

COMPRESSION THERAPY IN THE PREVENTION AND TREATMENT OF VENOUS DISEASES – A CROSS-SECTIONAL STUDY



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Summary

Introduction: The aim of the study was to evaluate nurses' knowledge of selected statements in the use of compression therapy in phlebology according to selected characteristics of nurses.

Material and methods: A cross-sectional study using a self-constructed 28-item questionnaire was conducted in 2023. Respondents included 330 nurses (103 practical, 179 general, and 48 general with specialization) from several dozen clinical workplaces in the Czech Republic. As part of the data analysis, descriptive, regression, and cluster analyses in an exploratory mode were applied.

Results: The respondents obtained an average of 19 points on the 16 multiple-choice items in the knowledge test, which is a 49% success rate on the test. They were most successful in answering question 19, which focused on the symptoms of venous thrombosis, and least successful in answering question 14, which focused on the method of checking the pressure under the bandage. Work position had the greatest influence on the level of knowledge. Practical nurses scored almost 3 points more on the test and general nurses about 2 points more than specialized nurses. The respondents' post-graduate education also had a positive effect on their knowledge (in terms of factual and statistical significance).

Conclusions: The results of the study show that there are major deficiencies in the application of compression therapy among the respondents. Improper compression can cause complications that can seriously harm the patient. Health care providers should provide mandatory training for nurses.

Key words: knowledge, nurse, compression therapy, venous diseases.

Introduction

Compression therapy in phlebology primarily targets the prevention of venous thromboembolism (VTE), in the prevention and treatment of lower limb oedema of various aetiologies, in the prevention and treatment of venous varices (after surgical treatment and sclerotherapy of varices), in the prevention and healing of leg ulcers, and in post-thrombotic syndrome. Indicated permanent compression is the most important component of conservative therapy of chronic venous insufficiency (CVI), including therapy of ulcer cruris [1–5].

Compression therapy is well tolerated and received positively by most patients. However, it also has its contraindications; for example, it cannot be used in ischaemic disease of the lower limbs stages III and IV according to Fontaine [6] in advanced heart insufficiency, i.e. NYHA III–IV [7], in superficial arterial bypasses at the point of compression, in advanced diabetic neuropathy or microangiopathy, in allergy on the material of compression aids, etc. [2, 8–10].

The current form of compression therapy is well-established, standardized, and substantiated by controlled clinical studies [8]. In practice, compression therapy is used to prevent and treat venous diseases (either alone or in combination with surgical therapy or the application of venous drugs). However, the combination of pharmacological and non-pharmacological prophylaxis is more effective than their separate use [8, 11–13].

In clinical practice, there are 4 main ways of applying non-pharmacological compression therapy:

- 1) compression elastic bandages,
- 2) compression elastic stockings (CES) – flat knit or circular knit elastic knee-length socks, stockings or tights,
- 3) circaid built-in-pressure system: adjustable, measurable, and re-adjustable compression (alternative therapy solution for patients who are not able to apply or tolerate compression stockings),
- 4) instrumental application of compression (intermittent pneumatic compression – IPC).

The selection of an external compression method is influenced by factors such as the type and stage of the disease, limb conditions, and the patient's cooperation level with treatment. Generally, in acute conditions like thrombosis, thromboembolism, and the post-operative phase (after surgical interventions, plastic operations, or caesarean sections), elastic bandages are commonly used. In contrast, compression stockings are preferred for the long-term therapy of chronically ill patients, while IPC is predominantly employed for chronic limb oedema treatment [8, 14, 15].

Pressure damage to patients' skin during compression therapy can occur due to several factors, and it is the nurse's responsibility to ensure that the compression bandage is applied safely and professionally. However, there are studies [16, 17], to which we also lean from practical experience, which state that nurses working in different departments are not sufficiently trained in compression therapy, especially in the application of compression bandages [16–18].

The aim of the study was to evaluate nurses' knowledge of selected statements when using compression therapy in phlebology according to selected characteristics of nurses (job position, postgraduate educational activities in the last 5 years, health sector, frequency of dressings, and age of nurses).

Material and methods

In 2023, we conducted a quantitative cross-sectional study using a questionnaire technique on the topic of compression therapy in phlebology, which was attended by nurses from several dozen clinical workplaces in the Czech Republic.

The questionnaire contained 3 parts:

- 1) basic characteristics of the respondents,
- 2) questions focused on knowledge of compression therapy in phlebology,
- 3) implementation of compression therapy in practice from the perspective of the respondents.

The first section included 6 items concentrating on socio-demographic details. These details encompassed the department providing health care, age of respondents, qualifications, job position, participation in postgraduate educational activities related to compression therapy in the past 5 years, and the frequency of bandaging.

The second section comprised 16 multiple-choice items designed to assess respondents' knowledge and identify correct statements related to compression therapy. In this section, a maximum of 39 points could be obtained if all correct answers were marked.

The third section consisted of 6 multiple-choice items concentrating on the implementation of compression therapy in practice. The questionnaire items were determined based on the most important find-

ings from professional studies, review articles, and guidelines [11, 19–21]. These items were developed in collaboration with a special needs teacher. The validity of the questionnaire was verified on a group of nursing students as part of a bachelor's study program.

The questionnaires were addressed to nurses (hereinafter referred to as respondents) working in inpatient surgical and internal wards and in follow-up care wards. The respondents filled out the questionnaires as part of educational events in 3 regional towns. The educational events were not primarily focused on the issue of thromboembolic disease and limb bandaging, and the respondents filled out the questionnaires without preparation. Respondents were assured by the researcher that their participation in the research was voluntary and anonymous, and that the results would be used only for research purposes. They placed the filled-out forms in prepared boxes. A total of 18 questionnaires had to be discarded due to their incompleteness, and 330 fully completed questionnaires were included in the analysis.

As part of the data analysis, basic descriptive statistics regarding the monitored properties of the research set and the test results were implemented. Furthermore, regarding the aim of the study, a linear regression analysis was carried out with the aim of evaluating the factors affecting the overall level of knowledge. Furthermore, a cluster analysis was implemented with the aim of finding groups of respondents with a similar spectrum of knowledge. All analyses were performed in IBM SPSS, version 26.

Limitations of the study

It must be emphasized that the research focused on the knowledge of nurses from only one country (Czech Republic). The results can be perceived and related to the given period of data collection. The size of the sample, which represents 330 nurses, is also a limitation. We recommend expanding the questionnaire survey to other countries of the European Union, focusing on the consequences for hospitals, the ministry, and consequences for patients and economic consequences for the country. Our study will continue with an observational study focused on the technique of performing compression therapy in practice.

Ethical approval

The study is as part of the project RVO Excellent/MSM-RVO/FHS/2023–2025/005: "A Multifactorial and Multidisciplinary Approach to Health and Disease" (anonymous questionnaire for health/social workers or students). It was awarded an internal grant from Tomas Bata University in Zlín. The RVO was approved by the

Ethics Committee of Tomas Bata University in Zlín on 19 May 2023.

All the respondents were informed in a document accompanying the questionnaire that their participation in the study was voluntary. Within the research no personal data were processed. The research was conducted in nurses who had shown interest in it and were willing to fill the form out voluntarily. The questionnaires were filled out anonymously. Immediately after collecting the questionnaires, it was not possible to identify the persons who had filled them out.

Results

The study was conducted in the Czech Republic on a sample of 330 nurses of whom 103 (31.2%) were practical nurses (with secondary school qualification), 179 (54.3%) were general nurses (completed qualification studies in the field at university or higher vocational school), and 48 (14.6%) were general nurses with specialization (postgraduate education). The basic structure of the nurses who participated in our research (a total of 330 nurses) is shown in Table 1. The age of the nurses ranged from 19 to 61 years, and their average age was 34 years (± 11).

First, we present descriptive results focused on 16 multiple-choice knowledge items. Theoretically, it was possible to get 0–39 points; the more points, the higher the overall level of knowledge about the issue (regardless of their spectrum). The nurses scored a total of 9–27 points and an average of 19.1 points, which is a 49% success rate on the test. Table 2 shows the individually correct answers in a descending order of success rate. The basis for calculating percentages is 330 responses to all the items, so the values are comparable.

Respondents were generally most successful in answering question No. 19, which focused on the symptoms of venous thrombosis (95–100% success rate in 3 partially correct answers). On the contrary, we can see a zero success rate in sub-parts of questions No. 14 (method of checking bandage pressure) and 11 (list of aids for compression bandages). It can be seen from the table that the success rate is not primarily linked to the 16 thematic units but can vary quite significantly within them (e.g. in the topic of question no. 15 it is a preference for the type of revolutions, while 81% chose one of the correct options, while only 16% chose the other).

Furthermore, in accordance with the aim of the study, multiple linear regression was implemented using the Enter method. In the model, the overall level of knowledge appears as a dependent variable, as well as a set of independent variables: age; profession (the reference category is nurses with special qualifications,

Table 1. Characteristics of respondents

| Job | n* | %** |
|---|-----|------|
| Practical nurse | 179 | 54.3 |
| General nurse | 119 | 36.1 |
| General nurse with specialization | 48 | 14.6 |
| Total | 330 | 100 |
| Educational activities in compression therapy in the past 5 years | | |
| Yes | 119 | 36.1 |
| No | 211 | 63.9 |
| Department providing health care | | |
| Internal medicine | 114 | 34.5 |
| Surgery | 125 | 37.9 |
| Follow-up care | 91 | 27.6 |
| Frequency of bandaging (how often a nurse changes patients' bandages) | | |
| Daily | 101 | 30.6 |
| Often | 164 | 49.7 |
| Seldom | 64 | 19.4 |
| Never | 1 | 0.3 |

* Frequency of respondents

** Percentage of respondents

practical nurses, and general nurses are compared with this category); department (follow-up care is the reference category, with which surgery is compared and then internal medicine); frequency of bandaging (daily vs. less often), and participation in postgraduate education (yes vs. no).

The model ($F = 4.308$; $df = 7$; $p \leq 0.005$) is characterized by a total level of explained variance of 9% (according to the coefficient R^2 ; in adjusted form then 7%). The values aimed at checking multicollinearity in the model are within the norm (tolerance is > 0.2 in all cases; variance inflation factor is < 5 in all cases). The resulting model is presented in Table 3.

When interpreting the table, we take into account measures of material significance, namely a combination of unstandardized and standardized β coefficients (Table 2).

The profession had the greatest influence on the level of knowledge. Practical nurses scored almost 3 points more on the test than general nurses with specialization. General nurses scored roughly 2 points more than general nurses with specialization. Participating in postgraduate education also had an impact, where those who participated in postgraduate education had less than a point more than those who did not. The other variables included in the model did not have a significant effect (in terms of factual and statistical significance).

The regression analysis model is relatively weak, explaining about 9% of the variability of the dependent

Table 2. Correct answers in descending order according to the success rate of respondents

| Correct answers | n* | %** |
|--|-----|-----|
| 19. Symptoms of venous thrombosis: pain | 330 | 100 |
| 19. Symptoms of venous thrombosis: colour change | 317 | 96 |
| 19. Symptoms of venous thrombosis: feeling of tension | 314 | 95 |
| 23. Correct holding of an elastic roller bandage in the hand: according to Figure B in our questionnaire | 300 | 91 |
| 17. Correct statement regarding the application of a bandage in the prevention of VTE: the limb is bandaged, including the foot, starting from the toes and moving over the heel | 274 | 83 |
| 15. Preference of the type of rotation: the reverse spiral technique of rotation while applying a compression bandage | 267 | 81 |
| 20. Compression stockings are not suitable for: gangrene | 257 | 78 |
| 21. Short-stretch bandages are: low-stretch bandages with high working pressure and low resting pressure | 254 | 77 |
| 19. Symptoms of venous thrombosis: swelling of the limb | 244 | 74 |
| 28. Competence to prescribe CES II classes: contractual doctor | 231 | 70 |
| 10. When do you apply the bandage to the lower extremities in the prevention of VTE?: in the morning, before the patient gets out of bed | 215 | 65 |
| 18. Compression stockings are produced in 4 compression classes | 215 | 65 |
| 17. Correct statement regarding the application of a bandage in the prevention of VTE: the bandage overlaps by 2/3 | 201 | 61 |
| 17. Correct statement regarding the application of a bandage in the prevention of VTE: apply the bandage in the morning while lying down | 201 | 61 |
| 17. Correct statement regarding dressing application in VTE prevention: short-stretch bandage | 188 | 57 |
| 20. Do not use compression stockings when: skin (recent skin graft) | 185 | 56 |
| 27. Competence to measure for the correct selection of the CES size: doctor | 178 | 54 |
| 20. Compression stockings are not suitable for: LLs swelling | 172 | 52 |
| 14. Possible methods of checking the pressure of the applied bandage: the elasticity of the bandage by hand | 165 | 50 |
| 27. Competence to measure: trained staff | 165 | 50 |
| 28. Power to prescribe CES II. classes: general practitioner | 152 | 46 |
| 12. Number of bandages per 1 leg: 2 bandages | 145 | 44 |
| 20. Do not use compression stockings for: peripheral neuropathy | 142 | 43 |
| 20. Do not use compression stockings for: peripheral artery disease | 142 | 43 |
| 20. Do not use compression stockings for: local disease | 125 | 38 |
| 11. List of aids for bandaging LLs in the prevention of VTE: short-stretch bandage | 122 | 37 |
| 18. Compression stockings: three types | 119 | 36 |
| 17. Correct statement regarding dressing application: use of 8–10 cm wide bandage | 119 | 36 |
| 18. Compression stockings: they have a high resting pressure, they have to be removed at night | 112 | 34 |
| 17. Correct statement regarding the application of the bandage: ankle at right angle | 89 | 27 |
| 10. Apply a compression bandage to the limb to prevent VTE: after 30 minutes in bed | 83 | 25 |
| 18. Compression stockings: they are always long-stretch elastic | 79 | 24 |
| 15. Preference of the type of rotation: the figure-of-eight technique of bandaging | 53 | 16 |
| 13. What pressure do you choose for compression to prevent VTE: 18–21 mm Hg | 50 | 15 |
| 24. Choose the correct width of the bandage in the prevention of VTE: In the area of the instep, the width of the bandage is 8 cm, and in the area of the shin 12 cm | 40 | 12 |
| 11. List of aids for bandaging lower legs in the prevention of VTE: inlay | 40 | 12 |
| 22. End of compression: 10 cm above visible varicosity/swelling | 26 | 8 |
| 14. Possible methods of checking the pressure of the applied bandage: using a measuring device | 0 | 0 |
| 11. List of aids for bandaging LLs in the prevention of VTE: adhesive tape for fixation | 0 | 0 |

CES – compression elastic stockings, LLs – lower legs, VTE – venous thromboembolic event

* Frequency of correct answers in descending order

** Percentage success rate achieved in the test in descending order

Table 3. Regression analysis model

| Parameters | Unstandardized coefficients | | Standardized coefficients | T** | Sig.*** | Collinearity statistics |
|--|-----------------------------|------------|---------------------------|--------|---------|-------------------------|
| | B* | Std. error | β | | | VIF**** |
| (Constant) | 16.172 | 0.926 | | 1.472 | 0.000 | |
| Age | 0.030 | 0.018 | 0.104 | 1.658 | 0.098 | 1.393 |
| Profession: practical nurse (vs. nurse with specialization) | 2.669 | 0.578 | 0.387 | 4.617 | 0.000 | 2.479 |
| Profession: general nurse (vs. nurse practitioner) | 1.947 | 0.511 | 0.304 | 3.811 | 0.000 | 2.238 |
| Department: surgery (vs. after care) | -0.357 | 0.436 | -0.054 | -0.818 | 0.414 | 1.549 |
| Department: internal medicine (vs. after care) | 0.053 | 0.467 | 0.008 | 0.114 | 0.909 | 1.708 |
| Frequency of bandaging: daily (vs. less-often-never) | -0.464 | 0.388 | -0.067 | -1.198 | 0.232 | 1.102 |
| Participation in bandaging education (vs. non-participation) | 0.825 | 0.381 | 0.124 | 2.167 | 0.031 | 1.155 |

VIF – variance inflation factor

* Unstandardized coefficient β

** Test criteria

*** Value of statistical significance (bolded values indicate statistically significant values at the 5% significance level)

Table 4. Composition of clusters according to the compared characteristics of respondents

| Comparison groups | Cluster | | | |
|-----------------------------------|---------|-----|----|-----|
| | 1 | | 2 | |
| | n* | %** | n* | %** |
| Job | | | | |
| Practical nurse | 61 | 59 | 42 | 41 |
| General nurse | 89 | 50 | 90 | 50 |
| General nurse with specialization | 18 | 38 | 30 | 63 |
| Department | | | | |
| Surgery | 56 | 45 | 69 | 55 |
| Internal medicine | 66 | 58 | 48 | 42 |
| Follow-up care | 46 | 51 | 45 | 49 |
| Frequency of bandaging | | | | |
| Daily | 45 | 45 | 56 | 55 |
| Educational activities | | | | |
| Yes | 53 | 45 | 66 | 55 |

* Frequency of correct answers in the test

** Percentage success rate achieved in the test

variable. Other factors not monitored by the questionnaire probably have a stronger influence on knowledge in the field of bandaging. It is also possible that the differences within the categories being compared are not reflected in the total amount of knowledge (expressed as the sum of points on the test), but instead to their internal structure. To verify this assumption, we further implemented a cluster analysis using the K-Means Cluster (Quick Cluster) method, using both iteration and classification. We created and evaluated different solutions for 2–4 clusters. The final solution for 2 clusters,

which appeared to us to be the most interpretable, was reached after 8 iterations. The analysis divided the respondents into groups very similar in size, Cluster 1 ($n = 168$, 51%) and Cluster 2 ($n = 162$, 49%). The composition of the clusters according to the compared characteristics of the respondents is shown in Table 4.

If we focus the interpretation on the biggest differences between the clusters, in Cluster 1 there are more practical nurses working at internal medicine wards, and there is a lower frequency of daily bandaging and education. The average age is 33 years. In Cluster 2,

there is a greater representation of general nurses with specialization scope working in surgery, who apply bandages more often and are involved in postgraduate education more often. The average age is 36 years.

The average level of knowledge varies relatively little between clusters, with Cluster 1 being 18 points and Cluster 2 being 20 points. However, it turns out that it is possible to identify specific items in which the clusters differ significantly (we consider a significant difference in the interpretation of the results to be at least 10% points), e.g. nurses from Cluster 1 are more orientated in compression stockings (they know that they are always long-stretch and are loosened at night, etc.), while nurses from Cluster 2 are better at applying bandages (e.g. when applying the bandage, the ankle is placed at a right angle, they use short-stretch wraps, etc.). The other items between the clusters are balanced (e.g. symptoms of thrombosis, competence to prescribe, correct holding of a bandage roll, etc.).

Discussion

As part of our quantitative cross-sectional study conducted on 330 nurses (Table 1), nurses who participated in 4 educational events that were not primarily focused on compression therapy completed a questionnaire. As part of question No. 9, the respondents stated that bandages are most often used for compression in their workplaces in up to 90%, CES in 39%, and IPC in only 1%. The reason is obvious: costs. In the years 2011–2013, a study was conducted in Germany, which was implemented as part of educational events focused on compression therapy [16]. This study investigated the knowledge of compression dressings and their use among 891 German health care providers (3.3% physicians, 5.5% physician assistants, 90.7% nursing staff). A practical test, focused on the participants' ability to apply bandage systems with the correct level of pressure, was also included (a total of 551 bandages were performed). As in our case, deficiencies in the provision of compression therapy were also revealed in this study. In our study, respondents were generally most successful in answering question No. 19, which focused on symptoms of venous thrombosis (Table 2). On the contrary, the respondents unsuccessfully answered the partial parts of question No. 14 regarding the method of checking the pressure of the bandage (no one knew about the possibility of checking the pressure under the bandage using a measuring device). In question No. 13, only 15% of respondents knew that for the prevention of VTE it is necessary to develop pressure in the range 18–21 mm Hg when bandaging the lower limbs. Also, in the study by Protz *et al.* 87% of respondents did not know compression pressures and their use. This was also reflected in the practical implemen-

tation, when only 10% of the participants during practical testing in the study applied the bandage with the correct pressure, 77.0% applied the bandage with less pressure, and 13.7% with too much pressure [16]. If the compression is applied incorrectly and does not create sufficient pressure, the therapy may be compromised. Conversely, if the pressure is too strong, complications may occur, such as the formation of pressure ulcers [22]. Achieving continuously graded pressure requires experience and skill. Pico-Press or Kikuhime® devices, whose sensor is inserted under a bandage (or stocking), are a good tool for determining the pressure of external compression [23]. We are currently using the Pico-Press in hands-on teaching of future nurses based on evidence-based practice.

In question No. 12 of our knowledge test, only 44% of respondents correctly stated that 2 bandages are used on one lower leg for a patient of average weight. Navrátilová (2008) adds that in the case of a larger limb, the number of bandages can be increased. Only 12% of respondents knew about the possibility of padding (inlay). At the same time, multi-component compression systems and adaptive compression bandages are nowadays a better alternative that brings greater comfort to the patient [23].

In question No. 17, only 57% of respondents knew that short-acting bandages should be used to prevent VTE. The explanation for this lack of knowledge was that the respondents are not interested in the quality of the material, it does not concern to them. For the bandage, they will use bandages that are available in the department. The head/station nurses, who oversee the ordering the material, stated that they order cheaper bandages, so-called universal bandages, because they are cheaper.

Short-stretch (75–90% elasticity) and medium-stretch elastic bandages should be used for compression bandaging in CVI. Short-stretch bandages have a high working pressure and a low resting pressure, i.e. they do not tend to shrink, do not strangle the limb at rest, and can therefore be left overnight. Bandages with medium elasticity (90–140% elasticity) have a higher resting pressure, so the bandage when sitting or while not moving can be felt as unpleasant. These bandages stretch more when walking; they have relatively low work pressure. The advantage is the possibility of application by the patient him/herself every morning (and removal in the evening), and thus better skin care. The disadvantage is a greater risk of strangulation. In patients with phleboedema, a simple compression bandage is usually recommended, while in the case of phlebolymphoedema and in the treatment of ulcers cruris venosum a multi-layered bandage is recommended (faster healing occurs underneath it) [2, 23–25].

The technique of applying a compression bandage has not been standardized in the Czech Republic; there are a number of special bandaging techniques, but all of them respect the above criteria for applying a compression bandage [23]. As part of question No. 15, 81% of respondents answered that they preferred the reverse spiral technique of rotation when compressing with a bandage, and 16% of respondents prefer the figure-of-eight technique of bandaging. Coull *et al.*, in 2006, published a study comparing the differences in lower extremity compression for leg ulcers induced on the extremity using the spiral dressing technique and the figure-of-eight technique. The pressure under the bandage was measured using pressure probes. The spiral technique (there is a free space between individual wraps) was evaluated as a safe and comfortable method of dressing application. The figure-of-eight also provided graded compression but with some high pressure areas, especially overlaying the Achilles tendon [26].

The nurse's role in compression therapy depends on his/her education and competence. The results shown in Tables 3 and 4 correspond to the competences of nurses in different job positions [27]. As part of the regression analysis model (Table 3), it was found that profession and participation in postgraduate education have the greatest influence on the level of knowledge. The other variables included in the model do not have a significant effect (in the sense of material and statistical significance). Despite this, the respondents agreed that compression therapy is given little space and time in both undergraduate and postgraduate nursing education. According to a study conducted in Germany, a maximum of 1–2 hours are devoted to bandaging in nursing schools [16]. If we focus the interpretation on the biggest differences between the clusters (Table 4), the nurses from Cluster 1, where the frequency of daily bandaging in the internal departments was manifested, are better oriented in the knowledge test in terms of compression stockings. Surgical nurses from Cluster 2, who stated that they apply bandages more often, are more proficient in applying bandages in the knowledge test. Other items between the clusters were balanced (e.g. symptoms of thrombosis, competence to prescribe, holding a bandage, etc.). In the surgical department, as part of post-operative care, to reduce swelling, first compression is often done with a bandage, and after the swelling has been reduced, stockings are put on. In the internal department, stockings are preferred; however, everything depends on the economy of the given medical facility.

Conclusions

The results of our study show that there are major deficiencies in knowledge and in the actual provision of

compression therapy among the respondents. Within the educational program, a small space is devoted to this topic. Nor is sufficient attention paid to verifying whether non-pharmacological compression therapy is carried out with quality in clinical practice.

Health care providers should provide mandatory training for nurses performing compression therapy in bandaging techniques under the supervision of experienced instructors using devices to measure pressure under the bandage. Furthermore, they should ensure retraining of nurses in bandaging technique training every 2 years directly at the workplace. It is also necessary to pay attention to nursing standards focused on compression therapy. Nursing standards are of key importance for improving the quality of care.

The authors declare no conflict of interest.

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