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Observational study of administering intranasal steroid sprays by healthcare workers

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3 Title: Observational study of administering intranasal steroid sprays by healthcare workers
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Abstract

Objectives: Patients with allergic rhinitis receive their information about administering intranasal corticosteroid sprays (INCS) from healthcare workers. Since the majority of patients do not administer these sprays correctly, we investigated whether healthcare workers know how to administer INCS.

Settings: we studied participants at their working place: pharmacy, outpatient clinic, or general practitioner centre for emergencies

Participants: pharmacist assistants, general practitioners, paediatricians, and ear nose throat doctors.

Design: observational study

Primary outcome: number of steps of administration of INCS, based on the established INCS protocol

Secondary outcome: number of the five steps that are labelled essential to obtain optimal distribution of the medication. All the participants demonstrated the administration technique with a spray device filled with water.

Results: Among the 75 participants, none performed all the steps correctly. The median of correctly performed steps in the protocol was 14 out of 29. A significantly better result was found among the pharmacist assistants. The essential steps were performed by 27 out of the 75 participants (36%).

Conclusion: The majority of healthcare workers do not know how to administer INCS correctly.

Patients could, therefore, receive incorrect and non-uniform instructions. The education of healthcare workers on how to administer INCS correctly may be an option for improvement

Article Summary

Strengths and limitations of this study

In this study we observed how healthcare workers, including general practitioners, ear nose throat doctors, paediatricians, and pharmacy assistants administered intranasal corticosteroid sprays (INCS).

This is the first study to observe healthcare workers administering INCS.

The administration technique was scored in a simple and robust way by the same investigator.

We used a protocol for correct administration on literature and patient information leaflets, however, not all steps are based on firm scientific evidence.

We do not know if administration of INCS depends on the instructions given by healthcare workers.

Introduction

Allergic rhinitis is a common chronic disease, with a prevalence ranging from 10 to 40% worldwide.¹⁻² The disease mostly affects people between 5 and 45 years old, with a peak incidence between 19 and 24 years old.³ In addition to allergen avoidance, the management of allergic rhinitis consists of either antihistamines, intranasal corticosteroids or a combination of both.⁴⁻⁵ When persistent symptoms occur, intranasal corticosteroid sprays (INCS) are the treatment of choice.⁶⁻⁷ Studies suggest that the administration technique for INCS is associated with efficacy, adverse events and compliance.^{5,8} For example, it was found that the optimal administration technique of INCS is spraying with a contralateral spray technique, pointing the nozzle away from the septum, because spraying towards the septum causes more nosebleeds than the recommended approach.⁸⁻¹⁰ Furthermore, the head should be kept in a neutral position, and it is important to breathe in calmly while spraying. This technique provides the best distribution of the medication.¹¹⁻¹³ In a recent study, we observed the method of administration among patients and found that most (94%) did not take their INCS as described in the patient information leaflets (PILs).¹⁴ Moreover, the available PILs are currently incomplete and non-uniform.¹⁵ Since patients do not only learn from PILs, but can also be instructed by healthcare workers, we wanted to know whether such they could demonstrate the administration of INCS correctly. As far as we know, this factor has never previously been studied. Therefore, we investigated the knowledge of healthcare workers regarding administering INCS.

Material and methods

Participants and setting

We performed an observational study in the northern part of the Netherlands. The healthcare workers observed included pharmacist assistants, general practitioners, paediatricians, and ENT physicians. Healthcare workers were excluded if they had been practising their profession for less than a year. Paediatricians and ENT physicians from eight hospitals were approached via email. We approached pharmacist assistants from six pharmacies. General practitioners were approached while working at the general practitioner centre for emergencies based at the Medical Centre Leeuwarden.

Study design

When eligible healthcare workers agreed to participate, a face-to-face interview was conducted. All the participants were aware of the aim of the study. To prevent inter-observer variation, all interviews and observations were performed by the same researcher (MdB).

During the interviews, the healthcare workers answered a questionnaire containing questions about their experiences prescribing INCS and about how they provide patients with information. Then, the healthcare workers were asked to demonstrate the administration technique with a spray device filled with water. The stages assessed were preparation, administration and cleaning of the INCS [Table 1]. Assessment of the administration technique was based on the established Dutch INCS protocol. In this protocol, five steps are labelled as essential.¹⁴ These steps are considered as essential because they most influence the distribution and efficacy of the medication. The essential steps include shaking the bottle, blowing or rinsing the nose, directing the nebuliser away from the nasal septum, breathing in while simultaneously squirting a spray of mist, and exhaling through the mouth.

In the statistical analysis, descriptive statistics were used to answer the question of whether healthcare workers know how to administer INCS. For the comparison of outcomes between populations, a Pearson correlation was used for continuous variables, a Spearman rho correlation for ordinal variables, and a Mann-Whitney U Test for categorical variables. The regional medical ethics committee approved the study protocol. All the participants provided written consent.

Patient and Public Involvement

Patients or the public WERE NOT involved in the design, or conduct, or reporting, or dissemination plans of our research.

Results

In the period between June 11th and December 18th, 2019, 75 healthcare workers participated in our study [Table 2], none of whom performed all the steps correctly. The median of correctly performed steps in the protocol was 14 out of 29, with a range between 9 and 24 and an interquartile range of 3.5. For preparing the spray, the median was six out of seven steps. The median for administering the spray was eight out of 10 steps, and the median for cleaning the spray was one out of 10 steps. The points for attention, which are taking the spray to the pharmacy when it does not work and checking the expiry date, were not performed by most participants [Figure 1]. When analysing the differences in total score between the healthcare workers, a significantly higher result was found among pharmacist assistants compared with the other groups [Table 3].

Twenty-seven out of 75 participants (36%) performed all the essential steps. Of the essential steps, nose-blowing was performed least frequently, being carried out 46 out of 75 times (61%). Inhaling while squirting a spray of mist into the open nostril was performed most often: 69 out of 75 times (92%). Shaking the bottle was done 61 times (81%). The nozzle was directed outwards 66 times (88%). Exhaling through the mouth was done by 57 participants (76%) [Table 4].

Sixteen participants (21%) performed all the preparation steps. The least performed steps during preparation were activating the nozzle by spraying in the air (59%) and blowing or rinsing the nose (61%). Two participants (3%) performed all the administration steps. Squirting the spray while breathing in (92%) and pointing the nozzle outwards (88%) were performed by most participants. The most frequent errors in administration were, in order, keeping the other nostril closed, spraying crosswise and keeping the head upright. These steps were performed 33 times (44%), 43 times (47%) and 49 times (65%), respectively. One participant (1%) performed all the cleaning steps, including cleaning the nozzle with a tissue and extensively cleaning the nozzle with water once a week and allowing it to air dry. Approximately half the participants (38; 51%) cleaned the spray with a tissue after every use [Table 4].

Discussion

In this study we found that most healthcare workers involved in the care for patients with allergic rhinitis did not know and could not demonstrate how to administer INCS correctly. None of the healthcare workers performed all the steps of the checklist correctly. The median of the 75 participants was 14 out of 29 well-executed steps. The five essential steps were correctly performed by 27 out of 75 participants (36%). We found that the pharmacist assistants administered the INCS significantly better than the other healthcare workers, suggesting that pharmacist assistants are most suitable for providing information about INCS.

To the best of our knowledge, the role of healthcare workers in informing patients about the correct administration of INCS has never previously been studied. One recent study found that face-to-face instruction, consisting of both verbal information and a physical demonstration, was most effective in teaching the correct technique for asthma medication.¹⁶ This finding may apply regarding the correct usage of INCS as well, meaning that it is important that healthcare workers have sufficient knowledge. Knowledge about inhaler technique for asthma and chronic obstructive pulmonary disease (COPD) has been researched using healthcare workers. These studies reveal similar results to ours; that is, inadequate knowledge regarding the use of inhalers.¹⁷⁻¹⁸ A recent study found only 12% of

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3 healthcare workers knew at least three essential steps of the correct metered-dose inhaler technique,
4 and none of the participants performed all the steps correctly.¹⁹
5 For the checklist, we used a standardised protocol recently published in Dutch healthcare. Although
6 this protocol is based on existing literature, a few instruction steps are only marginally substantiated
7 by research data, and we needed to make a few assumptions about the best spray technique [Table 5].
8 First, an essential step while preparing for administration is blowing or rinsing the nose. This step is
9 recommended in the literature, although no significantly better distribution of the active substance
10 was found.²⁰ Approximately 60% of the participants performed this step. Next, it was found that an
11 upright position of the head while spraying proved most effective.^{11,21} Bending the head backwards
12 can result in the active substance leaking into the pharynx, causing irritation and possibly more
13 systemic uptake. When bending the head forward, the active substance could easily run out again.
14 However, 45% of the ENT doctors and 10 to 20% of the paediatricians, general practitioners and
15 pharmacist assistants bent their heads forward while breathing in the spray. Their reasoning was that
16 the nasal cavity runs backwards, causing the spray to be sprayed towards the nasal cavity when the
17 head is bent forward. There is a study that confirms this theory.¹³ However, when administering the
18 nasal spray, the nozzle should be directed away from the nasal septum to prevent nose bleeding and
19 septum perforation. Furthermore, the lateral nasal wall has more cilia than the medial wall, so the
20 distribution of the active substance is better.⁸⁻¹⁰ We found that this essential step was performed
21 correctly by 88% of the participants. It is also advised to use the contralateral hand while spraying,
22 because this causes less mechanical irritation, and, thus, fewer side effects and better compliance.⁸
23 Approximately half the participants (57%) performed this step. However, not all these participants
24 recommended this step to their patients, because it is relatively complicated to perform. Another
25 essential step is to breathe in slowly during administration, because the airflow ensures a better
26 contribution of the active substance. A continuous, slow flow has the best effect. Breathing hard or
27 sniffing can lead to increased turbulence in the nose, which can cause the active substance to finish in
28 the pharynx.^{12,22} This was the best performed essential step: 92% of participants performed this
29 correctly. Only one participant stated that the nasal spray should be completely cleaned with water
30 once a week. Since these nasal sprays are used chronically and daily in many cases, good hygiene is
31 important. However, there is no uniform instruction for cleaning the nasal spray in the package
32 leaflets. This lack is a possible explanation why the healthcare workers did not mention this aspect.
33 Considering that there is little substantiated research about the correct administration technique, and
34 since the published INCS protocol is not widely known, healthcare providers apparently provide
35 instructions according to their own insights. Further research is necessary to substantiate the most
36 effective administration technique for nasal sprays. Currently, it is important to implement the present
37 available instructions to achieve clarity in the instructions for the administration of nasal sprays.
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46 Strengths and limitations

47 This study has a couple of limitations. First, we did not know what outcomes to expect, so we chose
48 to conduct this research with a relatively small research group.²³ Second, we could only include 15
49 ENT doctors despite many attempts and visits to their offices. We cannot explain their low
50 participation. Nevertheless, we do not think that the inclusion of five more ENT doctors would affect
51 the outcome significantly.
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53 The strengths of this study are as follows: since various hospitals, general practices and pharmacies
54 were included, the results are a good reflection of the population that both prescribes and informs
55 about INCS. All our interviews were conducted by the same researcher, so no inter-observer variation
56 occurred. We used a simple scoring system, making the scores less sensitive to errors.
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3 This research only studied healthcare workers' knowledge of the administration technique. Studying
4 whether the knowledge of a healthcare worker ultimately affects the correct spray technique, and,
5 thus, the efficacy of INCS in patients, is recommended.
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8 Conclusion

9 The majority of healthcare workers do not know how to administer an INCS correctly. This lack of
10 knowledge may prevent them from being able to provide adequate instructions to their patients. Clear
11 arrangements should be made regarding who provides these instructions and what these instructions
12 include. Healthcare workers should continually update their knowledge regarding the correct spray
13 technique. The established INCS protocols can be used to address this issue.
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Author contributions

Marielle de Boer was involved in developing the study protocol, interviewed the participants, analysed the data and wrote the first draft. Corine Rollema was involved in developing the study protocol, analysing the data, and in the process of writing. Eric van Roon was involved in developing the study protocol and the process of writing. Tjalling de Vries had the original idea, was involved in developing the study protocol, analysing the data, and the process of writing. All authors read the final version and agree.

Conflict of interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Data statement section

Technical appendix, statistical code, and dataset available from the authors

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Table 1. Assessed steps per stage of the INCS protocol

Preparation	
1.	Discuss purpose and action of the medication.
2.	Take off the dust cap.
3.	<i>Firmly shake the bottle.*</i>
4.	Place forefinger and middle finger on both sides of the nozzle and place thumb underneath the bottle.
5.	Point the nozzle upwards and away from yourself.
6.	Squirt a few sprays into the air until you see a cloud of mist.
7.	<i>Blow the nose or rinse the nose with saline if the nose is clogged.*</i>
Administration	
8.	Place forefinger and middle finger on both sides of the nozzle and place thumb underneath the bottle.
9.	A. Keep the head upright and place the nozzle in the nose. B. Use the right hand for spraying in the left nostril, and the left hand for spraying in the right nostril.
10.	<i>Point the end of the nozzle slightly outwards, away from the centre ridge of the nose.*</i>
11.	Close the other nostril with your opposite hand.
12.	<i>Squirt a spray of mist in the nose while breathing in.*</i>
13.	<i>Breathe out through the mouth.*</i>
14.	Repeat steps 8 through 13 for the other nostril.
15.	If two sprays per nostril are prescribed, repeat steps 11 through 16 for both nostrils.
16.	Replace the dust cap.
Cleaning	
17.	Wipe the nozzle with a tissue or handkerchief after every use.
18.	Extensively wash the nozzle once a week:
19.	Take off the dust cap and nozzle.
20.	Rinse the dust cap and nozzle with warm water.
21.	Shake off water.
22.	Air dry the dust cap and nozzle.
23.	Replace the nozzle.
24.	Firmly shake the bottle.
25.	Squirt a few sprays into the air until you see a cloud of mist.
26.	Replace the dust cap.
Points for attention	
27.	If the nozzle does not spray properly, perform the cleaning steps. If this does not work, take the spray to the pharmacy. Never puncture the opening.
28.	Check the expiry date on the package and the expiry date after opening.

* *Essential steps*

Table 2. Participant characteristics

Variable	Overall (n = 75)
Healthcare worker	
Pharmacist assistant	20 (26)
General practitioner	20 (26)
Paediatrician	20 (26)
ENT physician	15 (20)
Gender	
Male	27 (36)
Female	48 (64)
Age (mean), range (95% CI)	
	45.2 ±11
Years of professional practice	
1 – 5 years	18 (24)
5 – 10 years	12 (16)
10 – 20 years	22 (29)
> 20 years	23 (31)
Number of INCS prescriptions per week	
0 times	20 (27)
< 1 time	19 (25)
1 – 4 times	17 (23)
4 – 8 times	5 (7)
> 8 times	14 (19)
Number of INCS instructions per week	
< 1 time	24 (32)
1 – 4 times	27 (36)
4 – 8 times	9 (12)
> 8 times	15 (20)
Number of checks on INCS inhalations per week	
< 1 time	62 (83)
1 – 4 times	15 (14)
4 – 8 times	2 (3)
> 8 times	0 (0)
Use of information material	
Yes	19 (25)
No	56 (75)

All values are n (%).

Table 3. Difference in total score checklist

Healthcare worker	N	Mean rank	P-value between groups*
Pharmacist assistant	20	54.58 ^a	0.001
General practitioner	20	30.98	
Paediatrician	20	34.85	
ENT physician	11	29.47	

Tested using Kruskal-Wallis test (post hoc Mann-Whitney U) *P < 0.05. ^aSignificant difference compared with general practitioners, paediatricians and ENT physicians.

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Table 4. Number of well-executed steps protocol

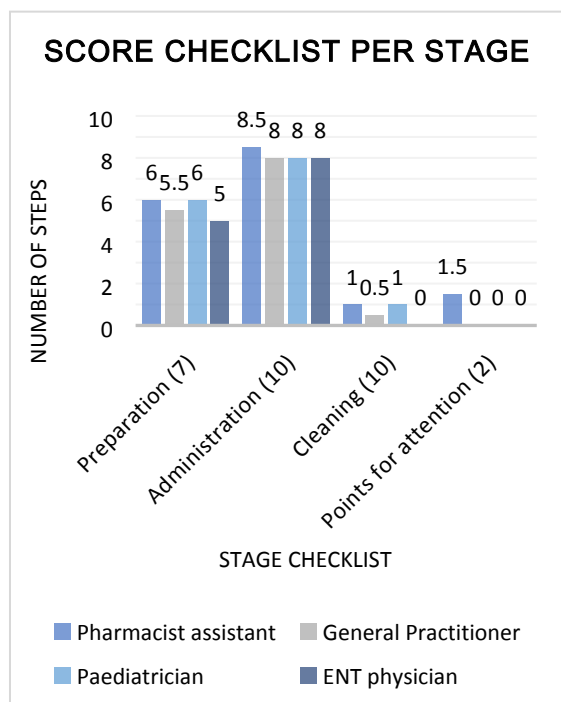
Preparation	n (%)
29. Discuss purpose and action of the medication.	75 (100)
30. Take off the dust cap.	75 (100)
31. <i>Firmly shake the bottle.*</i>	61 (81)
32. Place forefinger and middle finger on both sides of the nozzle and place thumb underneath the bottle.	58 (77)
33. Point the nozzle upwards and away from yourself.	44 (59)
34. Squirt a few sprays into the air until you see a cloud of mist.	44 (59)
35. <i>Blow the nose or rinse the nose with saline if the nose is clogged.*</i>	46 (61)
Administration	n (%)
36. Place forefinger and middle finger on both sides of the nozzle and place thumb underneath the bottle.	60 (80)
37. A. Keep the head upright and place the nozzle in the nose.	49 (65)
B. Use the right hand for spraying in the left nostril, and the left hand for spraying in the right nostril.	43 (57)
38. <i>Point the end of the nozzle slightly outwards, away from the centre ridge of the nose.*</i>	66 (88)
39. Close the other nostril with your opposite hand.	33 (44)
40. <i>Squirt a spray of mist in the nose while breathing in.*</i>	69 (92)
41. <i>Breathe out through the mouth.*</i>	57 (76)
42. Repeat steps 8 through 13 for the other nostril.	75 (100)
43. If two sprays per nostril are prescribed, repeat steps 11 through 16 for both nostrils.	75 (100)
44. Replace the dust cap.	75 (100)
Cleaning	n (%)
45. Wipe the nozzle with a tissue or handkerchief after every use.	38 (51)
46. Extensively wash the nozzle once a week:	1 (1)
47. Take off the dust cap and nozzle.	1 (1)
48. Rinse the dust cap and nozzle with warm water.	4 (6)
49. Shake off water.	1 (1)
50. Air dry the dust cap and nozzle.	1 (1)
51. Replace the nozzle.	1 (1)
52. Firmly shake the bottle.	1 (1)
53. Squirt a few sprays into the air until you see a cloud of mist.	1 (1)
54. Replace the dust cap.	1 (1)
Points for attention	n (%)
55. If the nozzle does not spray properly, perform the cleaning steps. If this does not work, take the spray to the pharmacy. Never puncture the opening.	13 (17)
56. Check the expiry date on the package and the expiry date after opening.	11 (15)

* *Essential steps*

Table 5. Scientifically and non-scientifically based steps in the corticosteroid nasal spray protocol

Scientifically based steps	Non-scientifically based steps
- Blow the nose or rinse the nose with saline if the nose is clogged. ²⁰	- Firmly shake the bottle.
- Keep the head upright. ^{11,21}	- Squirt a few sprays into the air until you see a cloud of mist.
- Use the right hand for spraying in the left nostril, and the left hand for spraying in the right nostril. ¹³	- Close the other nostril with your opposite hand.
- Point the end of the nozzle slightly outwards, away from the centre ridge of the nose.	- Breathe out through the mouth.
- Squirt a spray of mist in the nose while breathing in.	- Wipe the nozzle with a tissue or handkerchief after every use.
	- Extensively wash the nozzle once a week.

Figure 1. Median score checklist per stage, per group of healthcare workers



review only

Reporting checklist for cross sectional study.

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	#3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	#4	Present key elements of study design early in the paper	3
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	3
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for exposed and unexposed groups if applicable.	3
Bias	#9	Describe any efforts to address potential sources of bias	3
Study size	#10	Explain how the study size was arrived at	3

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3	Quantitative	#11	Explain how quantitative variables were handled in the	3
4	variables		analyses. If applicable, describe which groupings were	
5			chosen, and why	
6				
7				
8	Statistical	#12a	Describe all statistical methods, including those used to	3
9	methods		control for confounding	
10				
11	Statistical	#12b	Describe any methods used to examine subgroups and	3
12	methods		interactions	
13				
14	Statistical	#12c	Explain how missing data were addressed	3
15	methods			
16				
17				
18	Statistical	#12d	If applicable, describe analytical methods taking account of	3
19	methods		sampling strategy	
20				
21	Statistical	#12e	Describe any sensitivity analyses	3
22	methods			
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24				
25	Results			
26				
27	Participants	#13a	Report numbers of individuals at each stage of study—eg	4
28			numbers potentially eligible, examined for eligibility,	
29			confirmed eligible, included in the study, completing	
30			follow-up, and analysed. Give information separately for	
31			exposed and unexposed groups if applicable.	
32				
33				
34	Participants	#13b	Give reasons for non-participation at each stage	4
35				
36	Participants	#13c	Consider use of a flow diagram	
37				
38	Descriptive data	#14a	Give characteristics of study participants (eg demographic,	4
39			clinical, social) and information on exposures and potential	
40			confounders. Give information separately for exposed and	
41			unexposed groups if applicable.	
42				
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44	Descriptive data	#14b	Indicate number of participants with missing data for each	4
45			variable of interest	
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48	Outcome data	#15	Report numbers of outcome events or summary measures.	4
49			Give information separately for exposed and unexposed	
50			groups if applicable.	
51				
52	Main results	#16a	Give unadjusted estimates and, if applicable, confounder-	4
53			adjusted estimates and their precision (eg, 95% confidence	
54			interval). Make clear which confounders were adjusted for	
55			and why they were included	
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3	Main results	#16b	Report category boundaries when continuous variables were categorized	4
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6	Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	4
7				
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9				
10	Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	4
11				
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13	Discussion			
14				
15	Key results	#18	Summarise key results with reference to study objectives	4
16				
17	Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	5
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22	Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	5
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27	Generalisability	#21	Discuss the generalisability (external validity) of the study results	5
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30	Other			
31	Information			
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34	Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	7
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Observational study of administering intranasal steroid sprays by healthcare workers

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1 Title: Observational study of administering intranasal steroid sprays by healthcare workers

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38 28 administration, healthcare workers

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3 1 Abstract
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5 3 Objectives: Patients with allergic rhinitis receive their information about administering intranasal
6 4 corticosteroid sprays (INCS) from healthcare workers. Since the majority of patients do not
7 5 administer these sprays correctly, we investigated whether healthcare workers know how to
8 6 administer INCS.

9 7 Settings: we studied participants at their working place: pharmacy, outpatient clinic, or general
10 8 practitioner centre for emergencies

11 9 Participants: pharmacist assistants, general practitioners, paediatricians, and ear nose throat doctors.

12 10 Design: observational study

13 11 Primary outcome: number of steps of administration of INCS, based on the established INCS protocol

14 12 Secondary outcome: number of the five steps that are labelled essential to obtain optimal distribution
15 13 of the medication. All the participants demonstrated the administration technique with a spray device
16 14 filled with water.

17 15 Results: Among the 75 participants, none performed all the steps correctly. The median of correctly
18 16 performed steps in the protocol was 14 out of 29. A significantly better result was found among the
19 17 pharmacist assistants. The essential steps were performed by 27 out of the 75 participants (36%).

20 18 Conclusion: The majority of healthcare workers do not know how to administer INCS correctly.

21 19 Patients could, therefore, receive incorrect and non-uniform instructions. The education of healthcare
22 20 workers on how to administer INCS correctly may be an option for improvement

23 21
24 22
25 23
26 24 Strengths and limitations of this study
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28 26

29 27 This is the first study to observe healthcare workers administering INCS.
30 28

31 29 We conducted this study in a small research group, consisting of 75 healthcare workers.
32 30

33 31 The administration technique was scored in a simple and robust way by the same investigator.
34 32

35 33 We used a protocol for correct administration based on literature and patient information leaflets,
36 34 however, not all steps are based on firm scientific evidence.
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1 Introduction

2 Allergic rhinitis is a common chronic disease, with a prevalence ranging from 10 to 40% worldwide.¹
3 The disease mostly affects people between 5 and 45 years old, with a peak incidence between 19 and
4 24 years old.² In addition to allergen avoidance, the management of allergic rhinitis consists of either
5 antihistamines, intranasal corticosteroids or a combination of both.³⁻⁴ When persistent symptoms
6 occur, intranasal corticosteroid sprays (INCS) are the treatment of choice.⁵⁻⁶
7 Studies suggest that the administration technique for INCS is associated with efficacy, adverse events
8 and compliance.^{4,7} For example, it was found that the optimal administration technique of INCS is
9 spraying with a contralateral spray technique, pointing the nozzle away from the septum, because
10 spraying towards the septum causes more nosebleeds than the recommended approach.⁷⁻⁹
11 Furthermore, the head should be kept in a neutral position, and it is important to breathe in calmly
12 while spraying. This technique provides the best distribution of the medication.¹⁰⁻¹²
13 In a recent study, we observed the method of administration among patients and found that most
14 (94%) did not take their INCS as described in the patient information leaflets (PILs).¹³ Moreover, the
15 available PILs are currently incomplete and non-uniform.¹⁴ Since patients do not only learn from
16 PILs, but can also be instructed by healthcare workers, we wanted to know whether such they could
17 demonstrate the administration of INCS correctly. As far as we know, this factor has never previously
18 been studied. Therefore, we investigated the knowledge of healthcare workers regarding
19 administering INCS.

21 Material and methods

22 Participants and setting

23 We performed an observational study in the northern part of the Netherlands. The healthcare workers
24 observed included pharmacist assistants, general practitioners, paediatricians, and ENT physicians.
25 Healthcare workers were excluded if they had been practising their profession for less than a year.
26 Paediatricians and ENT physicians from eight hospitals were approached via email. We approached
27 pharmacist assistants from six pharmacies. General practitioners were approached while working at
28 the general practitioner centre for emergencies based at the Medical Centre Leeuwarden.

29 Study design

30 When eligible healthcare workers agreed to participate, a face-to-face interview was conducted. All
31 the participants were aware of the aim of the study. To prevent inter-observer variation, all interviews
32 and observations were performed by the same researcher (MdB).
33 During the interviews, the healthcare workers answered a questionnaire containing questions about
34 their experiences prescribing INCS and about how they provide patients with information. Then, the
35 healthcare workers were asked to demonstrate the administration technique with a spray device filled
36 with water. The stages assessed were preparation, administration and cleaning of the INCS [Table 1].
37 Assessment of the administration technique was based on the established Dutch INCS protocol.
38 During administration, this protocol was used as a scoring sheet, consisting of 29 steps. One point was
39 given each time the participant performed a step correctly. In the INCS protocol, five steps are
40 labelled as essential.¹⁴ These steps are considered as essential because they most influence the
41 distribution and efficacy of the medication. The essential steps include shaking the bottle, blowing or
42 rinsing the nose, directing the nebuliser away from the nasal septum, breathing in while
43 simultaneously squirting a spray of mist, and exhaling through the mouth.

45 Statistical analysis

46 In the statistical analysis, descriptive statistics were used to answer the question of whether healthcare
47 workers know how to administer INCS. For the comparison of outcomes between populations, a

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2
3 1 Kruskal Wallis test was used. Post hoc analysis was performed using a Mann Whitney U test. The
4 2 regional medical ethics committee approved the study protocol. All the participants provided written
5 3 consent.
6 4

8 5 Patient and Public Involvement

9 6 Patients or the public WERE NOT involved in the design, or conduct, or reporting, or dissemination
10 7 plans of our research.
11 8

13 9 Results

14 10 In the period between June 11th and December 18th, 2019, ten ENT-departments, seven paediatrician
15 11 departments and eight pharmacies were asked to participate in this study. General practitioners were
16 12 approached at the GP's emergency centre and asked to participate on the spot. 75 healthcare workers
17 13 participated in our study [Table 2], none of whom performed all the steps correctly. The median of
18 14 correctly performed steps in the protocol was 14 out of 29, with a range between 9 and 24 and an
19 15 interquartile range of 3.5. For preparing the spray, the median was six out of seven steps. The median
20 16 for administering the spray was eight out of 10 steps, and the median for cleaning the spray was one
21 17 out of 10 steps. The points for attention, which are taking the spray to the pharmacy when it does not
22 18 work and checking the expiry date, were not performed by most participants [Figure 1]. When
23 19 analysing the differences in total score between the healthcare workers, a significantly higher result
24 20 was found among pharmacist assistants compared with the other groups [Table 3].

25 21 Twenty-seven out of 75 participants (36%) performed all the essential steps. Of the essential steps,
26 22 nose-blowing was performed least frequently, being carried out 46 out of 75 times (61%). Inhaling
27 23 while squirting a spray of mist into the open nostril was performed most often: 69 out of 75 times
28 24 (92%). Shaking the bottle was done 61 times (81%). The nozzle was directed outwards 66 times
29 25 (88%). Exhaling through the mouth was done by 57 participants (76%) [Table 4].

30 26 Sixteen participants (21%) performed all the preparation steps. The least performed steps during
31 27 preparation were activating the nozzle by spraying in the air (59%) and blowing or rinsing the nose
32 28 (61%). Two participants (3%) performed all the administration steps. Squirting the spray while
33 29 breathing in (92%) and pointing the nozzle outwards (88%) were performed by most participants. The
34 30 most frequent errors in administration were, in order, keeping the other nostril closed, spraying
35 31 crosswise and keeping the head upright. These steps were performed 33 times (44%), 43 times (47%)
36 32 and 49 times (65%), respectively. One participant (1%) performed all the cleaning steps, including
37 33 cleaning the nozzle with a tissue and extensively cleaning the nozzle with water once a week and
38 34 allowing it to air dry. Approximately half the participants (38; 51%) cleaned the spray with a tissue
39 35 after every use [Table 4].
40 36

47 37 Discussion

48 38 In this study we found that most healthcare workers involved in the care for patients with allergic
49 39 rhinitis did not know and could not demonstrate how to administer INCS correctly. None of the
50 40 healthcare workers performed all the steps of the checklist correctly. The median of the 75
51 41 participants was 14 out of 29 well-executed steps. The five essential steps were correctly performed
52 42 by 27 out of 75 participants (36%). We found that the pharmacist assistants administered the INCS
53 43 significantly better than the other healthcare workers, suggesting that pharmacist assistants are most
54 44 suitable for providing information about INCS.

55 45 To the best of our knowledge, the role of healthcare workers in informing patients about the correct
56 46 administration of INCS has never previously been studied. One recent study found that face-to-face
57 47 instruction, consisting of both verbal information and a physical demonstration, was most effective in

1 teaching the correct technique for asthma medication.¹⁵ This finding may apply regarding the correct
2 usage of INCS as well, meaning that it is important that healthcare workers have sufficient
3 knowledge. Knowledge about inhaler technique for asthma and chronic obstructive pulmonary disease
4 (COPD) has been researched using healthcare workers. These studies reveal similar results to ours;
5 that is, inadequate knowledge regarding the use of inhalers.¹⁶⁻¹⁷ A recent study found only 12% of
6 healthcare workers knew at least three essential steps of the correct metered-dose inhaler technique,
7 and none of the participants performed all the steps correctly.¹⁸

8 For the checklist, we used a standardised protocol recently published in Dutch healthcare. Although
9 this protocol is based on existing literature, a few instruction steps are only marginally substantiated
10 by research data, and we needed to make a few assumptions about the best spray technique [Table 5].
11 First, an essential step while preparing for administration is blowing or rinsing the nose. This step is
12 recommended in the literature, although no significantly better distribution of the active substance
13 was found.¹⁹ Approximately 60% of the participants performed this step. Next, it was found that an
14 upright position of the head while spraying proved most effective.^{10,20} Bending the head backwards
15 can result in the active substance leaking into the pharynx, causing irritation and possibly more
16 systemic uptake. When bending the head forward, the active substance could easily run out again.
17 However, 45% of the ENT doctors and 10 to 20% of the paediatricians, general practitioners and
18 pharmacist assistants bent their heads forward while breathing in the spray. Their reasoning was that
19 the nasal cavity runs backwards, causing the spray to be sprayed towards the nasal cavity when the
20 head is bent forward. There is a study that confirms this theory.¹² However, when administering the
21 nasal spray, the nozzle should be directed away from the nasal septum to prevent nose bleeding and
22 septum perforation. Furthermore, the lateral nasal wall has more cilia than the medial wall, so the
23 distribution of the active substance is better.^{7,9} We found that this essential step was performed
24 correctly by 88% of the participants. It is also advised to use the contralateral hand while spraying,
25 because this causes less mechanical irritation, and, thus, fewer side effects and better compliance.⁷
26 Approximately half the participants (57%) performed this step. However, not all these participants
27 recommended this step to their patients, because it is relatively complicated to perform. Another
28 essential step is to breathe in slowly during administration, because the airflow ensures a better
29 contribution of the active substance. A continuous, slow flow has the best effect. Breathing hard or
30 sniffing can lead to increased turbulence in the nose, which can cause the active substance to finish in
31 the pharynx.^{11,21} This was the best performed essential step: 92% of participants performed this
32 correctly. Only one participant stated that the nasal spray should be completely cleaned with water
33 once a week. Since these nasal sprays are used chronically and daily in many cases, good hygiene is
34 important. However, there is no uniform instruction for cleaning the nasal spray in the package
35 leaflets. This lack is a possible explanation why the healthcare workers did not mention this aspect.
36 Considering that there is little substantiated research about the correct administration technique, and
37 since the published INCS protocol is not widely known, healthcare providers apparently provide
38 instructions according to their own insights. Further research is necessary to substantiate the most
39 effective administration technique for nasal sprays. Currently, it is important to implement the present
40 available instructions to achieve clarity in the instructions for the administration of nasal sprays.

41 Strengths and limitations

42 This study has a couple of limitations. First, we did not know what outcomes to expect, so we chose
43 to conduct this research with a relatively small research group in a particular region.²² Further
44 research must determine to what extent our results apply to other regions and countries. Second, we
45 could only include 15 ENT doctors despite many attempts and visits to their offices. Reasons given
46 were that they were too busy or not interested in participating. Nevertheless, we do not think that the
47 inclusion of five more ENT doctors would affect the outcome significantly. Thirdly, it is possible that
48

1 healthcare workers only agreed to participate in this study when they felt an affinity with the topic.
2
3
4 1 Greater interest might influence the knowledge of a correct administration technique. Healthcare
5 2 workers with less affinity would possibly score lower. Given the disappointing results of the studied
6 3 population, this only highlights the fact that the healthcare workers' knowledge about the correct
7 4 administration technique must improve. Lastly, we studied the knowledge of healthcare workers, not
8 5 the actual instruction patients receive from them.
9 6

10 7 The strengths of this study are as follows: since various hospitals, general practices and pharmacies
11 8 were included, the results are a good reflection of the population that both prescribes and informs
12 9 about INCS. All our interviews were conducted by the same researcher, so no inter-observer variation
13 10 occurred. We used a simple scoring system, making the scores less sensitive to errors.

14 11 This research only studied healthcare workers' knowledge of the administration technique. Studying
15 12 whether the knowledge of a healthcare worker ultimately affects the correct spray technique, and,
16 13 thus, the efficacy of INCS in patients, is recommended.
17 14

15 Conclusion

16 16 The majority of healthcare workers do not know how to administer an INCS correctly. This lack of
17 17 knowledge may prevent them from being able to provide adequate instructions to their patients. Clear
18 18 arrangements should be made regarding who provides these instructions and what these instructions
19 19 include. Healthcare workers should continually update their knowledge regarding the correct spray
20 20 technique. The established INCS protocols can be used to address this issue.
21 21

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Author contributions

Marielle de Boer was involved in developing the study protocol, interviewed the participants, analysed the data and wrote the first draft. Corine Rollema was involved in developing the study protocol, analysing the data, and in the process of writing. Eric van Roon was involved in developing the study protocol and the process of writing. Tjalling de Vries had the original idea, was involved in developing the study protocol, analysing the data, and the process of writing. All authors read the final version and agree.

Conflict of interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Data statement section

Technical appendix, statistical code, and dataset available from the authors

Figure 1 legend: Median score checklist per stage, per group of healthcare workers

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Table 1. Assessed steps per stage of the INCS protocol

Preparation	
1.	Discuss purpose and action of the medication.
2.	Take off the dust cap.
3.	<i>Firmly shake the bottle.*</i>
4.	Place forefinger and middle finger on both sides of the nozzle and place thumb underneath the bottle.
5.	Point the nozzle upwards and away from yourself.
6.	Squirt a few sprays into the air until you see a cloud of mist.
7.	<i>Blow the nose or rinse the nose with saline if the nose is clogged.*</i>
Administration	
8.	Place forefinger and middle finger on both sides of the nozzle and place thumb underneath the bottle.
9.	A. Keep the head upright and place the nozzle in the nose. B. Use the right hand for spraying in the left nostril, and the left hand for spraying in the right nostril.
10.	<i>Point the end of the nozzle slightly outwards, away from the centre ridge of the nose.*</i>
11.	Close the other nostril with your opposite hand.
12.	<i>Squirt a spray of mist in the nose while breathing in.*</i>
13.	<i>Breathe out through the mouth.*</i>
14.	Repeat steps 8 through 13 for the other nostril.
15.	If two sprays per nostril are prescribed, repeat steps 8 through 14 for both nostrils.
16.	Replace the dust cap.
Cleaning	
17.	Wipe the nozzle with a tissue or handkerchief after every use.
18.	Extensively wash the nozzle once a week:
19.	Take off the dust cap and nozzle.
20.	Rinse the dust cap and nozzle with warm water.
21.	Shake off water.
22.	Air dry the dust cap and nozzle.
23.	Replace the nozzle.
24.	Firmly shake the bottle.
25.	Squirt a few sprays into the air until you see a cloud of mist.
26.	Replace the dust cap.
Points for attention	
27.	If the nozzle does not spray properly, perform the cleaning steps. If this does not work, take the spray to the pharmacy. Never puncture the opening.
28.	Check the expiry date on the package and the expiry date after opening.

* *Essential steps*

Table 2. Participant characteristics

Variable	Overall (n = 75)
Healthcare worker, n (%)	
Pharmacist assistant	20 (26)
General practitioner	20 (26)
Paediatrician	20 (26)
ENT physician	15 (20)
Gender, n (%)	
Male	27 (36)
Female	48 (64)
Age (mean), range (95% CI)	
	45.2 ±11
Years of professional practice, n (%)	
1 – 5 years	18 (24)
5 – 10 years	12 (16)
10 – 20 years	22 (29)
> 20 years	23 (31)
Number of INCS prescriptions per week, n (%)	
0 times	20 (27)
< 1 time	19 (25)
1 – 4 times	17 (23)
4 – 8 times	5 (7)
> 8 times	14 (19)
Number of INCS instructions per week, n (%)	
< 1 time	24 (32)
1 – 4 times	27 (36)
4 – 8 times	9 (12)
> 8 times	15 (20)
Number of checks on INCS inhalations per week, n (%)	
< 1 time	62 (83)
1 – 4 times	15 (14)
4 – 8 times	2 (3)
> 8 times	0 (0)
Use of information material, n (%)	
Yes	19 (25)
No	56 (75)

Table 3. Difference in total score checklist

Healthcare worker	N	Median	Mean	Mean rank	P-value between groups*
Pharmacist assistant	20	16	16,2	54.58 ^a	0.001
General practitioner	20	13,5	13,3	30.98	
Paediatrician	20	14	13,8	34.85	
ENT physician	15	12	13,1	29.47	

Tested using Kruskal-Wallis test (post hoc Mann-Whitney U) *P < 0.05. ^aSignificant difference compared with general practitioners, paediatricians and ENT physicians.

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Table 4. Number of well-executed steps protocol

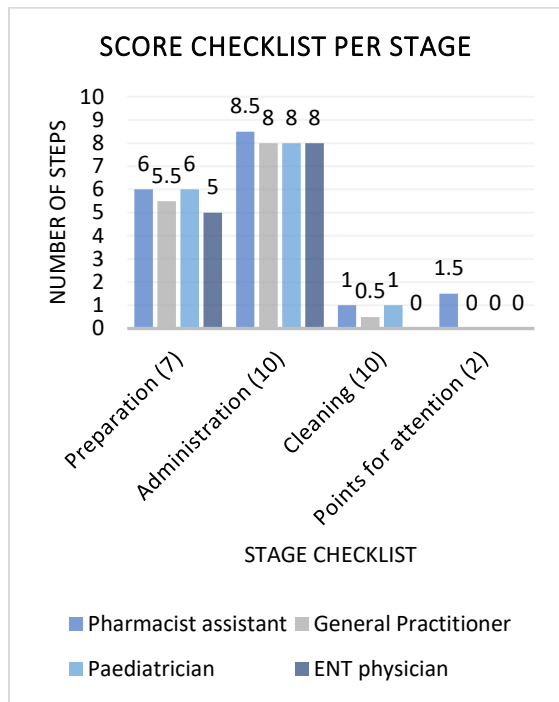
Preparation		n (%)
1.	Discuss purpose and action of the medication.	75 (100)
2.	Take off the dust cap.	75 (100)
3.	<i>Firmly shake the bottle.*</i>	61 (81)
4.	Place forefinger and middle finger on both sides of the nozzle and place thumb underneath the bottle.	58 (77)
5.	Point the nozzle upwards and away from yourself.	44 (59)
6.	Squirt a few sprays into the air until you see a cloud of mist.	44 (59)
7.	<i>Blow the nose or rinse the nose with saline if the nose is clogged.*</i>	46 (61)
Administration		n (%)
8.	Place forefinger and middle finger on both sides of the nozzle and place thumb underneath the bottle.	60 (80)
9.	A. Keep the head upright and place the nozzle in the nose.	49 (65)
	B. Use the right hand for spraying in the left nostril, and the left hand for spraying in the right nostril.	43 (57)
10.	<i>Point the end of the nozzle slightly outwards, away from the centre ridge of the nose.*</i>	66 (88)
11.	Close the other nostril with your opposite hand.	33 (44)
12.	<i>Squirt a spray of mist in the nose while breathing in.*</i>	69 (92)
13.	<i>Breathe out through the mouth.*</i>	57 (76)
14.	Repeat steps 8 through 13 for the other nostril.	75 (100)
15.	If two sprays per nostril are prescribed, repeat steps 11 through 16 for both nostrils.	75 (100)
16.	Replace the dust cap.	75 (100)
Cleaning		n (%)
17.	Wipe the nozzle with a tissue or handkerchief after every use.	38 (51)
18.	Extensively wash the nozzle once a week:	1 (1)
19.	Take off the dust cap and nozzle.	1 (1)
20.	Rinse the dust cap and nozzle with warm water.	4 (6)
21.	Shake off water.	1 (1)
22.	Air dry the dust cap and nozzle.	1 (1)
23.	Replace the nozzle.	1 (1)
24.	Firmly shake the bottle.	1 (1)
25.	Squirt a few sprays into the air until you see a cloud of mist.	1 (1)
26.	Replace the dust cap.	1 (1)
Points for attention		n (%)
27.	If the nozzle does not spray properly, perform the cleaning steps. If this does not work, take the spray to the pharmacy. Never puncture the opening.	13 (17)
28.	Check the expiry date on the package and the expiry date after opening.	11 (15)

* Essential steps

Table 5. Scientifically and non-scientifically based steps in the corticosteroid nasal spray protocol

Scientifically based steps	Non-scientifically based steps
<ul style="list-style-type: none"> - Blow the nose or rinse the nose with saline if the nose is clogged.¹⁹ - Keep the head upright.^{10,20} - Use the right hand for spraying in the left nostril, and the left hand for spraying in the right nostril.¹² - Point the end of the nozzle slightly outwards, away from the centre ridge of the nose. - Squirt a spray of mist in the nose while breathing in. 	<ul style="list-style-type: none"> - Firmly shake the bottle. - Squirt a few sprays into the air until you see a cloud of mist. - Close the other nostril with your opposite hand. - Breathe out through the mouth. - Wipe the nozzle with a tissue or handkerchief after every use. - Extensively wash the nozzle once a week.

Figure 1. Median score checklist per stage, per group of healthcare workers



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Reporting checklist for cross sectional study.

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	#3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	#4	Present key elements of study design early in the paper	3
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	3
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for exposed and unexposed groups if applicable.	3
Bias	#9	Describe any efforts to address potential sources of bias	3
Study size	#10	Explain how the study size was arrived at	3

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3	Quantitative	#11	Explain how quantitative variables were handled in the	3
4	variables		analyses. If applicable, describe which groupings were	
5			chosen, and why	
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7				
8	Statistical	#12a	Describe all statistical methods, including those used to	3
9	methods		control for confounding	
10				
11	Statistical	#12b	Describe any methods used to examine subgroups and	3
12	methods		interactions	
13				
14	Statistical	#12c	Explain how missing data were addressed	3
15	methods			
16				
17				
18	Statistical	#12d	If applicable, describe analytical methods taking account of	3
19	methods		sampling strategy	
20				
21	Statistical	#12e	Describe any sensitivity analyses	3
22	methods			
23				
24				
25	Results			
26				
27	Participants	#13a	Report numbers of individuals at each stage of study—eg	4
28			numbers potentially eligible, examined for eligibility,	
29			confirmed eligible, included in the study, completing	
30			follow-up, and analysed. Give information separately for	
31			exposed and unexposed groups if applicable.	
32				
33				
34	Participants	#13b	Give reasons for non-participation at each stage	4
35				
36	Participants	#13c	Consider use of a flow diagram	
37				
38	Descriptive data	#14a	Give characteristics of study participants (eg demographic,	4
39			clinical, social) and information on exposures and potential	
40			confounders. Give information separately for exposed and	
41			unexposed groups if applicable.	
42				
43				
44	Descriptive data	#14b	Indicate number of participants with missing data for each	4
45			variable of interest	
46				
47				
48	Outcome data	#15	Report numbers of outcome events or summary measures.	4
49			Give information separately for exposed and unexposed	
50			groups if applicable.	
51				
52	Main results	#16a	Give unadjusted estimates and, if applicable, confounder-	4
53			adjusted estimates and their precision (eg, 95% confidence	
54			interval). Make clear which confounders were adjusted for	
55			and why they were included	
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3	Main results	#16b	Report category boundaries when continuous variables were categorized	4
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6	Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	4
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10	Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	4
11				
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13	Discussion			
14				
15	Key results	#18	Summarise key results with reference to study objectives	4
16				
17	Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	5
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22	Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	5
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27	Generalisability	#21	Discuss the generalisability (external validity) of the study results	5
28				
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30	Other			
31	Information			
32				
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34	Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	7
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