

# Practicability of Enteritis – prevention in Trekking and Mountaineering at High Altitude by Systematic Hand Disinfection

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*A – the preparation of the research project*

*B – the assembly of data for the research undertaken*

*C – the conducting of statistic analysis*

*D – interpretation of results*

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## Abstract

**Introduction:** The hygienic conditions during trekking or mountaineering at high altitudes are reduced, especially regarding defecation and hand hygiene. An additional problem exists in regions above the snowline, especially in highly frequented regions: snow may be contaminated by faecal microbes, causing diarrhea. Prevention against faecal-oral infections must include not only disinfection of drinking water, but hand disinfection, too, e.g. by a water-free hand gel. The practicability of this measure was tested during a Himalaya expedition on the way to Mt. Everest.

**Material and methods:** 10 participants were instructed to use Stokosept-Gel, an alcohol based skin disinfectant, at least prior to meals, after using a toilet and after handling boot-laces and to note each use (including additional occasions).

**Results:** A very good practicability of using the hand gel, which was absorbed quickly (ca. ¼ min) was reported. 100 ml were sufficient for at least 2 weeks and there were no side effects or problems at the skin. During the mountaineering phase which included a total of 250 person days in the field no diarrhea occurred.

**Conclusion:** We conclude that using such hand gels is – additional to other procedures – a very practical prevention against diarrhea in mountaineering at high altitude.

**Keywords:** mountaineering, diarrhea, enteritis prevention, hand disinfection, hand gel, trekking

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## Introduction

The hygienic conditions during mountaineering at high altitude are reduced, especially regarding defaecation and hand hygiene. An additional problem exists in touristic regions above the snowline, because the snow may be more or less contaminated by faecal microbes. The snow at tracks often frequented by mountaineers contains faecal microbes, depending on the frequency of using these tracks by subjects: Collected snow from the Muztagh Ata region (Himalaya) contained coliform bacteria, *Escherichia coli* and *Enterococcus faecalis* as indicator for faecal contamination

[1]. A decreasing contamination with increasing altitude (between 4400 and 6800 m) could be shown. Even, if the places where snow was taken to melt water are separated systematically from places of defaecation, wind may mix the snow and by this previously non-contaminated areas may be contaminated.

In South East Asia the situation may be even more complicated than in other regions. For most countries ciprofloxacin was sufficient in case of severe travellers' diarrhea for years – if antibiotics should be indicated at all. The situation has changed now and after acithromycin was recommended as first choice substance (or even metronidazol) for South East Asia [2] it is now generally recommended also for other regions. Even harder: By misuse of antibiotics multi-resistant bacteria are typical in South East Asia and in the field it is very difficult to avoid such germs. Strictly practiced hand hygiene and exclusive consumption of packaged beverages cannot protect against colonization of the gastrointestinal tract by such germs. This does not necessarily

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cause disease, but treatment of travelers or people who returned home to countries without such problems is more complicated [3]. The principle of prevention should be to minimize the exposure to such germs as much as possible. This is not only a task for approach or in base camp. Even above 5000 m a distinct alteration in the composition of the faecal microflora was observed, including an increased health risk for mountaineers [4].

This leads to two consequences to reduce health risks: i) Hand disinfection. Disinfection with alcohol towels under mountaineering conditions was not practicable [5], and therefore Honka tested exemplarily the usefulness of a commercial hand gel suitable for use e. g. in nutrition factories in 2010 [6]. ii) Water disinfection. Melted water must be disinfected before use as potable water, e.g. by adequate heating, chemical materials or physical methods [7], but this does not protect against oral infection by contaminated hands [2]. Therefore we tested the practicability and the potential effect of hand disinfection by the same gel preparation as it was later done by Henry et al. [8], too.

Practicability is an important aspect, but effectiveness should be ascertained as well. Henry et al. confirmed not only the good use of a hand sanitizing gel, but also that this was “associated with a reduction in the incidence of travellers’ diarrhoea and/or vomiting” [8]. Therefore additional experiences with disinfection by a hand gel during an approach to Everest base camp (5364 m) are reported here, regarding the practicability of a hand gel and the consequences relating to the desired effect.

## Material and methods

In accordance to previous experiences we used Stokosept-Gel (SC Johnson Professional GmbH, Krefeld / Germany) in 100 ml plastic containers (alcohol based without water), licensed for industrial hand-disinfection [6]. 10 mountaineers participated (medical students and physicians, age 23 to 51 years). They were instructed how to use the gel correctly for hand disinfection and when: at least prior meals, after using a toilet and after handling boot-laces. Each participant got 3 documentation sheets to keep records on i) each use, ii) judgement of practicability and iii) in the case of enteritis: Pre- and post-questionnaire. The timing of the expedition was as follows: Arrival three days in Kathmandu (hotel, 1400 m), then via Lukla (2610 m) the 25 days mountaineering phase (accommodation in lodges) to Everest base camp (5364 m) and back to Lukla.

## Results

The hotel in Kathmandu was very clean and all participants used restaurants addressing tourists. Often they advertised washing vegetables and salad not with tap water. Some of the participants trusted to these advices. Some days later 5 of 10 participants had

diarrhea, 4 of them were beginners in mountaineering. After these first-days-infections enteritis did not appear during the following 25 days of trekking.

Not all documentation-sheets were filled out completely, mainly because during the scientific expedition many tasks had to be performed by the participants. However, the documentation gives the following results: The highest frequency of use of the disinfection gel was after using a toilet and before eating (Table 1). Some additional occasions, not defined before but noted by the participants, are listed in Table 2. In rare cases it was noted: “cleaning the toilet seat”, “before brushing teeth”.

**Table 1.** Reasons and frequency of use disinfection gel (N = 10 participants)

Rank		N, noted
1	After using a toilet	105
2	Before eating	92
3	After putting on shoes/ handling boot-laces	27

**Table 2.** Some additional occasions, not defined before

Rank		N, noted
1	Insertion of contact lenses	12
2	After contact with dirty material	6
3	Hands dirty or dusty	5
4	After medical contact with subjects	3
5	Before sleeping	2
6	As ultrasonic gel	2

The question about economics of the 100-ml-amount was answered by 5 participants (Table 3). All of them reported that the amount of disinfectant was sufficient for several weeks. The time needed for drying up of the gel was documented by seconds by 4 participants (Table 4); 5 other participants simply noted: Prompt/quickly absorbed/drying. There was a general consensus that this quick drying of the hands was very comfortable especially for daily routine work during the expedition. Nobody reported problems e.g. by freezing of the gel, although the environmental conditions were rough with temperatures down to  $-22^{\circ}\text{C}$ .

**Table 3.** Economics of 100 ml hand gel (5 participants)

Subject	100 ml-container empty
1	At day 33
4	Enough for 4 - 6 weeks
5	In the 4th week
6	At day 40
7	At day 15

**Table 4.** Time (seconds), needed dry the skin after use of the gel

Subject	s
1	11
2	19
3	14
5	11
<b>Mean</b>	<b>13.8</b>

The participants reported some other advantages of the hand gel (Table 5). Suggestions for further improvement included more stability of the container, a more stable cap which did not close the container sufficiently after frequent use, and a more reliable homogeneity of the gel after several changes of temperature which cannot be avoided in mountaineering.

**Table 5.** Some subjective assessments about characteristics of the hand gel

Subjective assessments	N
Not drying the skin	3
Not dripping / not very liquid	2
Not freezing up (up to $-7^{\circ}$ C)	2
Good handling / dosage	2
Good consistency	1
Neutral smelling	1
No cold feeling	1
No wet feeling	1
No stains	1
Sometimes sticky feeling	1

Concerning the skin compatibility no problems were documented with one exception: Participant 4 had symptoms suggesting an allergy, but a later retest during 2-3 weeks revealed no similar symptoms. Obviously this was more related to a cold-induced injury than to an allergy. During the mountaineering phase which included a total of 250 person days in the field there was no single case of diarrhea. The local leader of the study (J.R.) noted: “We were inspired and the use resembled a ceremony prior eating.”

## Discussion

We have no doubt about the practicability of the disinfecting hand gel under our realistic conditions for mountaineers up to 5360 m. Using it before meals was performed like a ceremony by the group and use after using a toilet was described as unproblematic, too. The low weight of the 100-ml-plastic-container can be seen as an advantage and the amount of 100 ml is sufficient at least for about two weeks. This is in accordance to previous experiences: the gel was proven to be more effective than any liquids

because of the minimized loss of material during use. The short time of “drying up” (ca.  $\frac{1}{4}$  min) and the good skin-compatibility underlines the practicability of this hand gel. Detailed clinical examination of the one case with skin symptoms showed that it was unlikely to assume the gel as causing agent, because the clinical situation was more compliant with a cold-induced urticaria and no symptoms occurred when the gel was used later by the person, which excludes contact dermatitis and allergy.

It seems curious that at the beginning of the excursion 5 of the 10 participants suffered from diarrhea, probably due to careless nutrition or drinking behaviour in the tourist restaurants during the first days after arrival. This underlines the necessity of preventing procedures from the first day of arrival. The basic rules to prevent diarrhea while travelling should include hand disinfection, because the faecal-oral infection by own hands – one typical way – should be avoided. Obviously this procedure often cannot prevent the colonization of the gastrointestinal tract with pathogens as described by Kleessen et al. [4] or Lübbert et al. [3], but the aim to prevent diarrhea must be to reduce the amount of microbes.

Perhaps the infections in our group during the first days caused a warning effect, and no subsequent diarrhea by gastrointestinal infections occurred by careful measures against faecal-oral infections. Similar to Henriey et al. [8] we interpret this as an indicator of effectiveness, and this can be expected by a licensed hand gel for industrial disinfection. An unsolved problem remains: What about the interior of the gloves, which could be a breeding ground for faecal bacteria, especially for dry-out-resistant streptococcus faecalis. To our best knowledge this was never investigated before. It could make sense to perform any kind of disinfection here, too, but this should be examined in a future study. However, the disinfection of the gloves’ interior is a tricky task. One procedure might be to slip in with fresh disinfected, still gel covered hands. It may be possible that this brings effective amounts of gel inside the gloves. A field test has shown that the gloves are dry again after a limited time. Therefore this may be done routinely in the mountains in the evening just before sleeping. By this dry gloves are guaranteed at the next morning.

There are some limitations of the study. Due to field conditions in the Himalayans we did not get microbiological smears of the hands. Therefore we base our conclusions on clinical observations only – similar to Henriey et al. [8] – and there are several other risk factors for gastrointestinal infections. However, with a reported incidence rate of diarrhoea of up to 80% in Nepal no single case of gastroenteritis in 250 field days this is a strong support of the effectiveness of the method. Some incomplete documentation sheets can be explained by the multiple-task expedition for the participants. However, this does not reduce the general validity of the results.

## Conclusion

According to Henriey et al. [8] we recommend systematic hand disinfection by using an alcohol based hand gel at least prior to meals, after using a toilet and after handling boot-laces. In other risk-occasions (e.g. seat of a toilet) it may be used, too.

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## Declaration of interest

The authors report no conflicts of interest.

## References

- [1] Adamek R, Kraft B, Pietsch M, et al. *Enteritis during mountaineering above the snow line – how to practice prophylaxis?* 4. Symposium “Höhenphysiologie und Praxis,” 08.09.2009–13.09.2009, Bohinjjska Bela. <http://www.uni-mainz.de/FB/Sport/physio/pdffiles/4HoehSymp09MzAdamek.pdf>. Published 2009. Accessed November 15, 2020.
- [2] Küpper T, Schoeffl V, Milledge JS, et al. *Recommendation of the UIAA Medical Commission. Vol. 5: Traveller's Diarrhoea – Prevention and Treatment in the Mountains – Intended for Doctors, Interested Non-Medical Persons and Trekking or Expedition Operators*. Bern: UIAA; 2012. [http://theuiaa.org/medical\\_advice.html](http://theuiaa.org/medical_advice.html).
- [3] Lübbert C, Straube L, Stein C, et al. Colonization with extended-spectrum beta-lactamase-producing and carbapenemase-producing Enterobacteriaceae in international travelers returning to Germany. *Intern J Med Microbiol*. 2015;305(1):148-156. doi: 10.1016/j.ijmm.2014.12.001.
- [4] Kleessen B, Schroedl W, Stueck M, et al. Microbial and immunological responses relative to high-altitude exposure in mountaineers. *Med Sci Sports Exerc*. 2005;37(8):1313-1318. doi: 10.1249/01.mss.0000174888.22930.e0.
- [5] Adamek R. *Wie infektiös ist Schneesmelzwasser für Höhenbergsteiger und welche Bedeutung hat die Händedesinfektion als Präventivmassnahme?* [master's thesis]. Mainz: University of Mainz, Institute of Sport Science; 2009. [abstract at: [http://www.uni-mainz.de/FB/Sport/physio/pdffiles/Adamek\\_Kurz-HP12XII2010.pdf](http://www.uni-mainz.de/FB/Sport/physio/pdffiles/Adamek_Kurz-HP12XII2010.pdf)].
- [6] Honka B, Ulmer H-V. Disinfection of hands at a high mountains expedition (Cho Oyu) – an experience report (Hypoxia symposium 2011). *Med Sport*. 2011;15 (3):170-171. [abstract at: [http://www.medicinasportiva.pl/new/pliki/ms\\_2011\\_03\\_09\\_Sympozjum.pdf](http://www.medicinasportiva.pl/new/pliki/ms_2011_03_09_Sympozjum.pdf)].
- [7] Küpper T, Schöffl V, Milledge JS. Water disinfection in the mountains – state of the art recommendation paper of the Union Internationale des Associations d'Alpinisme Medical Commission. *Travel Med Infect Dis*. 2009;7:7-14. doi: 10.1016/j.tmaid.2008.11.001.
- [8] Henriey D, Delmont J, Gautret P. Does the use of alcohol-based hand gel sanitizer reduce travellers' diarrhea and gastrointestinal upset? – A preliminary survey. *Travel Med Infect Dis*. 2014;12:494-498. doi: 10.1016/j.tmaid.2014.07.002.