

**NOTICE: THIS
MATERIAL MAY
BE PROTECTED
BY COPYRIGHT
LAW (TITLE 17
U.S. CODE).**

Control of large institutional scabies outbreaks

Johanna Stoevesandt¹, Lydia Carlé¹, Martin Leverkus^{1,2}, Henning Hamm¹

(1) Department of Dermatology, Venereology and Allergology, University Hospital Würzburg, Germany

(2) Department of Dermatology, Venereology and Allergology, University Hospital Mannheim, Germany

JDDG; 2012 · 10:637–647

Submitted: 24.10.2011 | Accepted: 12.12.2011

Keywords

- disabled people
- community facilities
- ivermectin
- permethrin
- scabies outbreak
- crusted scabies

Summary

Background: Scabies outbreaks in community facilities may reach large dimensions and take a protracted course. Highly contagious crusted scabies is a major cause of nosocomial outbreaks.

Patients and methods: On the occasion of an extensive scabies outbreak in a north Bavarian sheltered workshop and its associated residential homes with over 500 exposed individuals, a multifaceted control strategy was developed and pursued. Knowledge from a comprehensive review of the literature was utilized. **Results:** Our successful scabies elimination concept includes: 1) Careful organization (formation of an outbreak management team, registration and information of all exposed individuals, prospective time management, financial calculation); 2) simultaneous clinical examination of all individuals at risk; 3) synchronous topical treatment of all exposed individuals with permethrin 5 % cream on day 0, repeated treatment of proven and doubtful cases on days 1 and 14; systemic treatment of selected cases with oral ivermectin; 4) decontamination and quarantine measures; 5) follow-up investigations and repeated treatment if indicated.

Conclusions: Management of large institutional scabies outbreaks requires a high degree of motivation, communication skills and perseverance.

Introduction

In Western European countries the prevalence of scabies is estimated to be less than 1 % [1]. Exact figures from the German-speaking nations do not exist because scabies is not a reportable disease. Outbreaks in community facilities can be quite extensive due to the biology of the pathogen and the clinical course of the disease. Fertilized female mites of the species *Sarcoptes scabiei* var. *hominis* lay several eggs daily which develop into sexually mature and infective animals within about 2 weeks [2]. Patients infected for the first time are still asymptomatic after this time period while the number of mites increases rapidly to several hundred per patient, only to decrease gradually again over the course.

Only after the development of an immune response after about 3–5 weeks do symptoms appear making the diagnosis possible: agonizing, particularly nocturnal pruritus and typical skin lesions with a predilection for interdigital spaces, axillae, nipples and the anogenital region. Immunocompromised or disabled patients with crusted scabies play a key role in the development of scabies outbreaks, as they can harbor up to several million mites and are thus highly contagious. At the same time crusted scabies due to its peculiar clinical features with diffuse erythema and hyperkeratoses is frequently misdiagnosed, also promoting the spread of the mites (Figure 1a, b, c). The diagnostic gold standard is the microscopic detection of

the mite in skin scrapings or the targeted extraction of a mite from its burrow with a needle. Significantly less time-consuming and particularly well-suited for screening in outbreaks is dermatoscopy [4] (Figure 2).

On the occasion of an extensive scabies outbreak in a north Bavarian sheltered workshop and its associated residential homes, we developed detailed recommendations on the approach to epidemic scabies in large community facilities. Knowledge from a comprehensive review of the literature was utilized here.

Patients and methods

Profile of the involved institution

The involved workshop is an institution of the German Lebenshilfe (a non-profit

organization supporting disabled people and their families) providing jobs and vocational training for people with physical, intellectual or multiple disabilities. It includes a large workshop with about 400 disabled and non-disabled coworkers as well as associated workshops, support centers and associated residential homes. An extensive outbreak of scabies had occurred in 1998 and was successfully controlled by our clinic and office-based dermatologists [5].

Collection of data

The more recent outbreak was analyzed retrospectively in a medical doctoral thesis (L.C.) with review of patient files of our clinic as well as outbreak-specific documents (lists of persons, conference protocols, correspondence, bills, information material) of our clinic and the involved institution. Additional oral and written information was obtained from clinic physicians, the personnel of the workshop and residential homes, the medical director of the public health department as well as the owners and employees of the supplying pharmacies. Problems and difficulties in bringing the outbreak under control were explicitly discussed and documented. The literature search was done using the medical data bank of the US-American National Library of Medicine, PubMed. Search items were “scabies”, “outbreak”, “nosocomial” and “epidemic”. Publications in the Epidemiological Bulletin of the Robert Koch Institute were also taken into consideration.

Initial situation

In August 2003 office-based physicians diagnosed scabies in several workshop coworkers and inhabitants of the residential homes. In the subsequent months further cases occurred and were treated with topical antiscabietics. With increasing case numbers an outbreak was recognized in November 2003 and the workshop management contacted our clinic. Subsequently an outbreak management team consisting of the responsible senior staff physician (H.H.) of the clinic, the social work manager of the workshop and representatives of the workshop and home personnel and the health department was formed. A synchronous initial examination of exposed individuals was conducted in January 2004 in the common rooms of the workshop. About 420 persons were examined, of whom a total of 30 were classified as “affected” or “possibly affected”. In 5 persons crusted scabies was diagnosed. Further, initial examinations of smaller person groups in associated residential homes and auxiliary workshops were performed in a temporally coordinated manner. The total number of potentially exposed individuals was over 500 at this point in time.

Topical and systemic therapy

The simultaneous first topical treatment of all exposed persons was conducted 2 days following the initial examination. Overall 550 initial treatments with 5 % permethrin in unguentum emulsificans aquosum were performed, in the majority of cases by trained nursing personnel. Asymptomatic contact persons were allowed to perform self-treatment. In all definitely and possibly affected persons, treatment was repeated on the following day as well as again after 14 days. The 5 patients with crusted scabies were additionally treated at least twice with ivermectin in a weight-adapted dosage; three patients were treated on an inpatient basis, in 2 cases isolation was performed at home.

Decontamination and quarantine measures

Decontamination and cleaning measures were performed by the personnel of the residential homes and workshop as well as by additionally commissioned companies. Potentially infectious workers were prohibited from continuing their job in the workshop from the time of diagnosis until the first adequate topical therapy. The main workshop was closed completely after the coordinated initial examination for 3 days; community social events were cancelled.

Follow-up examinations and other measures

Fourteen days after the last coordinated treatment 11 persons were still identified as “affected” or “possibly affected”, and the treatment cycle (day 0, 1, 14) was again performed. In the following weeks targeted examinations and re-treatment were performed in individual residential

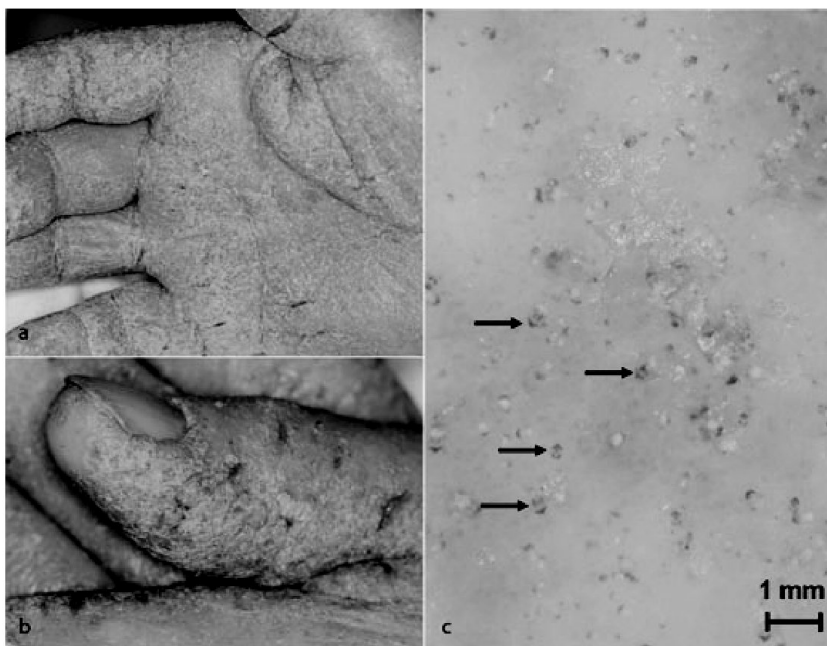


Figure 1: Highly contagious crusted scabies exhibits a clinically distinct pattern featuring diffuse hyperkeratosis (a, b). Numerous mites (→) are identified by dermatoscopic examination (c).

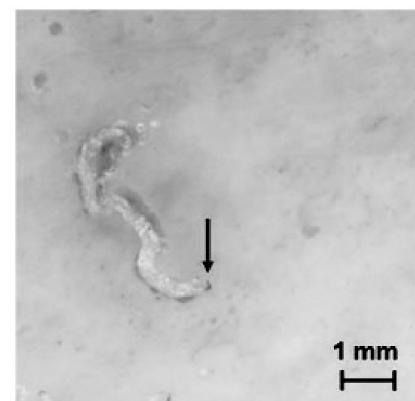


Figure 2: Standard dermatoscopy of a single scabies mite. The mite (→) appears as a characteristic dark triangle, sometimes at the end of an air-filled burrow.

homes and work groups. To improve therapy compliance, individual presumed non-responders were treated in the day clinic of our hospital. Further follow-up examinations were performed in 14-day intervals. In May 2004 the eradication measures were finally successfully concluded after no new suspected cases had occurred over 6 weeks. A final meeting of the outbreak management team for follow-up discussion and critical reflection on the process was held in August 2004.

Results

Balance sheet

Approximately 1000 examinations were cumulatively performed by 11 physicians of our clinic as well as 6 office-based dermatologists. About 750 individual topical therapies were performed by trained nursing personnel. Numerous additional self-treatments were performed by asymptomatic contact persons. A total of 51 kg of 5 % permethrin cream was prescribed and dispensed. The total costs for medical personnel, medication, treatment utensils and decontamination measures were subsequently estimated to be about 50,000 €. As the scabies in employees of the workshop was recognized as an occupational disease (according to BK Nr. 3101 of the German occupational disease list), the employers' liability insurance association covered a large proportion of the costs. Indirect costs to the workshop resulted from loss of production during treatment and quarantine periods.

Concept for control of scabies outbreaks

The interruption of the chain of infection requires simultaneous, effective therapy of all exposed persons, quarantine and decontamination measures as well as regular follow-up. The concept discussed in the following is summarized in Table 1.

Planning and organization

The first step is the formation of and clear assignment of responsibilities within a management team [3] consisting of a leading physician, the head of the institution as well as representatives of nursing personnel, affected individuals and the health department. The management team draws up a time plan for examination, treatment and follow-up examinations, quarantine times and

information events. All exposed persons are recorded in lists and promptly and adequately informed about the outbreak and the necessary measures. If required, the consent of the legal guardian must be obtained. Space must be reserved and prepared for the examination and treatments, the reimbursement of costs by employers' liability insurance associations and health insurance funds must be clarified and – if necessary – additional personnel be recruited, e. g. an outpatient nursing service.

Synchronous initial examination

The synchronous initial examination of all exposed persons serves to identify those actually having scabies. "Definitely affected" are persons where direct detection of mites (e. g. by dermatoscopy) succeeds. "Possibly affected" are persons with cutaneous lesions compatible with this diagnosis at predilection sites [5]. Additionally, persons with hyperinfective forms of scabies, who require isolation and intensified treatment, are identified. Examination results are documented in prepared patient lists to determine the required amount of the antiscabietic agents which must be ordered.

Simultaneous therapy of all affected and contact persons

Simultaneous therapy (day 0) of all exposed persons is performed soon after the initial examination. Clinically possibly and definitely affected persons receive repeat treatment on the following day (day 1) and after 2 weeks (day 14). Asymptomatic contact persons are treated only once on day 0. Contact persons of contact persons (e. g. family members of inconspicuous coworkers) are not treated. The clinically affected are treated by trained nursing personnel. Healthy contact persons perform self-therapy after adequate instruction. Topical therapy is performed according to valid guidelines [6] with 5 % permethrin in a cream base. In patients with crusted scabies or if an effective topical treatment is not possible additional systemic therapy with ivermectin in weight-adapted dosage (0.2 mg/kg) is performed at least twice in an interval of 7–14 days.

Decontamination and quarantine measures

Contaminated textiles are washed at 60 °C or stored in sealed plastic bags for

4 days. Textile surfaces are vacuumed; floors and other surfaces are wiped with a damp cloth. Personnel rotation in the affected institution is reduced as far as possible. Community events or new admissions are cancelled or postponed. Isolation of affected individuals until the first follow-up examination is ideal, but can often not be realized. Patients with crusted scabies are ideally removed temporarily from the affected institution and treated in a dermatology clinic on an inpatient basis.

Follow-up examinations and treatments

The first follow-up examination of all definitely or possibly affected persons as well as presumably new cases is scheduled 2 weeks after the last treatment (day 28). All persons identified as (possibly) affected at the follow-up examination receive another treatment cycle as described above. Follow-up examinations are subsequently performed in 14-day intervals until no new suspected cases occur for at least 6 weeks.

Self-control: mistakes and pitfalls

In the conferences of the management team and retrospective interviews difficulties and disturbances in the course of outbreak control were discussed. Table 2 lists items to be improved.

Discussion

Scabies outbreaks in community facilities are the subject of numerous publications (Table 3) and are also discussed in national and international treatment guidelines [6–9]. While papers on endemic scabies naturally document the situation in developing countries [10] or socially disadvantaged minorities [2], the majority of publications on epidemic scabies come from industrial nations with a correspondingly low prevalence. At the first glance, a wide spectrum of institutions is affected by outbreaks: hospitals, senior citizen homes, nursing homes, institutions for the disabled [5], schools, prisons as well as rarely orphanages [11], homes for asylum seekers [12] or a tourist ship [13]. The majority of documented outbreaks, however, involves hospitals (n = 27) and nursing homes (n = 26) – institutions harbouring elderly, sick or otherwise immunocompromised persons, who are predestined to develop crusted scabies. The key role of these "core transmitters", runs like a

Table 1: Concept to control large institutional scabies outbreaks.

I. Planning and organization	
Formation and regular meetings of a management team with clear assignment of responsibilities	Head physician, director of the institution involved, representatives of the nursing personnel, of affected persons and of the health department
Development of a time schedule	Information events, examinations, treatments, quarantine time, follow-up examinations
Preparation of person lists	Inhabitants, personnel, further contact persons
Information of all involved persons	Bulletins, leaflets, e-mails, information events
Reservation of suitable rooms for examination and treatment	Bright light, partition walls
Clarification of reimbursement of costs	Employers' liability insurance associations and/or health insurance funds
Other	Recruiting of additional medical and/or nursing personnel, obtaining of consent forms for examination and treatment
II. Synchronous initial examination	
Preparation and assistance	Check of consent forms and insurance data, provision of dermatoscopes, disinfectants, gloves and protective clothing
Nursing activities	Support of immobile patients, help in dressing and undressing
Physician's examination and documentation	Classification into definitely affected, possibly affected and not affected persons, identification of persons with hyper-infective scabies
Calculation and ordering of the required amount of the antiscabietic agent	60 g 5 % permethrin cream per individual treatment, purchase of ivermectin tablets (0.2 mg/kg) through international pharmacy
III. Simultaneous therapy of all affected and contact persons	
Preparation and assistance	• Patients present freshly showered with a fresh set of clothing including shoes and underwear • Provision of protective gloves and clothing for the treating nursing personnel as well as cotton gloves for the treated persons
Topical therapy with 5 % permethrin in a cream base	• Synchronous treatment of all affected and contact persons on day 0, additional treatment of all possibly and definitely affected on day 1 and 14 • Treatment of all affected persons by trained nursing personnel, self-treatment of healthy contact persons • Documentation of all treatments by nursing personnel and self-treatments
Systemic therapy with ivermectin in weight-adapted dosage	Adjuvant to topical therapy in hyper-infective scabies or impossibility of an effective topical therapy
IV. Decontamination and quarantine measures	
Cleaning of clothing, bed linens, towels etc.	Wash at 60 °C or store in sealed plastic bags for at least 4 days
Cleaning of surfaces, furniture and objects	Vacuum textile surfaces, damp wiping of floors and other surfaces, disinfection of frequently used objects
Minimization of transmission pathways	• Reduction of personnel rotation, canceling of community activities and if possible of new admissions • Observation of hygiene measures, wearing of protective gloves
Isolation of those affected	Inpatient treatment of patients with crusted scabies, in residential homes cohort isolation is recommended
V. Follow-up examinations and treatments	
Schedule 2 weeks after the last treatment (day 28)	Examination of all formerly definitely or possibly affected persons as well as, if applicable, new suspected cases
Treatment of all still or newly affected persons	Renewed treatment on day 0, 1 and 14
Repeated follow-up examination of all definitely and possibly affected persons at intervals of 14 days	Outbreak is considered over, when no new cases occur for at least 6 weeks

Table 2: Mistakes and pitfalls in planning and realization of the control of large institutional scabies outbreaks.

Diagnostics and therapy
• Misdiagnoses and inadequate therapy at the start of the outbreak • Delayed inclusion of contact persons
Logistics
• Inadequate supply of gloves and dressing material in examination and treatment rooms • Unnecessary storage of permethrin cream in a refrigerator before the simultaneous initial treatment, making it stiff and hard to apply, and thus requiring use of greater than expected amounts • Poor preparation of individual affected persons at the treatment appointment (e. g. lack of replacement clothing and shoes)
Communication and information
• Insufficient or delayed information of affected persons about the disease and the resulting consequences • Lack of inclusion of the family physician as the primary contact of the affected • Delayed transmission of relevant information between involved groups of persons (physicians of the clinic, office-based dermatologists, personnel of the workshop, health department, pharmacies, manufacturer)
Psychosocial aspects
• Lack of or reduced understanding of some disabled and non-disabled affected persons as cause of fear, shame and noncompliance • Pressure of time, excess workload of medical and nursing personnel • Demoralization of personnel and affected persons by the protracted course

common thread through the documented outbreaks and is confirmed by our own experiences (Figure 3).

Large sized institutions involving extensive physical contact between people and cooperating with other, potentially affected institutions [3, 14] – conditions that can be routinely found in a sheltered workshop – are at an increased for scabies outbreaks. Scabies, despite its widespread occurrence, is often misdiagnosed and a taboo disease. Misdiagnoses and inadequate therapy, e. g. exclusively with topical corticosteroids, do commonly precede scabies outbreaks. Even acaricide therapy of *individual* affected persons is an obstacle to control of the outbreak, when potentially infested contact persons remain untreated [5]. Further, psychological factors and disturbed interaction may impede outbreak management: Information deficit or lack of understanding often lead to rejection of the diagnosis, therapy and quarantine measures.

As varied as the published scabies outbreaks are the documented treatment strategies, which are determined by the availability of adequate therapeutic agents, economic aspects and exceptionally by local resistance to antiscabietic agents in endemic areas [15, 16]. In the herein reported outbreak, topical treatment with the pyrethroid permethrin

was performed according to the German therapy guideline [6]. Permethrin is considered to be particularly effective in comparison to other antiscabietic agents (Table 4) [17]. In Germany, a commercial product containing 5 % permethrin (InfectoScab®) has been approved for the treatment of scabies in 2004. Compounded prescription of a 5 % permethrin cream is more cost effective if large amounts are required. A single treatment over 8–12 hours is sufficient in many cases [18]. In agreement with other authors [2, 3] and the German therapy guidelines [6] we recommend repetitive treatment of all definitely and possibly affected individuals, in order to minimize treatment failure in the context of scabies outbreaks. Initial treatment on two consecutive days is particularly suited to compensate for inaccurate treatment on either single day by effectively reducing mite numbers and preventing further transmission of scabies.

Systemic therapy with ivermectin (Table 5) is of particular significance in the situation of an outbreak. The lack of approval in Germany (available through international pharmacies within 3–4 working days) necessitates careful consideration of the indication as well as written information and consent of the patients or guardians and is thus a seri-

ous argument against the occasionally propagated systemic therapy of all exposed individuals [10, 12, 19, 20]. Ivermectin is indicated when adequate topical therapy has failed, is not possible due to comorbidities or lack of compliance to therapy or – in crusted scabies – presumably would be insufficient [6]. The substance is considered to have few side effects; a documentation of therapy-associated increased mortality in patients with dementia [21] could not be confirmed by other groups [22, 23].

Publications on scabies control in community facilities uniformly document the need to simultaneously treat all potentially exposed individuals [3, 6, 9, 14, 24, 25]. This approach requires foresighted, organized cooperation of the involved groups of persons. The control of scabies outbreaks is time consuming and cost-intensive and requires above-average personal motivation, communication skills and perseverance. The concept presented here shall provide support in this complex and demanding situation. <<<

Conflicts of interest

H.H. receives honoraria from InfectoPharm® Arzneimittel und Consilium GmbH, Heppenheim, Germany, for holding continuing education seminars

Table 3: Overview of published institutional scabies outbreaks (a complete reference list is provided at the end of this article).

First author, year of publication	Duration (months)	Institution, country	Number of cases (n)	Therapy	Crusted scabies	Causes of delayed control of outbreak
Paterson WD [1], 1973	2	Hospital, UK	19	Lindane	+	
Hubler WR [2], 1976	2	Home for the disabled, USA	28	Lindane	+	
Kanaaneh HA [3], 1976	64	Schools of a village community, Israel	638	Benzyl benzoate	N.n.	Poor hygienic conditions, noncompliance, delayed therapy of contact persons
Rycroft RJ [4], 1977	About 12	Tourist ship, UK	13	Lindane	N.n.	Asynchronous therapy
Gooch JJ [5], 1978	3	Hospital, USA	39	Lindane	N.n.	Misdiagnoses
Moberg SA [6], 1984	7	Rehabilitation clinic, Sweden	14	Tenutex (DDT, disulfiram, benzyl benzoate)	+	Misdiagnoses, topical monotherapy of index patient with corticosteroids
Lempert KD [7], 1985	N.n.	Dialysis ward of a university clinic, USA	16	Lindane	N.n.	Misdiagnosis as uremic pruritus
Reilly S [8], 1985	2	Hospital, UK	26	Lindane, benzyl benzoate	+	Misdiagnoses, topical monotherapy of index patient with corticosteroids
Burns DA [9], 1987	N.n.	Senior citizen home, UK	4	Lindane	+	Delayed diagnosis, asynchronous therapy
Meyers LN [10], 1988	N.n.	Senior citizen nursing home, USA	32	Lindane	N.n.	Misdiagnoses and topical pre-treatment with corticosteroids
Yonkosky D [11], 1990	3, 5 and 26	3 Senior citizen homes, USA	80, 57, 65	Lindane, benzyl benzoate, crotamiton, permethrin, sulfur	N.n.	
Hopper AH [12], 1990	2	Senior citizen home, UK	20	Lindane	+	
Sirera G [13], 1990	5	Hospital (AIDS ward), Spain	37	Lindane	+	
Hsueh PR [14], 1992	2	Hospital (intensive care unit), Taiwan	30	Benzyl benzoate, crotamiton	+	Misdiagnoses and topical pre-treatment with corticosteroids
Clark J [15], 1992	2	Hospital, USA	68	Lindane, permethrin	+	Delayed diagnosis
Holness DL [16], 1992	3 and 6	2 senior citizen homes, Canada	34, 19	Lindane, crotamiton	N.n.	Asynchronous therapy
Bannatyne RM [17], 1992	4	Hospital, Canada	77	Lindane, permethrin	+	
Jimenez-Lucho VE [18], 1995	12	Hospital, USA	119	Lindane, crotamiton	+	Delayed diagnosis
Marshall R [19], 1995	2	School, UK	68	Permethrin	+	
Danchaivijit S [20], 1995	1	Hospital, Thailand	32	Lindane	+	Misdiagnoses and topical pre-treatment with corticosteroids
Corbett EL [21], 1996	16	Hospital (AIDS ward), UK	N.n.	Malathion, ivermectin	+	Insufficient isolation measures, inadequate effectiveness of topical therapy
Anclle T [22], 1997	14	Senior citizen home, France	49	Allethrin, benzyl benzoate, ivermectin	+	Asynchronous therapy

Tabelle 3: Continued.

First author, year of publication	Duration (months)	Institution, country	Number of cases (n)	Therapy	Crusted scabies	Causes of delayed control of outbreak
Reinijes R [23], 1997	12	Senior citizen home, Netherlands	33	Ivermectin	+	Misdiagnoses and topical pre-treatment with corticosteroids
Weber D [24], 1997	About 9	Hospital and senior citizen home, Germany	About 30	N.n.	N.n.	Delayed diagnosis
Boix V [25], 1997	8	Hospital, Spain	17	Lindane, permethrin	+	Delayed diagnosis
Bock-Hensley O [26], 1998	18	Senior citizen home, Germany	About 60	Lindane, ivermectin	N.n.	Information deficit of those affected, delayed therapy of contact persons, suspected lindane resistance
Reisch K [27], 1999	3	Workshop and home for the disabled, Germany	8	Lindane, benzyl benzoate	+	
Papini M [28], 1999	3 and 4	2 Senior citizen homes, Italy	19, 36	Permethrin	+	
Dannaoui E [29], 1999	11	Senior citizen home, France	42	Lindane, ivermectin	+	Delayed diagnosis
Mayer J [30], 2000	11	Workshop and home for the disabled, Germany	19	Lindane, benzyl benzoate, alle-thrin, ivermectin	+	Asynchronous therapy
Andersen BM [31], 2000	1, 4 and 13	3 Senior citizen homes, Norway	3, 3, 19	Permethrin, benzyl benzoate	+	Misdiagnoses and topical pre-treatment with corticosteroids
Leppard B [32], 2000	7	Prison, Tanzania	883	Ivermectin, lindane	+	Inadequate effectiveness of a single dose of ivermectin in crusted scabies
Chan LY [33], 2000	3	Senior citizen home, Hong Kong	9	Benzyl benzoate, crotamiton	+	Misdiagnoses and topical pre-treatment with corticosteroids
Obasanjo OO [34], 2001	7	Hospital (AIDS ward), USA	195	Permethrin, lindane, ivermectin	+	Delayed diagnosis
Paasch U [35], 2001	12	3 Senior citizen homes, Germany	7, 33, 52	Allethrin, permethrin, ivermectin	+	Asynchronous therapy
Deabate MC [36], 2001	10	Dialysis center, Italy	16	Benzyl benzoate	N.n.	Misdiagnosis as uremic pruritus
Wilson MM [37], 2001	5	Senior citizen home, USA	15	Permethrin, ivermectin	+	Misdiagnoses and topical pre-treatment with corticosteroids
Zafar AB [38], 2002	2	Hospital, USA	8	Permethrin	+	
Pruksachatkunakorn C [39], 2002	2	Orphanages, Thailand	131	Lindane, sulfur, benzyl benzoate	N.n.	

Tabelle 3: Continued.

First author, year of publication	Duration (months)	Institution, country	Number of cases (n)	Therapy	Crusted scabies	Causes of delayed control of outbreak
Millership S [40], 2002	4	Geriatric hospital, UK	11	Permethrin, ivermectin	N.n.	Asynchronous therapy
Larrosa A [41], 2003	3	Hospital, Spain	18	Permethrin	N.n.	Delayed diagnosis, insufficient protective measures for nursing personnel
Fajardo-Velázquez R [42], 2004	2	Hospital, Mexico	49	Benzyl benzoate	+	Delayed diagnosis
Abt C [43], 2005	2½	Home for asylum seekers, Germany	23	Ivermectin	N.n.	Poor hygienic conditions, noncompliance of those affected
Ribeiro Fde A [44], 2005	1	Prison, Brazil	96	Ivermectin	–	
Tsutsumi M [45], 2005	10	Geriatric hospital, Japan	20	Crotamiton, lindane	N.n.	Lack of understanding of disease in patients with dementia
Makigami K [46], 2005	4	Psychiatric hospital, Japan	26	Lindane, ivermectin	+	Asynchronous therapy
De Beer G [47], 2006	14	Senior citizen nursing home, Canada	23	Permethrin, lindane, ivermectin	+	Misdiagnoses and topical pre-treatment with corticosteroids
Achtari Jeanneret L [48], 2007	9	Hospital with dialysis unit, Switzerland	24	Lindane, permethrin, ivermectin	+	Misdiagnoses and topical monotherapy with corticosteroids
Ejidokun OO [49], 2007	2	School for persons with learning difficulties, UK	4	Permethrin, malathion	N.n.	
Garcia C [50], 2007	2	Hospital (intensive care unit), Peru	32	Ivermectin	N.n.	
Van den Hoek JA [51], 2008	10	Senior citizen home, Netherlands	20	Lindane, ivermectin, permethrin	N.n.	Suspected lindane and ivermectin resistance
Buchlmann M [52], 2009	7	Hospital (intensive care unit), Switzerland	19	Lindane, permethrin, ivermectin	+	Asynchronous therapy, noncompliance, inadequate effectiveness of lindane
Kienbaum T [53], 2009	2	Senior citizen home, Germany	35	Permethrin, lindane	N.n.	Wearing of private clothes while on duty, delayed diagnosis, rotation of nursing personnel in other divisions
Makigami K [54], 2011	> 42	Hospital (geriatrics), Japan	148	Lindane, ivermectin	N.n.	Noncompliance of dementia patients
Ross BG [55], 2011	9	Hospital (neonatology), USA	13	Permethrin	–	Continued work of an infected nurse

N.n. = Not noted.

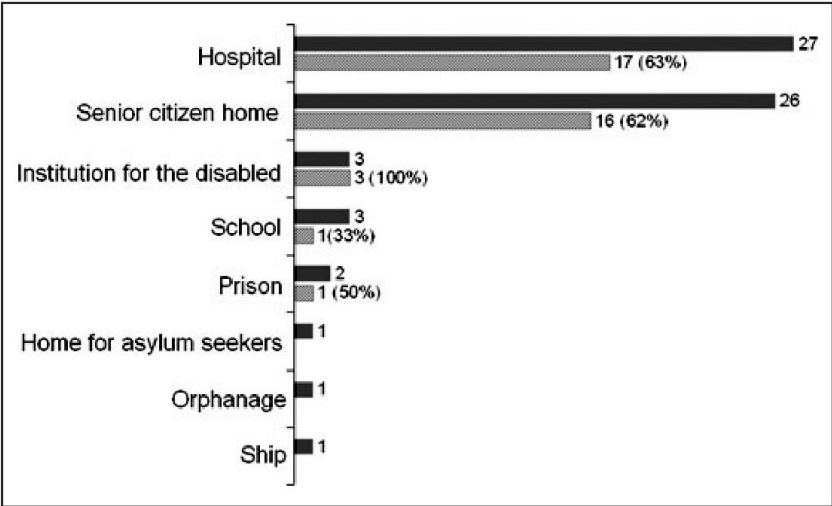


Figure 3: Overview of published institutional scabies outbreaks. *Dark blue bars:* overall number of publications. *Light bars:* Percentage of publications documenting relevant transmission by index patients with crusted scabies.

Table 4: Characteristics of permethrin.

Active ingredient
- Pyrethroid disrupting function of voltage-gated sodium channels of arthropods - Scabicide and ovicide effects
Preparations
- InfectoScab® cream 5 % Permethrin cream from concentrate (individual prescription): Permethrin 25 % concentrate (Infectopharm®) 20 Unguentum emulsificans aquosum ad 100
Approval status
Adults and children 2 months and older
Indication
Drug of first choice for therapy of scabies
Use
30–60 g per individual treatment - Older children and healthy adults: apply completely from the jaw downwards - Children < 3 years, adults > 60 years, immunosuppressed and patients with crusted scabies: also treat face and scalp (omit orifices) - Application time 8–12 hours, then shower off, apply moisturizer, put on fresh clothing - Single treatment possibly sufficient, in an outbreak repetitive treatment (day 0, 1, 14)
Contraindications and limitations
- Severely eczematous or erosive skin - Infants < 2 months (lack of approval) - Pregnancy and breastfeeding (strict indication) - Noncompliance
Side effects
Occasionally pruritus, skin irritation, rarely contact dermatitis

Table 5: Characteristics of ivermectin.

Active ingredient
- Broad spectrum antiparasitic agent acting on ligand-gated chloride channels in parasites - Scabicide action, but not ovicide
Preparations
Stromectol® 3 mg tablets, Mectizan® 3 mg tablets
Approval status
- No approval in Germany (available through international pharmacy) - Strict indication and comprehensive information with written consent
Indication
- Failure or impossibility of effective topical therapy - Crusted scabies - Scabies in immunosuppressed patients
Use
- Administration on empty stomach - Dosage: 0.2 mg/kg as single dose - Repeat administration after 10–14 days (more treatments may be required in immunosuppression and/or crusted scabies) - Combine with topical therapy if possible
Contraindications
- Pregnancy - Children < 5 years or with a weight < 15 kg
Side effects
<i>Skin:</i> often transient increase of pruritus, rarely exanthema <i>Gastrointestinal tract:</i> occasionally nausea, vomiting, stool irregularity <i>CNS:</i> occasionally vertigo, headache, fatigue <i>Musculoskeletal system:</i> occasionally joint and muscle pains <i>Laboratory alterations:</i> rarely leukopenia, elevated transaminases - Fever, anaphylaxis (more commonly during therapy of filariasis due to pathogen disintegration)

and for scientific responses to questions by dermatologists and pediatricians.

Correspondence to

Dr. Johanna Stoevesandt
Department of Dermatology,
Venereology and Allergology
University of Würzburg
Josef-Schneider-Straße 2
D-97080 Würzburg, Germany
Tel.: +49-931-201-26726
Fax: +49-931-201-26026
E-mail:
Stoevesandt_J@klinik.uni-wuerzburg.de

References

- Lassa S, Campbell MJ, Bennett CE. Epidemiology of scabies prevalence in the U.K. from general practice records. *Br J Dermatol* 2011; 164: 1329–34.
- Currie BJ, McCarthy JS. Permethrin and ivermectin for scabies. *N Engl J Med* 2010; 362: 717–25.
- Bouvresse S, Chosidow O. Scabies in healthcare settings. *Curr Opin Infect Dis* 2010; 23: 111–8.
- Dupuy A, Dehen L, Bourrat E, Lacroix C, Benderdouche M, Dubertret L, Morel P, Feuilhade de Chauvin M, Petit A. Accuracy of standard dermoscopy for diagnosing scabies. *J Am Acad Dermatol* 2007; 56: 53–62.
- Mayer J, Wever S, Lurz C, Bröcker EB. Skabiesepidemie in einer Behindertenwerkstatt - was tun? *Hautarzt* 2000; 51: 75–8.
- Sunderkötter C, Mayser P, Fölster-Holst R, Maier WA, Kampen H, Hamm H. Scabies. *J Dtsch Dermatol Ges* 2007; 5: 424–30.
- Scott GR, Chosidow O. European guideline for the management of scabies, 2010. *Int J STD AIDS* 2011; 22: 301–3.
- Workowski KA, Berman S. Sexually transmitted diseases treatment guidelines, 2010. *MMWR Recomm Rep* 2010; 59: 1–110.
- Feldmeier H, Hengge U, Jahnke C. Krätzmilbenbefall (Scabies). *Epidemiologisches Bulletin* 2009; 19/09: 177–82.
- Lawrence G, Leafasia J, Sheridan J, Hills S, Wate J, Wate C, Montgomery J, Pandeya N, Purdie D. Control of scabies, skin sores and haematuria in children in the Solomon Islands: another role for ivermectin. *Bull World Health Organ* 2005; 83: 34–42.
- Pruksachatkunakorn C, Damrongsak M, Sinthupuan S. Sulfur for scabies outbreaks in orphanages. *Pediatr Dermatol* 2002; 19: 448–53.
- Abt C, Ahr W. Skabies: Zu einem Ausbruch in einem Asylbewerberheim. *Epidemiologisches Bulletin* 2005; 4/05: 26–7.
- Rycroft RJ, Calnan CD. Occupational scabies. *Br Med J* 1977; 2: 303–4.
- Vorou R, Remoudaki HD, Maltezou HC. Nosocomial scabies. *J Hosp Infect* 2007; 65: 9–14.
- Currie BJ, Harumal P, McKinnon M, Walton SF. First documentation of in vivo and in vitro ivermectin resistance in *Sarcoptes scabiei*. *Clin Infect Dis* 2004; 39: e8–12.
- Mounsey KE, Holt DC, McCarthy J, Currie BJ, Walton SF. Scabies: molecular perspectives and therapeutic implications in the face of emerging drug resistance. *Future Microbiol* 2008; 3: 57–66.
- Strong M, Johnstone P. Interventions for treating scabies. *Cochrane Database Syst Rev* 2007; CD000320.
- Hamm H, Beiteke U, Höger PH, Seitz CS, Thaci D, Sunderkötter C. Therapie der Skabies mit 5%iger Permethrin-Creme: Ergebnisse einer deutschen multizentrischen Studie. *J Dtsch Dermatol Ges* 2006; 4: 407–13.
- Ribeiro Fde A, Taciro E, Guerra MR, Eckley CA. Oral ivermectin for the treatment and prophylaxis of scabies in prison. *J Dermatolog Treat* 2005; 16: 138–41.
- Garcia C, Iglesias D, Terashima A, Canales M, Gotuzzo E. Use of ivermectin to treat an institutional outbreak of scabies in a low-resource setting. *Infect Control Hosp Epidemiol* 2007; 28: 1337–8.
- Barkwell R, Shields S. Deaths associated with ivermectin treatment of scabies. *Lancet* 1997; 349: 1144–5.
- Reintjes R, Hoek C. Deaths associated with ivermectin for scabies. *Lancet* 1997; 350: 215; author reply 16.
- Coyne PE, Addiss DG. Deaths associated with ivermectin for scabies. *Lancet* 1997; 350: 215–6; author reply 16.
- Buehlmann M, Beltraminelli H, Strub C, Bircher A, Jordan X, Battegay M, Itin P, Widmer AF. Scabies outbreak in an intensive care unit with 1,659 exposed individuals – key factors for controlling the outbreak. *Infect Control Hosp Epidemiol* 2009; 30: 354–60.
- Paasch U, Hausteil UF. Behandlung der endemischen Skabies mit Allethrin, Permethrin und Ivermectin. Evaluation eines Behandlungskonzeptes. *Hautarzt* 2001; 52: 31–7.

References to Table 3

- Paterson WD, Allen BR, Beveridge GW. Norwegian scabies during immunosuppressive therapy. *Br Med J* 1973; 4: 211–2.
- Hubler WR, Jr. Epidemic Norwegian scabies. *Arch Dermatol* 1976; 112: 179–81.
- Kanaaneh HA, Rabi SA, Badarneh SM. The eradication of a large scabies outbreak using community-wide health education. *Am J Public Health* 1976; 66: 564–7.
- Rycroft RJ, Calnan CD. Occupational scabies. *Br Med J* 1977; 2: 303–4.
- Gooch JJ, Strasius SR, Beamer B, Reiter MD, Gene PD, Correll GW. Nosocomial outbreak of scabies. *Arch Dermatol* 1978; 114: 897–8.
- Moberg SA, Lowhagen GB, Hersle KS. An epidemic of scabies with unusual features and treatment resistance in a nursing home. *J Am Acad Dermatol* 1984; 11: 242–4.
- Lempert KD, Baltz PS, Welton WA, Whittier FC. Pseudoremic pruritus: a scabies epidemic in a dialysis unit. *Am J Kidney Dis* 1985; 5: 117–9.
- Reilly S, Cullen D, Davies MG. An outbreak of scabies in a hospital and community. *Br Med J (Clin Res Ed)* 1985; 291: 1031–2.
- Burns DA. An outbreak of scabies in a residential home. *Br J Dermatol* 1987; 117: 359–61.
- Meyers LN. Clinical presentation of scabies in a nursing home population. *J Am Acad Dermatol* 1988; 18: 396–7.
- Yonkosky D, Ladia L, Gackenhimer L, Schultz MW. Scabies in nursing homes: an eradication program with permethrin 5 % cream. *J Am Acad Dermatol* 1990; 23: 1133–6.
- Hopper AH, Salisbury J, Jegadeva AN, Scott B, Bennett GC. Epidemic Norwegian scabies in a geriatric unit. *Age Ageing* 1990; 19: 125–7.
- Sirera G, Rius F, Romeu J, Llibre J, Ribera M, Soriano V, Tor J, Ferrandiz C, Clotet B. Hospital outbreak of scabies stemming from two AIDS patients with Norwegian scabies. *Lancet* 1990; 335: 1227.

- 14 Hsueh PR, Lin BH, Hwang CC, Hsieh BL, Liu JC, Lin M. Nosocomial outbreak of scabies. *J Formos Med Assoc* 1992; 91: 228–32.
- 15 Clark J, Friesen DL, Williams WA. Management of an outbreak of Norwegian scabies. *Am J Infect Control* 1992; 20: 217–20.
- 16 Holness DL, DeKoven JG, Nethercott JR. Scabies in chronic health care institutions. *Arch Dermatol* 1992; 128: 1257–60.
- 17 Bannatyne RM, Patterson TA, Wells BA, MacMillan SA, Cunningham GA, Tellier R. Hospital outbreak traced to a case of Norwegian scabies. *Can J Infect Control* 1992; 7: 111–3.
- 18 Jimenez-Lucho VE, Fallon F, Caputo C, Ramsey K. Role of prolonged surveillance in the eradication of nosocomial scabies in an extended care Veterans Affairs medical center. *Am J Infect Control* 1995; 23: 44–9.
- 19 Marshall R, Barkess-Jones L, Sivayoham S. An outbreak of scabies in a school for children with learning disabilities. *Commun Dis Rep CDR Rev* 1995; 5: R90–2.
- 20 Danchavijitr S, Suthipinittharm P, Srihapol N. An outbreak of Norwegian scabies in a surgical ward. *J Med Assoc Thai* 1995; 78 Suppl 2: S99–101.
- 21 Corbett EL, Crossley I, Holton J, Levell N, Miller R, De Cock KM. Crusted ("Norwegian") scabies in a specialist HIV unit: successful use of ivermectin and failure to prevent nosocomial transmission. *Genitourin Med* 1996; 72: 115–7.
- 22 Ancelle T, Morice J, Tourte-Schaefer C. Investigation d'une épidémie de gale dans une centre de long et moyen séjour pour personnes âgées de la région parisienne, 1995–1996. *Bull Epidemiol Hebd* 1997; 6: 23–4.
- 23 Reintjes R. Untersuchung und Bekämpfung eines Skabiesausbruchs in den Niederlanden. *Epidemiologisches Bulletin* 1997; 21/97: 144–5.
- 24 Weber D. Untersuchung und Bekämpfung eines Skabiesausbruchs in Nordrhein-Westfalen. *Epidemiologisches Bulletin* 1997; 21/97: 143–4.
- 25 Boix V, Sanchez-Paya J, Portilla J, Merino E. Nosocomial outbreak of scabies clinically resistant to lindane. *Infect Control Hosp Epidemiol* 1997; 18: 677.
- 26 Bock-Hensley O, Klett. Zur Bekämpfung eines Scabies-Ausbruchs in einem Altenheim. *Epidemiologisches Bulletin* 1998; 35/98: 249–51.
- 27 Reisch K, Gonser T. Scabies-Ausbruch in einer Einrichtung für Behinderte. *Epidemiologisches Bulletin* 1999; 26/99: 196–7.
- 28 Papini M, Maccheroni R, Bruni PL. O tempora o mores: the cost of managing institutional outbreaks of scabies. *Int J Dermatol* 1999; 38: 638–9.
- 29 Dannaoui E, Kiazand A, Piens M, Picot S. Use of ivermectin for the management of scabies in a nursing home. *Eur J Dermatol* 1999; 9: 443–5.
- 30 Mayer J, Wever S, Lurz C, Bröcker EB. Skabiesepidemie in einer Behindertenwerkstatt – was tun? *Hautarzt* 2000; 51: 75–8.
- 31 Andersen BM, Haugen H, Rasch M, Heldal Haugen A, Tageson A. Outbreak of scabies in Norwegian nursing homes and home care patients: control and prevention. *J Hosp Infect* 2000; 45: 160–4.
- 32 Leppard B, Naburi AE. The use of ivermectin in controlling an outbreak of scabies in a prison. *Br J Dermatol* 2000; 143: 520–3.
- 33 Chan LY, Tang WY, Ho HH, Lo KK. Crusted (Norwegian) scabies in two old-age home residents. *Hong Kong Med J* 2000; 6: 428–30.
- 34 Obasanjo OO, Wu P, Conlon M, Karanfil IV, Pryor P, Moler G, Anhalt G, Chaisson RE, Perl TM. An outbreak of scabies in a teaching hospital: lessons learned. *Infect Control Hosp Epidemiol* 2001; 22: 13–8.
- 35 Paasch U, Haustein UF. Behandlung der endemischen Skabies mit Allethrin, Permethrin und Ivermectin. Evaluation eines Behandlungskonzeptes. *Hautarzt* 2001; 52: 31–7.
- 36 Deabate MC, Calitri V, Licata C, Fidelity T, Rocchetti M, Pieri F, Gagliano P, Rabbia C, Dogliani M. La scabbia in un centro dialisi. *Mistero e pregiudizio. Minerva Urol Nefrol* 2001; 53: 69–73.
- 37 Wilson MM, Philpott CD, Breer WA. Atypical presentation of scabies among nursing home residents. *J Gerontol A Biol Sci Med Sci* 2001; 56: M424–7.
- 38 Zafar AB, Beidas SO, Sylvester LK. Control of transmission of Norwegian scabies. *Infect Control Hosp Epidemiol* 2002; 23: 278–9.
- 39 Pruksachatkunakorn C, Damrongsak M, Sinthupuan S. Sulfur for scabies outbreaks in orphanages. *Pediatr Dermatol* 2002; 19: 448–53.
- 40 Millership S, Readman R, Bracebridge S. Use of ivermectin, given orally, to control scabies in homes for the elderly mentally ill. *Commun Dis Public Health* 2002; 5: 144–6.
- 41 Larrosa A, Cortes-Blanco M, Martinez S, Clerencia C, Urdaniz LJ, Urban J, Garcia J. Nosocomial outbreak of scabies in a hospital in Spain. *Euro Surveill* 2003; 8: 199–203.
- 42 Fajardo-Velazquez R, Urdez-Hernandez E, Ysita-Morales A. Brote intrahospitalario de escabiosis, a partir de un caso de sarna noruega. *Salud Publica Mex* 2004; 46: 251–4.
- 43 Abt C, Ahr W. Skabies: Zu einem Ausbruch in einem Asylbewerberheim. *Epidemiologisches Bulletin* 2005; 4/05: 26–7.
- 44 Ribeiro Fde A, Taciro E, Guerra MR, Eckley CA. Oral ivermectin for the treatment and prophylaxis of scabies in prison. *J Dermatolog Treat* 2005; 16: 138–41.
- 45 Tsutsumi M, Nishiura H, Kobayashi T. Dementia-specific risks of scabies: retrospective epidemiologic analysis of an unveiled nosocomial outbreak in Japan from 1989–90. *BMC Infect Dis* 2005; 5: 85.
- 46 Makigami K, Ohtaki N, Sato Y, Yamaguchi N. [Nosocomial outbreak of scabies in a psychiatric hospital—epidemiological assessment and prophylactic treatment with oral ivermectin]. *Nippon Eiseigaku Zasshi* 2005; 60: 450–60.
- 47 de Beer G, Miller MA, Tremblay L, Monette J. An outbreak of scabies in a long-term care facility: the role of misdiagnosis and the costs associated with control. *Infect Control Hosp Epidemiol* 2006; 27: 517–8.
- 48 Achteri Jeanneret L, Erard P, Gueissaz F, Malinverni R. An outbreak of scabies: a forgotten parasitic disease still present in Switzerland. *Swiss Med Wkly* 2007; 137: 695–9.
- 49 Ejidokun OO, Aruna OS, O'Neill B. A scabies outbreak in a further education college in Gloucestershire. *Epidemiol Infect* 2007; 135: 455–7.
- 50 Garcia C, Iglesias D, Terashima A, Canales M, Gotuzzo E. Use of ivermectin to treat an institutional outbreak of scabies in a low-resource setting. *Infect Control Hosp Epidemiol* 2007; 28: 1337–8.

- 51 van den Hoek JA, van de Weerd JA, Baayen TD, Molenaar PM, Sonder GJ, van Ouwerkerk IM, de Vries HJ. A persistent problem with scabies in and outside a nursing home in Amsterdam: indications for resistance to lindane and ivermectin. *Euro Surveill* 2008; 13.
- 52 Buehlmann M, Beltraminelli H, Strub C, Bircher A, Jordan X, Battegay M, Itin P, Widmer AF. Scabies outbreak in an intensive care unit with 1,659 exposed individuals – key factors for controlling the outbreak. *Infect Control Hosp Epidemiol* 2009; 30: 354–60.
- 53 Kienbaum T. Skabiesausbruch in einem Seniorenheim in der Vorderpfalz. *Epidemiologisches Bulletin* 2009; 19/09: 183–4.
- 54 Makigami K, Ohtaki N, Ishii N, Tamashiro T, Yoshida S, Yasumura S. Risk factors for recurrence of scabies: A retrospective study of scabies patients in a long-term care hospital. *J Dermatol* 2011; 38(9): 874–9.
- 55 Ross BG, Wright-McCarthy JK, DeLaMora PA, Graham PL, 3rd. Transmission of scabies in a newborn nursery. *Infect Control Hosp Epidemiol* 2011; 32: 516–7.