuscript.

Funding

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Research data are not shared.

References

1. S. F. Alfadli, Y. S. Alotaibi, M. J. Aqdi, et al., "Effectiveness of Continuous Glucose Monitoring Systems on Glycemic Control in Adults With Type 1 Diabetes: A Systematic Review and Meta-Analysis," *Metabolism Open* 27 (2025): 100382, https://doi.org/10.1016/j.metop.2025.100382.

2. E. Benioudakis, E. Karlafti, A. Kalaitzaki, G. Kaiafa, C. Savopoulos, and T. Didangelos, "Technological Developments and Quality of Life in Type 1 Diabetes Mellitus Patients: A Review of the Modern Insulin Analogues, Continuous Glucose Monitoring and Insulin Pump Therapy," *Current Diabetes Reviews* 18, no. 7 (2022): e031121197657, https://doi.org/10.2174/1573399818666211103163208.

3. L. B. von Kobyletzki, J. Ulriksdotter, T. Sukakul, et al., "Prevalence of Dermatitis Including Allergic Contact Dermatitis From Medical Devices Used by Children and Adults With Type 1 Diabetes Mellitus: A Systematic Review and Questionnaire Study," *Journal of the European Academy of Dermatology and Venereology* 38, no. 7 (2024): 1329–1346, https://doi.org/10.1111/jdv.19908.

4. J. Ulriksdotter, T. Sukakul, M. Bruze, N. Hamnerius, M. Mowitz, and C. Svedman, "A Cross-Sectional Study Demonstrating a High Prevalence of Skin Rash to Diabetes Medical Devices: An Underestimated Problem," *Journal of Diabetes Science and Technology* 20, no. 5 (2026): 1576–1584, https://doi.org/10.1177/19322968251336261.

5. L. B. von Kobyletzki, J. Ulriksdotter, E. von Kobyletzki, M. Mowitz, J. Jendle, and C. Svedman, "Insulin Pump Therapy and Adverse Skin Reactions With Focus on Allergic Contact Dermatitis in Individuals Living With Diabetes Mellitus: A Systematic Review and Clinical-Based Update," *Journal of Diabetes Science and Technology* 18, no. 6 (2024): 1300–1312, https://doi.org/10.1177/19322968241252613.

6. J. Ulriksdotter, M. Mowitz, T. Sukakul, M. Bruze, N. Hamnerius, and C. Svedman, "Patch Testing in Individuals With Diabetes Using Medical Devices. Part 2-Contact Allergy to Medical Device Allergens and New Patch Test Recommendations," *Contact Dermatitis* 95, no. 2 (2026): 169–181, https://doi.org/10.1111/cod.70149.

7. A. de Groot, E. M. van Oers, N. A. Ipenburg, and T. Rustemeyer, "Allergic Contact Dermatitis Caused by Glucose Sensors and Insulin Pumps: A Full Review: Part 2. Case Reports and Case Series, Clinical Features, Patch Test Procedures, Differentiation From Irritant Dermatitis, Management of Allergic Patients and (Proposed) Legislation," *Contact Dermatitis* 92, no. 3 (2025): 164–175.

8. J. Ulriksdotter, M. Mowitz, C. Svedman, and M. Bruze, "Patch Testing and Diagnosis When Suspecting Allergic Contact Dermatitis From Medical Devices," *Contact Dermatitis* 83, no. 4 (2020): 333–335, https://doi.org/10.1111/cod.13650.

9. K. Aalto-Korte, M. Pesonen, S. Suomela, and K. Suuronen, "Nine Years of Patch Testing With Isocyanates in a Clinic of Occupational Dermatology," *Contact Dermatitis* 91, no. 3 (2024): 212–221, https://doi.org/10.1111/cod.14621.

10. Merck, "2-Carboxyethyl Acrylate," (2026), https://www.sigmaaldrich.com/NL/en/product/aldrich/552348.

11. N. A. Ipenburg, M. Yaâkoubi, A. C. de Groot, and T. Rustemeyer, "(Meth)acrylate Allergy in the Era of Nail Cosmetics and Medical Devices: Limitations of HEMA and Optimization of Patch Testing," *Contact Dermatitis*.

12. W. Uter, O. Aerts, T. Agner, et al., "European Society of Contact Dermatitis Guideline for Diagnostic Patch Testing-Recommendations on Best Practice (Update 2026)," *Contact Dermatitis* 95 (2026): 237–275, https://doi.org/10.1111/cod.70195. Epub ahead of print.

13. A. De Groot, E. M. van Oers, N. A. Ipenburg, and T. Rustemeyer, "Allergic Contact Dermatitis Caused by Glucose Sensors and Insulin Pumps: A Full Review: Part 1: Sensors and Pumps, Adverse Cutaneous Reactions, Allergens, and Diabetes Devices Causing Allergic Contact Dermatitis," *Contact Dermatitis* 92, no. 2 (2025): 87–112, https://doi.org/10.1111/cod.14698.

14. E. M. Van Oers, A. C. de Groot, P. Verolme, N. A. Ipenburg, and T. Rustemeyer, "Results of GC-MS Analyses of 40 Extracts of Diabetes Devices. Table S1," *Contact Dermatitis* 94, no. 3 (2026): 234–244, https://doi.org/10.1111/cod.70052.

15. E. Dendooven, F. Haentjens, S. Kanokrungsee, et al., "1,6-Hexanediol Diacrylate, Isocyanates and Other Skin Sensitizers Are Emerging Contact Allergens in Guardian Glucose Sensors," *Contact Dermatitis* 93, no. 6 (2025): 514–526, https://doi.org/10.1111/cod.70010.

16. C. Svedman, J. Ulriksdotter, T. Lejding, M. Bruze, and M. Mowitz, "Changes in Adhesive Ingredients in Continuous Glucose Monitoring Systems May Induce New Contact Allergy Pattern," *Contact Dermatitis* 84, no. 6 (2021): 439–446, https://doi.org/10.1111/cod.13781.

17. Q. Samaran, N. Raison-Peyron, O. Dereure, C. Svedman, and J. Dahlin, "Allergic Contact Dermatitis to Isobornyl Acrylate in a Hospital Wristband," *Contact Dermatitis* 91, no. 1 (2024): 62–64, https://doi.org/10.1111/cod.14539.

18. P. Baek and B. L. Adler, "Allergic Contact Dermatitis to Isobornyl Acrylate in a Home Nail Glue," *Contact Dermatitis* 91, no. 1 (2024): 64–66, https://doi.org/10.1111/cod.14541.

19. V. Amat-Samaranch, C. Garcia-Melendo, C. Tubau, L. Puig, and E. Serra-Baldrich, "Occupational Allergic Contact Dermatitis to Isobornyl Acrylate Present in Cell Phone Screen Protectors," *Contact Dermatitis* 84, no. 5 (2021): 352–354, https://doi.org/10.1111/cod.13747.

20. W. A. Christoffers, P. J. Coenraads, and M. L. Schuttelaar, "Two Decades of Occupational (Meth)acrylate Patch Test Results and Focus on Isobornyl Acrylate," *Contact Dermatitis* 69, no. 2 (2013): 86–92, https://doi.org/10.1111/cod.12023.

21. L. Malinauskiene, G. Šlekyte, M. Mowitz, M. Isaksson, and R. Zablockis, "Allergic Contact Dermatitis Caused by Isobornyl Acrylate in Two Patients Treated for Idiopathic Pulmonary Arterial Hypertension," *Contact Dermatitis* 83, no. 2 (2020): 170–171, https://doi.org/10.1111/cod.13617.

22. E. Dendooven, K. Foubert, A. Goossens, et al., "Concomitant Positive Patch Test Reactions in FreeStyle-Allergic Patients Sensitized to Isobornyl Acrylate," *Contact Dermatitis* 84, no. 3 (2021): 166–174, https://doi.org/10.1111/cod.13706.

23. M. Cichoń, M. Trzeciak, M. Sokołowska-Wojdyło, and R. J. Nowicki, "Contact Dermatitis to Diabetes Medical Devices," *International Journal of Molecular Sciences* 24, no. 13 (2023): 10697, https://doi.org/10.3390/ijms241310697.

24. E. Oppel, C. Högg, A. Oschmann, B. Summer, and S. Kamann, "Contact Allergy to the Dexcom G6 Glucose Monitoring System-Role

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

of 2,2′-Methylenebis(6-Tert-Butyl-4-Methylphenol) Monoacrylate in the New Adhesive," *Contact Dermatitis* 87, no. 3 (2022): 258–264, https://doi.org/10.1111/cod.14141.

25. M. Mowitz, A. Herman, M. Baeck, et al., "N,N-Dimethylacrylamide-A New Sensitizer in the FreeStyle Libre Glucose Sensor," *Contact Dermatitis* 81, no. 1 (2019): 27–31, https://doi.org/10.1111/cod.13243.

26. J. Ulriksdotter, C. Svedman, M. Bruze, et al., "Contact Dermatitis Caused by Glucose Sensors—15 Adult Patients Tested With a Medical Device Patch Test Series," *Contact Dermatitis* 83, no. 4 (2020): 301–309, https://doi.org/10.1111/cod.13649.

27. M. Mowitz, T. Lejding, J. Ulriksdotter, A. Antelmi, M. Bruze, and C. Svedman, "Further Evidence of Allergic Contact Dermatitis Caused by 2,2′-Methylenebis(6- Tert -Butyl-4-Methylphenol) Monoacrylate, a New Sensitizer in the Dexcom G6 Glucose Sensor," *Dermatitis* 33, no. 4 (2022): 287–292, https://doi.org/10.1097/DER.0000000000000767.

28. N. Hamnerius, J. Dahlin, M. Bruze, K. Nilsson, T. Sukakul, and C. Svedman, "Colophonium-Related Allergic Contact Dermatitis Caused by Medical Adhesive Tape Used to Prevent Skin Lesions in Soldiers," *Acta Dermato-Venereologica* 103 (2023): adv18428, https://doi.org/10.2340/actadv.v103.18428.

29. M. Bruze, I. Dahlquist, and S. Fregert, "Patch Testing With Colophony at 60% Concentration," *Contact Dermatitis* 15, no. 3 (1986): 193, https://doi.org/10.1111/j.1600-0536.1986.tb01330.x.

30. C. C. A. van Amerongen, R. Ofenloch, D. Dittmar, and M. L. A. Schuttelaar, "New Positive Patch Test Reactions on Day 7-The Additional Value of the Day 7 Patch Test Reading," *Contact Dermatitis* 81, no. 4 (2019): 280–287, https://doi.org/10.1111/cod.13322.

31. O. Aerts, E. Dendooven, and N. Raison-Peyron, "Sensitization to Modified Colophonium in Glucose Sensors: Another Problem for Diabetes Patients," *Contact Dermatitis* 87, no. 6 (2022): 553–555, https://doi.org/10.1111/cod.14213.

32. E. Dendooven, T. Naessens, K. Foubert, N. Hermans, and O. Aerts, "Tert-Butylhydroquinone and Tert-Butylcatechol Positivity as Warning Lights of Skin Sensitization to Tert-Butylphenol Derivatives in Adhesives and Diabetes Devices," *Contact Dermatitis* 91, no. 5 (2024): 387–391, https://doi.org/10.1111/cod.14670.

Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Allergens and related chemicals and the devices in which they have been identified. **Table S2:** Sensors causing skin complaints. **Table S3:** Sensors causing no skin complaints. **Table S4:** Pumps and infusion sets causing skin complaints. **Table S5:** Time from first device use to onset of skin complaints. **Table S6:** Time from device application to onset of symptoms. **Table S7:** Patient-reported effect of topical corticosteroids. **Table S8:** Summary of reported effects of underpatches/barrier products for sensors. **Table S9:** Summary of reported effects of underpatches/barrier products for pumps/infusion sets. **Table S10:** Underpatches/barrier products used for sensor related complaints. **Table S11:** Underpatches/barrier products used for pump/infusion set-related complaints. **Table S12:** Devices causing dermatitis from clinically relevant positive allergens. **Table S13:** Allergens present in devices responsible for dermatitis. **Table S14:** Personal products patch tested. **Table S15:** Positive patch test reactions to personal products. **Table S16:** Added clinical value of testing personal products. **Table S17:** Results of paired testing with adhesives and their extracts. **Table S18:** Pattern of positive reactions to colophonium, hydroabietyl alcohol and abietic acid. **Table S19:** Diabetes device series in Amsterdam and in Malmö.

16000536, 0, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/cod.70275, Wiley Online Library on [04/11/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License