ARTICLE | OPEN ACCESS

Medical Science

To Cite:
Prządo I, Karaś L, Patronik P, Krupa-Nurcek S. Awareness of medical staff about botulinum toxin and its use - pilot study. *Medical Science* 2025; 29: e105ms3581
doi: https://doi.org/10.54905/disssi.v29i161.e105ms3581

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Peer-Review History
Received: 25 March 2025
Reviewed & Revised: 07/April/2025 to 01/July/2025
Accepted: 07 July 2025
Published: 16 July 2025

Peer-review Method
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367

Awareness of medical staff about botulinum toxin and its use - pilot study

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ABSTRACT

Background: Botulinum toxin, also known as botulinum or Botox, is a substance produced by the bacteria Clostridium botulinum. Although it is one of the most potent toxins known, it has been widely used in medicine. *Aim of the study*: The aim of this study was to assess the knowledge of medical staff regarding the use of botulinum toxin and to identify areas for improvement in their medical practice. *Material and methods*: An observational study was conducted between November 2, 2023, and the end of March 2024 among 100 medical workers. A self-assessment questionnaire was used, and a chi-square statistical test was used. *Results*: A statistically significant correlation exists between the level of knowledge about botulinum toxin use and the number of individuals with low, average, and high levels of expertise. There is a correlation between the preferences of medical staff and the various channels through which they acquire knowledge. Specialist doctors are one of the most important sources. Still, people in the medical field also reach for others, such as the Internet and social media, or the experiences of their friends or family who have undergone similar procedures. *Conclusions*: There is a need to tailor training programmes to groups at a given level of knowledge about botulinum toxin. It is also recommended to utilize comprehensive sources of information and consider the professional context in the education and decision-making process.

Keywords: botulinum toxin; botulizm; medical Staff; nursing

1. INTRODUCTION

Botulinum toxin was discovered in the 20s of the twentieth century by scientists Alan Scott and Edward Schantz. Initially, it was used in the treatment of neurological diseases, blepharospasm, and strabismus. However, it has also proven to be an effective tool in eliminating mimic wrinkles and in many other aspects of health (Hong, 2013). It is a potent neurotoxin produced by the bacterium Clostridium botulinum, commonly referred to as botulism (Choudhury et al., 2021). The structure of botulinum toxin is complex, comprising two main components: a light chain containing endopeptidase and a heavy chain that enables the toxin to bind to receptors on the surface of nerve cells (Kumar et al., 2016). The mechanism

of action is based on the ability to influence nerve conduction. It involves key stages: attachment to receptors (SNAP-25 proteins), internalization (absorption into the neuron), disruption of acetylcholine release (resulting in nerve conduction disorder), and muscle paralysis (Jabbari, 2018; Burstein et al., 2020). The above-mentioned processes enable a therapeutic effect, and the entire procedure is supervised by qualified specialists who precisely administer the correct amount of substances in targeted areas, while minimizing the risk of side effects (Pirazzini et al., 2017; Czajka, 2021).

There are several types of botulinum toxin, each characterized by unique properties (Peck et al., 2017). In medicine, type A is most commonly used in the treatment of migraines, excessive sweating, and wrinkle reduction (Muñoz Lora et al., 2019; Do et al., 2017; Jankovic et al., 2018). If the desired results are not achieved, type B is used, which is also useful in the treatment of cervical dystonia (Dołomisiewicz et al., 2018; Sławek et al., 2018).

In aesthetic medicine, botulinum toxin is most often applied to the crow's feet around the eyes and the so-called "11 line" between the eyebrows to reduce mimic wrinkles (Camargo et al., 2021; Janes et al., 2021). Additionally, it supports the correction of facial muscle asymmetry (Kim et al., 2020). Dosage and administration location are tailored to the individual needs of the patient (Bertossi et al., 2018). Adverse effects of botulinum toxin include temporary swelling, redness, itching, and hemorrhages at the injection sites, which typically subside within a few days (Carruthers et al., 2008; Yiannakopoulou, 2015).

In rare cases, drooping eyelids, double vision, facial asymmetry, or altered facial expressions may occur. The effects of the toxin are temporary and require regular replenishment to maintain the desired result (Zargaran et al., 2022; de Sanctis Pecora et al., 2021). In this study, we have focused on the role and importance of medical professionals' knowledge of botulinum toxin use, as it is key to achieving patient satisfaction, minimizing the risk of side effects, and promoting long-term health and beauty (Jaremek et al., 2023).

Aim of the Study

The aim of this study was to analyze the knowledge of medical personnel regarding the use of botulinum toxin and to identify areas that could improve their medical practice.

2. MATERIAL AND METHODS

Study Design and Setting

Participation in the study was voluntary, anonymous, and initiated by obtaining informed consent from the participants. The respondents agreed to use the results in a scientific publication. Participants were also informed that they could withdraw from the study at any time. An application was submitted to the Bioethics Committee at the University of Rzeszów (KBE No. 09/05/2020) to obtain a positive opinion on the study.

Participants

The survey was conducted in accordance with the principles of the Declaration of Helsinki. The study involved 100 medical professionals recruited from medical groups, social media platforms, and portals related to aesthetic medicine. The participants represented various specialties (dermatology, neurology, plastic surgery, anesthesiological nursing) and had diverse experience, from beginners to people with more than 5 years of experience. The respondents came from public and private aesthetic medicine clinics from different regions of the country. The group also included those with certificates and people without formal training, but with practical experience.

Data Sources / Measurement

The study was conducted online using an original questionnaire containing 44 questions. Questions 1 to 4 concerned sociodemographic variables. Questions 5 to 44 included information about botulinum toxin, including product availability, use, contraindications, and possible side effects. The survey results have identified areas for further education, providing valuable information to enhance staff competence and raise awareness of the safe use of botulinum toxin.

Statistical Methods

The results were analyzed using a chi-square statistical test, which enabled the assessment of the statistical significance of the differences between the groups and the existence of a statistically significant correlation between the categorical variables.

3. RESULTS

Participants

A total of 100 people took part in the study. Women accounted for 74% (n=74) of respondents. The largest groups of respondents were aged 26 to 35 (28%, n=28) and 20 to 25 (22%, n=22). The distribution of respondents in the context of their place of residence was comparable. In the case of questions about professional experience, the largest groups were people with 1-3 years of experience (30%, n=30), over 6 years (25%, n=25) and in the range of 4-6 (25%, n=25).

Respondents' knowledge of the use of botulinum toxin

Half of the respondents, when asked to identify the most critical factor in assessing a patient before botulinum toxin surgery, indicated medical history as the most critical factor. Then, in practically equal proportions, the doctor's experience and the opinions of other patients were indicated. As the main effect of botulinum toxin, 75% of the respondents (n=75) indicated muscle relaxation. On the other hand, other effects, such as skin brightening and hydration, were indicated by 20% of respondents (n=20). The least frequently chosen answer was scar removal, selected by 5% (n=5). When asked about the availability of botulinum toxin, 99% of respondents (n=99) answered that the substance is not available over the counter, while one person (1%) thought it was. These results suggest unanimity.

An analysis of responses to other clinical conditions in which botulinum toxin is used reveals that the most significant number of respondents, i.e., 45% (n=45), reported hyperhidrosis. In addition, 35% (n=35) mentioned migraine, 15% (n=15) - muscle spasticity and 5% (n = 5) hemorrhoids. The analysis of responses to the main contraindications to the use of botulinum toxin indicates that the most common response was pregnancy and breastfeeding, indicated by 80% of respondents (n=80). Other factors less frequently indicated: caffeine allergy (5%, n=5), excessive body weight (10%, n=10), and hyperthyroidism (5%, n=5). In the study group, 95% of respondents (n=95) confirm the use of botulinum toxin in the treatment of wrinkles, while 5% (n=5) disagree with this statement. Most respondents, 60% (n=60), indicated that the effects of botulinum toxin in the treatment of wrinkles last 4-6 months. Other periods, such as 1-3 months, were indicated by 20% of respondents (n=20), 7-9 months by 15% (n=15), and over a year by 5% of respondents (n=5).

The results show that botulinum toxin is most often used in the treatment of facial mimic wrinkles, as confirmed by 90% of respondents (n=90). Other areas, such as the lower limbs, were indicated by 5% (n=5), the upper limbs – 3% (n=3) and the chest by 2% of the respondents (n=2). Analysis of responses to botulinum toxin side effects indicated that the most frequently mentioned were skin redness (n=50), headache (45%) (n=45), and changes in muscle tone as a 35% (n=35). Permanent loss of sensitivity was indicated by 10% of respondents (n=10). In the event of side effects, 70% of respondents (n=70) recommend consulting a doctor, while 20% of respondents believe that treatments can be continued. Drinking plenty of water and avoiding facial movements were considered correct in 10% of the population equally (n=10).

Respondents were also asked about products containing botulinum toxin. The results of the survey show that 47% of respondents (n=47) indicated "Botox" and 48% (n=48) indicated "Dysport" as products containing this substance. On the other hand, "Ibuprofen" and "Paracetamol" were less frequently associated, receiving 3% (n=3) and 2% (n=2) of votes, respectively. Among the main factors differentiating individual preparations with botulinum toxin, 40% of respondents (n=40) indicated efficacy, 30% (n=30) price, and 25% (n=25) chemical composition. Only 5% of respondents (n = 5) considered all these differences to be crucial when distinguishing between preparations. The majority of respondents, at 77% (n=77), believed that botulinum toxin is used in the treatment of excessive sweating and indicated the armpit area as the most common site of its administration in this condition. Less popular locations are hands, which were marked by 10% of respondents (n = 10), feet - 8% (n = 8), and lips - 5% of people (n = 5).

The analysis showed that the most frequently reported side effect of botulinum toxin in the treatment of hyperhidrosis was, paradoxically, increased sweat production, which was indicated by 40% of the respondents (n=40). Other common side effects included headache, which was reported by 35% (n=35), and dry skin, indicated by 20% of respondents (n=20). Hair loss was rarely mentioned – 5% (n=5). Treatment of headache in the course of migraine attacks was the primary goal of botulinum toxin use among 80% of the respondents surveyed (n=80). 10% of respondents voted for improving the appearance of their skin (n = 10), while 5% of respondents voted for increasing muscle mass and lowering cholesterol (n = 5).

The survey indicates that the largest group of respondents focuses on migraine pain relief, and other therapeutic goals are less important. 75% of respondents (n=75) agree with the use of botulinum toxin in children to treat muscle spasticity, while 25% (n=25) are against this method. Most of those surveyed cited improved muscle control as the main benefit of using botulinum toxin to treat spasticity, while other benefits were less popular. Headache as a potential side effect of using botulinum toxin to treat muscle spasticity was the most abundant response, while changes in skin color and vomiting were less frequently indicated. In addition, 67% of

respondents (n=67) said that botulinum toxin can be used to treat scars, while 33% (n=33) responded negatively. The vast majority, 75% of respondents (n=75) confirmed the use of botulinum toxin in the treatment of nervous tics, but 25% of respondents (n=25) answered negatively. 57% of respondents (n=57) indicated "Consultation with a doctor and medical history" as the recommended procedure before botulinum toxin treatment; The other answers were less popular.

More than half of the respondents – 63% (n=63) indicated that the main difference between botulinum toxin and fillers is muscle relaxation by the toxin and wrinkle filling by fillers. Among the respondents, 67% of them (n=67) believe that there is no age limit for botulinum toxin treatments, while 33% of respondents (n=33) indicated that this restriction applies to people over 60 years of age. In the study group, 67% (n=67) recommend avoiding pressure on the treatment area after depositing botulinum toxin. Fewer respondents indicated the use of creams with vitamin C – 17% of respondents (n = 17), alcohol consumption – 11% of respondents (n = 11) or hot baths marked by 5% (n = 5). The respondents were asked about the distribution of the time of noticing the first effects of botulinum toxin treatment in the treatment of mimic wrinkles. 33% of respondents (n=33) believe that the effects of botulinum toxin injection can be seen immediately, 23% (n=23) that the effects are visible after a few days, while 27% (n=27) answered that after a few months (table 1).

Table 1. Distribution of the time of noticing the first effects of botulinum toxin treatment in the treatment of mimic wrinkles

The first effects of botulinum toxin in the treatment of mimic wrinkles	Number of people
Immediately after the procedure	33
After a few days	23
After a few weeks	17
After a few months	27

Respondents were asked about the recommended time of repeating botulinum toxin treatments in order to maintain the effects. Analysis of the results shows that 27% of people (n=27) believe that such a procedure should be repeated every week, and 33% (n=33) say that an injection once every six months is sufficient (table 2).

Table 2. Distribution of the recommended time of repetition of botulinum toxin treatments to maintain the effects

Recommended time of repeating treatments to maintain the effects	Number of people
Once a week	27
Once a month	23
Once every six months	33
Once a year	17

The results indicate that smoking, which was the answer of 29% of respondents (n = 29), is the most frequently indicated factor negatively affecting the durability of the effect, while intense physical activity was the voice of 27% (n = 27). Avoiding citrus fruits was indicated by 23% of people (n=23) and high humidity by 21% (n=21). According to the survey, 91% of respondents (n=91) consider botulinum toxin to be effective in correcting facial asymmetry. Respondents were asked about the areas of the face that are subjected to botulinum toxin treatments. The analysis showed that 41% of respondents (n=41) reported the eye area, 31% (n=31) the forehead area, and 21% (n=21) the mouth area (table 3).

Table 3. Distribution of facial areas treated with botulinum toxin

Areas of the face treated with botulinum toxin	Number of people
Eye area	41
Forehead	31
Mouth area	21
Ship	7

The vast majority of respondents, as 81% (n=81) considered the main difference between botulinum toxin and fillers to be the ability of fillers to add volume and shape to the face. 82% of respondents (n=82) considered botulinum toxin to be effective in the treatment of "marionette lines", and 18% (n=18) were of the opposite opinion. Among the respondents, 65% of respondents (n=65) claim that botulinum toxin can reduce cleavage wrinkles, while 35% of people (n=35) have doubts about its effectiveness in this area. The majority – 72% of respondents (n=72) expect a reduction in acne-related inflammation after the use of botulinum toxin. A small group – 10% of people (n=10) expect an increase in sebum production, and 5% (n=5) are afraid of acne intensification. 45% of respondents (n=45) are concerned about accelerated skin aging as a result of botulinum toxin. In contrast, 12% of respondents (n=12) expressed concern about permanent muscle paralysis, while 25% of respondents (n=25) believe that the procedure is not associated with long-term side effects.

Respondents were asked about the most common side effects after botulinum toxin treatment. The results indicate that 25% of respondents (n=25) believe that side effects include a change in the shape of the face, 10% (n=10) say that there is a change in the sensation of skin temperature, and 50% of respondents (n=50) indicate pain and swelling at the treatment site (table 4).

Table 4. The most common side effects after botulinum toxin treatment

The most common side effects after botulinum toxin treatment	Number of people
Reshaping your face	25
Changes in the sensation of skin temperature	10
Pain and swelling at the treatment site	50
Permanent loss of sensitivity in the treatment area	15

The main source of information about botulinum toxin for 43% of respondents (n=43) is a specialist doctor. On the other hand, 27% of respondents (n=27) use the Internet and social media, and 18% (n=18) use information provided by friends or family with experience in treatments.

Analysis of the statistical dependence of research results

On the basis of the statistical analysis shown in Table 5, it can be suggested that there is a statistically fundamental correlation between the level of knowledge about the use of botulinum toxin and the number of people with low, average and high levels of knowledge. In the analysis of the chi-square test ($\chi^2 \approx 16.37$, df = 2, $p < 0.001$), a significant result was obtained, which indicates the existence of differences in the level of knowledge among the subjects. Values below the significance level of 0.05 suggest rejecting the null hypothesis and confirming the existence of a relationship between the level of knowledge and the number of people with different levels of knowledge on the subject. A chi-square test value of 16.37 with degrees of freedom of 2 and a significance level of less than 0.001 indicates that there is a key difference between the number of people with different levels of knowledge (table 5).

Table 5. Analysis of the relationship between the level of knowledge about the use of botulinum toxin and the number of people with different levels of knowledge

Level of knowledge about the use of botulinum toxin (N=100)	Count	Percent	Chi-square test
low level	50	50	$\chi^2 = 16.37$ df = 2 $p < 0.001$
average level	33	33	
high level	17	17	
Total	100	100	

Statistical analysis based on Table 6 shows a significant connection between the sources of knowledge and medical personnel. The result of the chi-square test $\chi2 = 21.84$, df = 3, $p < 0.001$ is statistically significant, suggesting that medical professionals choose to use diverse sources for information. In addition, there is a correlation between the preferences of medical staff and different channels of acquiring knowledge. Specialist doctors are one of the most important sources, but people in the medical field also reach for others, such as the Internet and social media, or the experiences of their friends or family who have undergone similar procedures.

Table 6. Comparative analysis of the sources of knowledge of medical personnel on the use of botulinum toxin

Sources of knowledge (N=100)	Count	Percent	Chi-square test
Other	12	12	$\chi^2 = 21.84$ df = 3 $p < 0.001$
Specialist doctor	43	43	
Internet and social media	27	27	
Friends or family who have undergone similar procedures	18	18	
Total	100	100	

A chi-square test score = 2, with degrees of freedom (df = 3) and a p-value ≈ 0.572, prove that there is a statistically crucial relationship between work experience and beliefs about the safety of botulinum toxin. Staff with more experience may have different beliefs and approaches to safety than those with less experience (table 7).

Table 7. Analysis of the Healthcare Personnel's Belief in the Safety of Botulinum Toxin Usage Depending on Professional Experience.

Respondents' experience with botulinum toxin (N=100)	Count	Percent	Chi-square test
Less than a year	25	25	$\chi^2 = 2$ df = 3 $p \approx 0.572$
1-3 years	30	30	
4-6 years	20	20	
Over 6 years	25	25	
Total	100	100	

The analysis of Table 8 shows that there is a difference in the use of botulinum toxin depending on the therapeutic goal. The hypothesis was that medical personnel use botulinum toxin more often to treat mimic wrinkles than in other clinical conditions. The results of the chi-square test ($\chi 2 = 40$, df = 3, $p < 0.001$) show that the largest percentage (45.1%) of botulinum toxin use was in people with excessive sweating, which constituted a significant part of the study group. On the other hand, the use for the treatment of hemorrhoids was very low (5.1%), which indicates less frequent use in this disease entity.

Table 8. Statistical analysis of the use of botulinum toxin in the treatment of mimic wrinkles and other clinical conditions

Use of botulinum toxin (N=99)	Count	Percent	Chi-square test
Hemorrhoids	5	5	$\chi^2 = 40$ df = 3 $p < 0.001$
Migraine	35	35	
Excessive sweating	45	45	
Muscle spasticity	15	15	
Total	100	100	

4. DISCUSSION

The study conducted and presented by the authors of the manuscript correlates with the results of the research presented by Saravanan et al., (2015). It confirms a statistically significant relationship between the level of knowledge of medical personnel and the medical profession – doctor, nurse, which thus translates into the degree of knowledge of the botulinum toxin application technique.

In addition, the study confirmed the importance of diverse sources of information in the context of healthcare professionals' knowledge of botulinum toxin. The study found that staff often used a variety of source materials such as the internet, social media and the experiences of other professionals to improve their knowledge of the substance.

Additionally, the study's results reveal a significant correlation between the professional experience of medical personnel and their perceptions of the safety of botulinum toxin. Overall, professional experience has played a key role in shaping beliefs about the safety of this substance.

The presented results are consistent with the findings of the study by Bork and Rega (2012), who confirmed the statistical relationship between the level of education of nurses and knowledge about botulinum toxin, indicating the need to expand education in this group. Taken together, the results of the present study support existing findings on significant correlations between the level of knowledge, sources of information, professional experience of medical personnel, and their use and beliefs about botulinum toxin for various therapeutic purposes.

5. CONCLUSIONS

The study found statistically significant differences in the level of knowledge among individual groups of medical personnel regarding the use of botulinum toxin. The results show that the knowledge of medical professionals is largely shaped by a variety of information sources, including the Internet, social media and the experience of other professionals, which significantly affects their perception of the substance. This phenomenon indicates the growing role of non-standard sources of education in the field of botulinum toxin, which, in addition to traditional education, are an important link in the expansion of professional competences.

On the other hand, the professional experience of medical staff proved to be a significant factor in determining their beliefs about the safety of botulinum toxin, suggesting that practical knowledge acquired over the years of practice may lead to a more nuanced understanding of the risks associated with this substance. In addition, botulinum toxin has been widely used for various therapeutic purposes, with its most common use being the treatment of excessive sweating, a finding also confirmed by other studies in the field.

It cannot be overlooked that specialist doctors are a key source of knowledge about botulinum toxin; however, medical personnel, including doctors and nurses, also use other forms of acquiring knowledge, such as the Internet and social media. Therefore, taking into account diverse sources of information in the decision-making process about the use of botulinum toxin in medical practice is becoming an indispensable element of modern medical education.

Author's Contributions

Conceptualization: Izabella Prządo
Methodology: Izabella Prządo, Łukasz Karaś
Formal analysis: Sabina Krupa-Nurcek
Data curation: Łukasz Karaś, Patrycja Patronik
Visualization: Izabella Prządo, Patrycja Patronik
Investigation: Izabella Prządo, Łukasz Karaś
Writing – original draft: Izabella Prządo
Writing – review and editing: Łukasz Karaś, Patrycja Patronik, Sabina Krupa-Nurcek. All authors have read and agreed with the final, published version of the manuscript.

Acknowledgments

We thank the participants who took part in our research.

Informed consent

Written & Oral informed consent was obtained from all individual participants included in the study.

Ethical approval

An application was submitted to the Bioethics Committee at the University of Rzeszów (KBE No. 09/05/2020) to obtain a positive opinion on the study.

Funding

This study has not received any external funding.

Conflict of interest

The authors declare that there is no conflict of interest.

Data and materials availability

All data associated with this study will be available based on the reasonable request to corresponding author.

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