

Original article

Contact allergies in haemodialysis patients: a prospective study of 75 patients

Background: Haemodialysis exposes patients to many potentially sensitizing allergens.

Objectives: The primary objective of this study was to evaluate the prevalence of delayed hypersensitivity in a population of haemodialysis patients. Secondary objectives were to identify the possible risk factors for contact sensitization and to propose a series of skin tests adapted to haemodialysis patients.

Methods: A prospective monocentric study was carried out in a nonselected population of haemodialysis patients. For each patient, medical history of atopy and allergic contact dermatitis, ongoing treatments (including topical ones), presence of eczema at the site of vascular access for haemodialysis were recorded. Allergological investigation included delayed hypersensitivity tests (European Environmental and Contact Dermatitis Research Group battery, tests GERDA, additional list and a battery of antiseptics and other dialysis-specific allergens) and latex skin prick test.

Results: Seventy-five patients (41 men, 34 women, mean age of 65 years old), with a mean 3.8 years under dialysis, were included. Nineteen patients (25%) had at least one positive skin test and 13 (17%) a positive patch test to at least one allergen relative to dialysis process including eight tests to lidocaine–prilocaine cream and three to povidone–iodine. Tests results seemed clinically relevant since nine patients had localized pruritus at the fistula site and six patients active eczema around it.

Conclusion: Contact sensitizations are frequent in haemodialysis patients and are linked to vascular access conditioning especially the use of lidocaine–prilocaine cream. Designing a specific test battery could help to diagnose the potential allergens and subsequently to give advice to avoid contact with sensitizing agents.

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Key words: allergic contact dermatitis; arteriovenous fistula; delayed hypersensitivity; eczema; haemodialysis; lidocaine prilocaine cream.

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Haemodialysis treatment exposes patients to many potentially sensitizing allergens such as antiseptics, nickel (in the needles), local anaesthetics, latex, etc. However, very few studies have explored allergic contact dermatitis in such populations (1–5) while eczema and pruritus are commonly found around the vascular access suggesting the presence of a contact sensitization (6).

The primary objective of this study was to evaluate the prevalence of delayed hypersensitivity to specific allergens in a population of haemodialysis patients. Secondary objectives were to identify the possible risk factors for cutaneous sensitization in these subjects and to propose a specific adapted skin tests battery to patients treated with haemodialysis.

Methods

This prospective monocentric study was carried out in a nonselected population of patients treated at an haemodialysis unit in Marseille, France. All patients undergoing conventional haemodialysis three

times a week (Monday, Wednesday and Friday) 5 ± 1 h duration in January 2004 were included, after having given their consent.

Allergological investigation

Assessment of the different dialysis methods

Topical agents such as antiseptics and anaesthetic creams, needles and adhesives used, allergens from different types of dialysis membrane and dialysis circuitry, and sterilization methods used in the haemodialysis unit were recorded to identify the most representative allergens to be tested.

Patient history

All patients were interviewed by the same investigator using a standard questionnaire, checking for an history of atopy (childhood asthma, atopic eczema, allergic rhinitis or conjunctivitis, positive skin prick test from house dust mites and pollens) and a history of contact dermatitis. Patients did not suffer from other dermatological conditions.

All treatments likely to interfere with the allergological investigation were recorded, including H1 antihistamines, topical and systemic corticosteroids and immunosuppressive drugs. Any antihistamines being taken were stopped at least 8 days before the skin tests.

The patients were asked about any localized pruritus at the site of the vascular access. A dermatological examination searched for contact dermatitis, particularly at the site of the vascular access.

Laboratory tests

Routine laboratory tests were performed looking for hypereosinophilia defined by levels above $500 \times 10^9/l$ and hyper-IgE levels (Pharmacia®, Uppsala, Sweden) defined by levels above 150 kU/l.

Patch tests

Tests were carried out using 53 allergens including 25 allergens from the standard European Environmental and Contact Dermatitis Research Group series (7), 10 additional tests from the French Dermatology and Allergology Research Group (GERDA) (8), and a battery of antiseptics and other dialysis-specific allergens listed in Table 1. Substances tested were placed in aluminium chambers (Finn Chambers®, Chiesi, Courbevoie, France) and fixed in place with an adhesive (Fixomull®, Beiersdorf, Hilton, Keynes, UK) for 48 h. Positive tests were interpreted at 48 and 96 h by the same investigator in accordance with the International Contact Dermatitis Research Group (ICDRG) criteria (9). The relevance of patch tests was validated by the existence of contact dermatitis at the contact site. Moreover in all cases, contact dermatitis disappeared after cessation of allergen application. When a positive test was found with a commercialized product, a second series of test was carried out with the separate components.

Statistical analysis

A univariate analysis of predictive factors for contact dermatitis occurrence was carried out as well as a multivariate analysis using the logistic regression model.

Quantitative variables were compared using the Student's *t*-test when the normality test passed, otherwise the Wilcoxon rank test, with a 5% threshold limit value. For the qualitative variables, the chi-square test was used.

Candidate variables for logistic regression model were: variables significant after univariate analysis, variables with significance below a threshold of 0.20 and variables considered to facilitate contact allergy. Variables were selected using an ascending stepwise procedure, using SPSS, 10.5.1 version.

Results

Demographic data

Among the 85 eligible patients, 10 were subsequently excluded: one patient moved to a different dialysis unit, four refused to participate, three had understanding problems, one patient was under 18 years and one patient's condition was too unstable. Therefore, 75 patients were included in the study.

This included 41 men and 34 women (male : female ratio of 1.2 : 1) ranging from 37 to 92 years with a median age of 67 years (mean: 65 years). The mean duration of dialysis treatment was 3.8 years, ranging from 1 month to 34.6 years (median 3.9 years). The causes of the patients' renal insufficiency are given in Table 2.

There were no significant differences between the 75 patients studied and the remaining haemodialysis patients

at this dialysis unit ($n = 107$) with regard to age, sex ratio, duration of haemodialysis treatment, history of atopy, long-term antihistamine use or use of lidocaine–prilocaine cream (EMLA® Reims, France) (data not shown).

Dialysis procedures

Dialysis membranes

Forty-four patients (59%) were dialysed using a synthetic hydrophobic membrane of polysulphone, polyamide, polymethylmetacrylate or polyacrylonitrile. Thirty-one patients (41%) were dialysed using a modified cellulosic membrane of di- or tricellulose acetate. No pure cellulose membrane, such as cuprophane, was used in any of the patients.

Sterilization methods

Gamma rays were used to sterilize the dialysers and tubing. It has to be noticed that ethylene oxide and formaldehyde have not been used since 10 years to sterilize dialysis equipment or to disinfect surfaces.

Vascular access

Vascular access was arteriovenous fistula (AVF) (native or prosthetic) implanted in arm (elbow) after surgical procedure in 68 cases (90.6%) and internal jugular venous catheter tunnelled on anterior chest wall in seven cases (9.4%).

Topical agents applied to the vascular access

Most patients (61.81%) had used a local anaesthetic cream or a patch lidocaine–prilocaine on the AVF site. Fifty-two patients (69%), including 23 males and 29 females, were still using it 1 h before vascular puncture, three times a week but nine had stopped for various reasons: eight patients for a local reaction and one for unsatisfying analgesic effects.

Polyvidone–iodine (Meda pharma, Paris, France) was used as a standard skin disinfection for the patients dialysed with central venous catheter and chlorhexidine for AVF dialysed patients, except in one patient with a suspected allergy to chlorhexidine, using a mild soap.

A single type of needle (Plume®, Hôpital, Lyon, France) containing nickel was used and left in situ all along the dialysis for the 68 patients dialysed via AVF. The needle was fixed on the site by plaster (Steristrip®, Hôpital, Cergy Pontoise, France) in 60 patients (89%) and Urgofilm® (Urgo Chenôve, France) in eight patients (11%) intolerant to the former.

Clinical data

Possible influencing factors for contact sensitivity: history of atopy

Thirty-three patients (44%) were taking H1 antihistamines on a long-term basis and 13 patients (17%) fulfilled atopy criteria. Sixteen patients (22%) claimed to have an allergy

Table 1. Allergens tested in the 75 patients

European Environmental and Contact Dermatitis Research Group (9)	1. Potassium dichromate 0.5% pet	Metal
	2. Neomycin sulphate 20% pet	Antibiotic
	3. Thiuram mix 1% pet	Rubber
	4. Para-phenylenediamine base 1% pet	Hair dye
	5. Cobalt chloride 1% pet	Metal
	6. Benzocaine 5% pet	Local anaesthetic
	7. Formaldehyde 1% aq.	Preservative/disinfectant
	8. Colophonium 20% pet	Adhesive
	9. Quinoleine mix 6% pet	Antiseptic
	10. <i>Myroxylon pereirae</i> (Balsam of Peru) 25% pet	Fragrance
	11. IPPD 0.1% pet	Rubber
	12. Lanolin alcohol 30% pet	Wool alcohols
	13. Mercapto mix 2% pet	Rubber
	14. Epoxy resin 2% pet	Plastic, glues
	15. Parabens 12% pet	Preservative
	16. <i>p-tert</i> -Butylphenol-formaldehyde resin 1% pet	Plastics, resins
	17. Fragrance mix 8% pet	Fragrance
	18. Sesquiterpene lactone mix 0.1% pet	Composite allergens
	19. Quaternium 15.1% pet	Preservative
	20. Nickel sulphate 5% pet	Metal
	21. Methyl (chloro)isothiazolinone 0.01% aq.	Preservative
	22. Mercaptobenzothiazole 2% pet	Rubber
	23. Primin 0.01% pet	Plant
	24. Tixocortol pivalate 0.1% vas.	Corticoid
	25. Budesonide 0.01% vas.	Corticoid
GERDA additions (10)	26. Euxyl K400 (mixture of methylidibromo glutaronitrile and phenoxyethanol) 1.5% vas.	Preservative
	27. Amerchol L101 50% vas.	Wool alcohols
	28. Dimethylaminopropylamine (DMAPA) 1% aq.	Impurity in betaines (soft detergents)
	29. Hydroxyisohexyl cyclohexene carboxaldehyde (Lyrall®) 5% vas.	Fragrance
	30. Sodium lauryl sulphate 0.25% aq.	Detergent, cutaneous reactivity indicator
	31. Disperse blue 106 1% pet	Clothing dye
	32. Propylene glycol 15% aq.	Excipient
	33. Dialkylthiourea mix 1% pet	Rubber
	34. Imidazolidinyl urea 2% aq.	Preservative
	35. Benzalkonium chloride 0.1% aq.	Preservative/ antiseptic
Antiseptics additions	36. Povidone–iodine red 10% aq.	Antiseptics, preservatives
	37. Chlorocresol 1% vas	
	38. Chlorhexidine digluconate 0.5% aq.	
	39. Eosin 50% vas.	
	40. Glutaraldehyde 0.2% pet	
	41. Hexamidine diisethionate 0.15% aq.	
	42. Thiomersal 0.1% pet	
'Dialysis' additions	43. Sodium metabisulphite 1% pet	Preservative/antioxidant
	44. Lidocaine–prilocaine cream (EMLA® cream) 5% aq.	Local anaesthetics
	45. Cetylpyridonium chloride 0.1% pet	Preservative
	46. Cetylstearyl alcohol 20% vas.	Excipient
	47. Carba mix 3% pet	Rubber
	48. Bufenamac 5% vas.	Topical nonsteroidal anti-inflammatory drug
	49. Acetic acid 0.5% aq	Dialysis 'bath'
	50. F60S (polysulphone, Fresenius)	Synthetics dialysers membrane (DM)
	51. HF80 (polysulfone, Fresenius)	
	52. Polyflux® (polyethersulfone, Gambro)	
	53. Tricea® (cellulose triacetate, Baxter)	Cellulosic DM

to iodine, four patients (5%) an allergy to latex and three patients (4%) an allergy to ethylene oxide. Latex allergy was diagnosed on clinical history and confirmed in each case by specific IgE dosage and prick tests.

There was no significant link between atopy and a previous history of immediate hypersensitivity reactions, contact dermatitis, hypereosinophilia or hyper-IgE levels (data not shown).

Table 2. Causes of chronic renal failure among the tested haemodialysis patients

Renal insufficiency causes	<i>n</i>	%
Vascular nephropathies (including cortical necrosis)	18 (2)	25 (3)
Diabetic glomerulopathies	8	11
Other glomerulopathies (including amylosis)	17 (2)	22 (3)
Interstitial nephropathies	10	13
Hereditary nephropathies, renal polykystosis	7	9
Polyfactorial and undetermined nephropathies	15	20

Clinical manifestations

Twelve patients (16%) complained about a localized itching at the fistula site. Active eczema was found around the fistula in six patients (8%). There were no significant differences between them and the rest of the population tested in terms of age and duration of haemodialysis treatment. Patients with localized pruritus at the fistula site had more often an active eczema around the fistula than those without localized pruritus (33% vs 5% respectively, $P = 0.02$).

Laboratory data

Polymorphonuclear eosinophil count

The mean count per patient was $237 \times 10^9/l$ (ranges $20\text{--}1730 \times 10^9/l$) with a median of $190 \times 10^9/l$ and was not significantly higher among patients with atopy or positive skin tests (data not shown). Six patients (8%) had hypereosinophilia.

Total IgE levels

Eleven patients (14.6%) had hyper-IgE levels. The mean IgE level per patient was 125.4 kU/l (ranges 1–2391 kU/l), with median of 27.4 kU/l and was not significantly higher among patients with atopy, history of immediate hypersensitivity reactions or positive skin tests (data not shown).

Patch tests

Out of the 75 patients tested by skin patch tests, the results were difficult to interpret in four cases (5.3%): two patients who could not stand the tests and two with 'angry back syndrome' (false-positive patch tests reactions due to skin hyperreactivity (10)) after 48 h. In these four patients, a second series of test was not performed.

Nineteen patients (25%) had one or more positive skin tests. In eight patients (10%) this involved contact polysensitization. The mean number of positive skin tests was 2.1 with a maximum of six positive skin tests. Prevalence of sensitizations to different allergens are shown in Table 3.

Thirteen patients (17.3%) had a positive test potentially linked to one or more products used during dialysis process.

Six patients (8%) had a positive test to antiseptics. One patient had a positive skin test to thiomersal, another to hexamidine and one to glutaraldehyde.

However they did not record any skin reaction with these antiseptics that were no longer used in the dialysis unit. Three patients (4%), already known to be allergic to povidone-iodine, which they no longer used, had a positive test.

In contrast, none of these seven patients who were using povidone-iodine to disinfect the central catheter had any eczema, or positive skin test with this antiseptic.

Eight patients (10.7%) had positive patch tests to lidocaine-prilocaine cream according to the ICDRG criteria. This result was clinically relevant for seven of these patients (see Table 4). The eighth patient had neither pruritus nor lesion at the AVF site. A second series of skin tests was carried out on all these patients, using separate components of the anaesthetic cream: prilocaine, lidocaine and hydrogenated polyoxyethylenated castor oil. In all cases, skin tests demonstrated an exclusive contact sensitization to prilocaine.

Four patients (5.3%) had skin tests positive to allergens from dialysis equipment and vascular puncture material including two patients with positive tests to nickel. Both had a history of atopy and one claimed skin reactions to jewellery. None had pruritus or eczematous lesions on the AVF site, despite the use of stainless steel needles containing nickel that remained in situ for the duration of the dialysis session. Another patient had a positive skin test to epoxy resins contained in dialysis needles but had no reaction at the vascular access site. The remaining patient tested positively to colophonium and was known to react to certain adhesives hence used 'hypoallergenic' plasters not containing colophonium. Colophonium tests were negative for seven other patients although they claimed to be allergic to adhesives.

Twelve patients (16%) had positive test results to excipients and preservatives. This could be related to haemodialysis process in five patients (6.7%) who tested positively to sodium metabisulphite widely used as a preservative in local anaesthetics containing adrenaline. In the remaining cases, the allergy seemed to be linked to cosmetics.

Factors associated with positive skin tests

In univariate analysis, among the 75 patients: (1) subjects with localized pruritus at the AVF were more likely to have positive skin test results than those with no pruritus (77.8% vs 18%, $P = 0.0006$), (2) subjects with a known history of eczema were more likely to have positive skin test results than those with no known history of eczema (61% vs 14%, $P = 0.0002$) and (3) subjects on examination with active eczema localized on vascular access were more likely to have positive skin tests than subjects without active eczema (83% vs 20%, $P = 0.003$).

Age, sex, duration of dialysis, atopy, antihistamine treatments and/or hypereosinophilia did not significantly affect positive skin tests (data not shown).

There was no significant difference between patients with ≥ 2 positive skin tests and mono- or nonsensitized

Table 3. Prevalence of sensitization to the various allergens tested in the haemodialysis patient's population

Class	Allergen	Number and % of patients with positive patch tests (%)	% of the positive patch tests
Local anaesthetic Antiseptics	Lidocaine–prilocaine cream	8 (10.7)	19
	Povidone–iodine	3 (4)	8
	Thiomersal	1 (1.3)	2
	Hexamidine	1 (1.3)	2
	Glutaraldehyde	1 (1.3)	2
Preservatives, excipients	Sodium metasilphite	5 (6.7)	12
	Euxyl K400	3 (4)	8
	Parabens	1 (1.3)	2
	Benzalkonium chloride	1 (1.3)	2
	Quaternium-15	1 (1.3)	2
	Propylene glycol	1 (1.3)	2
	Neomycin	1 (1.3)	2
Antibiotic Metals	Cobalt	3 (4)	8
	Nickel	2 (2.7)	6
	Epoxy resins	1 (1.3)	2
Hardener, dialysis needles	Formaldehyde resins	1 (1.3)	2
Plastics, resins	Dimethylaminopropylamine	1 (1.3)	2
Markers for impurity in betaines (soft detergents)	Colophonium	1 (1.3)	2
Adhesive	Amerchol L101	1 (1.3)	2
Wool alcohols	Fragrances	2 (2.7)	6
Fragrances	Disperse blue 106	1 (1.3)	2
Clothing dyes	Sodium lauryl sulphate	2 (2.7)	6
Detergent, cutaneous reactivity indicator			

PT, patch tests.

Table 4. Skin patch tests among patients with clinical manifestations

Patient	Clinical symptoms	Positives PT
1. H69	AVF pruritus	Povidone–iodine
	AVF eczema	Prilocaine
2. H71	Lidocaine–prilocaine cream intolerance	
	AVF pruritus	Parabens
	AVF eczema	Fragrances
	Lidocaine–prilocaine cream intolerance	Euxyl K400 Prilocaine
3. H80	AVF pruritus	Prilocaine
	AVF eczema	
4. H81	Lidocaine–prilocaine cream intolerance	
	AVF pruritus	Fragrances
	AVF eczema	Prilocaine
5. H56	AVF pruritus	Euxyl K400
	AVF eczema	Amerchol L101
	Lidocaine–prilocaine cream intolerance	Benzalkonium chloride
		Povidone–iodine
6. H70	Lidocaine–prilocaine cream intolerance	Prilocaine
7. F42	Lidocaine–prilocaine cream intolerance	Nickel
		Prilocaine
		Quaternium
8. H44	No AVF pruritus	Euxyl K400
	No AVF eczema	DMA
		Hexamidine
		Prilocaine
10. F88	AVF pruritus	None
	AVF eczema	
11. H52	AVF pruritus	Parabens
		Povidone–iodine

AVF, arteriovenous fistula; PT, patch tests.

Table 5. Predictive factors of contact sensitization in haemodialysis: multivariate analysis (binary logistic regression models with ascending stepwise method)

Variable	β	<i>P</i>	OR	95% CI of OR
Localized pruritus at the fistula site	2.2	0.007	8.9	1.8–43.6
History of eczema at the fistula site	1.7	0.01	5.6	1.5–21.3

patients in terms of sex ratio, age, atopic history and dialysis duration.

Candidate variables for multivariate analysis were: localized pruritus at the AVF, history of active eczema on AVF, presence of an active eczema of the AVF, age, sex, dialysis duration, atopy, antihistamine treatments and hypereosinophilia. Logistic regression model retained localized pruritus at the AVF and history of eczema at the AVF as predictive factors for contact sensitization. Results are listed in Table 5.

Discussion

This study, which evaluated the prevalence of contact allergies in a representative sample of a dialysis centre in France showed a 25% prevalence of delayed skin contact hypersensitivity which is higher than the 17.5% of patients in Gonzalo's study (1) in Spain. This difference is probably linked to the number of tested allergens 53 vs 39, respectively.

The majority of previous studies investigated only symptomatic patients who demonstrated active eczema around the AVF (2, 4, 5), or unexplained pruritus (3), or concerned a smaller population (3–5), focused more on immediate hypersensitivity reactions (11, 12) or only on one (4), or a small number of allergens (1). In contrast, in our series, tests were prospectively performed whether or not the patients presented clinical manifestations that indicated allergies and we used a large battery of allergens, targeting the equipment and topical agents used in dialysis, notably topical medications introduced recently such as local anaesthetics.

The subjects tested were representative of the population of dialysis patients at the unit in terms of demographics and previous allergic histories. In addition, the different reasons for dialysis, which could influence allergies, were distributed similarly to those described in the literature (13). However, it is not certain that our results can be extrapolated to all patients treated with haemodialysis.

In this study, the 17% prevalence of atopic subjects was comparable with that described in the general population (15–30%) (14) but was higher than that usually reported for dialysis patients (10–13.5%) (1, 6, 11).

We observed that 8% of patients had localized eczema at the vascular access site at the time of examination despite the relative immunodepression of haemodialysis patients (11). This finding is comparable with the literature as, according to publications, 1.25 up to 24% of haemodialysis patients had such lesions (1,5). An expected, prediction of contact dermatitis was strongly linked to the existence of localized pruritus at the vascular access. In our study, this parameter was the most predictive factor of contact sensitization and was also the most relevant. Anergy of haemodialysis patients may minimize clinical manifestations of contact sensitization, leading to isolated pruritus without eczema.

This study also aimed to optimize the existing care procedures by limiting exposure to the allergens most frequently involved. Patch testing allowed us to eliminate contact allergies that had been suspected after questioning in 33 cases, and to confirm it in 12 cases. We discovered that the majority of delayed hypersensitivity reactions were specifically linked to vascular access conditioning and preparatory procedures, i.e. local anaesthetics and antiseptics. These reactions affected 13 patients (68% of the total of all patients with delayed contact hypersensitivity) and have a strong correlation with clinical data like localized pruritus at the fistula, or eczema at the vascular access.

Although it had never been mentioned before, lidocaine–prilocaine cream was the primary allergen concerned, as 9% of the population developed delayed sensitization after an average period of use of 4 years, affecting 37% of patients with positive skin tests and 13.1% of patients which had previously used lidocaine–prilocaine cream. Wehle et al. (15) described reactions caused by repeated use

of lidocaine–prilocaine cream in 31 patients, but found only local vasculomotor reactions in 66% of patients, and two cases of local irritation. In addition, these reactions are exclusively linked to prilocaine, which had already been reported (16, 17). The main risk factors for emerging a delayed hypersensitivity to lidocaine–prilocaine cream appear to be application on damaged skin and repeated and prolonged use under bandages or dressings on the same cutaneous area (17–19). The increase in topical agents containing lidocaine suggests that a raise in contact allergy will be expected, like in Australia where a doubling of the number of topical agents containing lidocaine between 1985 and 1996 has resulted in a wave of contact allergies (20). However, local anaesthetics have considerably improved the comfort of patients submitted to repeated vascular punctures.

According to this study, contact allergies to antiseptics are the second most common allergies: 7% of patients, of which 4% are allergic to povidone–iodine. These figures are consistent with the literature (21). Furthermore, the quasi-daily use of these products weakens the cutaneous barrier and promotes the occurrence of irritative dermatitis which may leads to sensitization. However, and despite many cases of polysensitization to antiseptics (7% of cases), none of our patients had positive patch tests for chlorhexidine, an antiseptic widely used in the haemodialysis department. Although cases of anaphylaxis have been reported in the literature (22), this antiseptic would appear to be the one to use in the first instance when preparing the vascular access.

All skin tests using fragments of dialysis membranes were negative as was the case in Rollino's study (3). This was also the case with formaldehyde used to disinfect the tubing and valves. Although several cases of contact dermatitis to epoxy resins from dialysis needles have been reported in the literature (23, 24), in our study only one patient had an isolated positive skin test, the relevance of which is questionable, as no clinical manifestations were recorded at the AVF.

As reported in the literature (1), the prevalence of an allergy to nickel was less common than in the general population, as it only affects 2.7% of dialysis patients, while 10–20% of women and 2–5% of men in the general population (7, 25). Beside the relative cellular immunodepression of haemodialysis patients leading to global anergia, these low rates of sensitization can be explained by the use of stainless steel of good medical quality releasing less nickel ions and by the specific patient profile as most of them were aged males and so have been less exposed to jewellery or buttons. Frequent association of contact allergy to cobalt with allergy to nickel, can explain low rates of cobalt sensitization (4%). Only one patient developed a positive skin reaction to colophonium, compared with 3.7% of sensitizations from the general population (24). Differences in the choice and use of haemodialysis procedures, such a hypoallergenic adhesives which are

preferred for patients with history of skin reactions to conventional adhesives may explain low sensitization to colophonium.

This study also shows positive tests linked to the topical products used rather than the dialysis procedure (3). Thus, 5% of patients were allergic to an excipient, or preservative found in medication as well as in cosmetics.

Therefore our results confirm that carrying out tests designed for and aimed at haemodialysis patients could help to adapt haemodialysis procedures and remove sensitizing agents. Primary prevention involves the practical management of haemodialysis procedures, for example by using a minimum amount of topical agents at the vascular access site, and 'hypoallergenic adhesives' of

known composition (4). The results also allow us to propose a series for haemodialysis patients, which would ideally include a total of 44 allergens (number 1 to 44 listed in Table 1) among the 53. This would need to be tested and validated in a different population of dialysis patients.

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