

Duration of smoking cessation for the prevention of surgical wound healing complications

TEMPO DE CESSAÇÃO DO TABAGISMO PARA A PREVENÇÃO DE COMPLICAÇÕES NA CICATRIZAÇÃO DE FERIDAS CIRÚRGICAS

TIEMPO DE CESE DE TABACO PARA LA PREVENCIÓN DE COMPLICACIONES EN LA CICATRIZACION DE HERIDAS QUIRURGICA

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ABSTRACT

The study aimed to find scientific evidence about the duration of preoperative smoking cessation required to reduce surgical wound healing complications. An integrative review was performed in the databases, Latin American and Caribbean Literature on Health Sciences (LILACS) and Medical Literature Analysis and Retrieval System Online (MEDLINE), from 08/17/2012 to 09/17/2012, using the keywords: tobacco use cessation and wound healing; tobacco use cessation and preoperative period; tobacco use cessation and perioperative period (LILACS) and tobacco use cessation and perioperative period; tobacco use cessation and wound healing (MEDLINE). Out of the 81 eligible studies, 12 were included. The duration of smoking cessation needed to reduce healing complications was at least four weeks (four studies with level of evidence I, three studies with level of evidence II, two studies with level of evidence IV, and one study with level of evidence VII).

DESCRIPTORS

Tobacco use cessation
Wound healing
Postoperative complications
Nursing
Review

RESUMO

O estudo objetivou buscar evidências científicas sobre o tempo requerido para interrupção do tabagismo no pré-operatório para a redução de complicações na cicatrização da ferida cirúrgica. Revisão integrativa realizada nas bases Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS) e *Medical Literature Analysis and Retrieval System on-line* (MEDLINE) no período de 17/08/2012 a 17/09/2012, utilizando os descritores: abandono do uso de tabaco e cicatrização de feridas; abandono do uso de tabaco e período pré-operatório; abandono do uso de tabaco e período perioperatório (LILACS) e *tobacco use cessation e perioperative period*; *tobacco use cessation e wound healing* (MEDLINE). Dos 81 estudos elegíveis, 12 foram incluídos. O tempo de cessação do tabagismo necessário para redução de complicações de cicatrização é de no mínimo quatro semanas (quatro estudos com nível de evidência I; três estudos nível de evidência II; dois estudos nível de evidência IV; um estudo nível de evidência VII).

DESCRITORES

Abandono do uso de tabaco
Cicatrização de feridas
Complicações pós-operatórias
enfermagem
Revisão

RESUMEN

El estudio tuvo como objetivo reunir evidencia científica sobre el tiempo necesario para dejar de fumar antes de la cirugía, para reducir las complicaciones en la cicatrización de la herida quirúrgica. Se realizó una revisión integradora en las bases de datos de América Latina y del Caribe (LILACS) y en MEDLINE durante el período comprendido entre el 17/08/2012 al 17/09/2012, utilizando los descriptores: cese del uso de tabaco y cicatrización de heridas, cese del uso de tabaco y período preoperatorio, cese del uso de tabaco y período perioperatorio en LILACS y *tobacco use cessation e perioperative period*; *tobacco use cessation e wound healing* en MEDLINE. De los 81 estudios elegibles, 12 fueron incluidos. El tiempo necesario para dejar de fumar para reducir las complicaciones de curación es de al menos cuatro semanas (cuatro estudios con nivel de evidencia I, tres estudios de evidencia de nivel II, dos estudios de evidencia de nivel IV, un estudio de nivel de evidencia VII).

DESCRIPTORES

Cese del uso de tabaco
Cicatrización de heridas
Complicaciones postoperatorias
Enfermería
Revisión

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INTRODUCTION

Smoking is considered the leading cause of potentially preventable deaths worldwide by the World Health Organization (WHO). It is estimated that currently there are approximately one billion, 200 million smokers worldwide, of whom 690 million are addicted to nicotine. Tobacco-related deaths have reached six million deaths per year and, among them, more than five million are users and ex-users. In addition, over 600 thousand people are directly exposed to secondhand smoke⁽¹⁾. Half of current tobacco users will die as a result of problems related to it: chronic obstructive pulmonary disease (85%), cardiovascular disease (45%), cerebrovascular disease (25%), and cancer (30%), as well as almost 100% of those with lung cancer⁽²⁾.

It is impossible to measure the impact caused by tobacco use on the health of the world's population. Currently smoking is levied on one of the lesser age ranges of experimentation among adolescents and young people, preceded only by alcohol⁽³⁾. If the current pattern of consumption is maintained, statistical projections for 2030 predict the emergence of 400 million new cases of smokers and one in every six million deaths each year⁽⁴⁾.

Chronic exposure to cigarette smoke causes physiologic changes that may modify responses to interventions and contribute to increased postoperative morbidity, consequently increasing the risk of respiratory, cardiovascular and wound healing complications⁽⁴⁻⁶⁾. The literature indicates that smoking cessation may be beneficial to reduce these complications⁽⁵⁻⁶⁾.

Tobacco cessation has been suggested to reduce the risk of postoperative complications in surgical wound healing⁽⁶⁻⁷⁾. There are clinical studies that clarify the relationship between the components of cigarettes and wound healing⁽⁸⁻¹⁰⁾. Some mention the duration of smoking cessation required to avoid postoperative complications^(7,11). However, the optimal duration of preoperative smoking cessation to reduce surgical wound complications is not well established.

Therefore, the objective of this study was to seek scientific evidence in the literature about the duration of preoperative smoking cessation required to reduce surgical wound healing complications.

METHOD

This is an integrative literature review, which considered the following steps: identification of the research question, literature search, categorization and assessment of studies, interpretation of results, and synthesis of knowledge⁽¹²⁾. The guiding question of this review was: *What is the period of preoperative smoking cessation required to reduce surgical wound healing complications?*

Two databases were used: Latin American and Caribbean Literature on Health Sciences (LILACS) and Medical Literature Analysis and Retrieval System Online (MEDLINE), accessed through PubMed System.

The inclusion criteria established for this review were: studies involving human beings 18 years old or older and articles published in Portuguese, English and Spanish. Data collection was performed from 08/17/2012 to 09/17/2012, and no limits on the time of publication were set.

The controlled descriptors of the Regional Library of Medicine (BIREME), Descriptors in Health Sciences (DECS) and the National Library of Medicine (NLM) Medical Subjects Headings (MeSH) were used for the search. In the LILACS database, the following combinations of descriptors were used: 1) *tobacco use cessation and wound healing*; 2) *tobacco use cessation and preoperative period*; 3) *tobacco use cessation and perioperative period, but no studies were identified*. In MEDLINE, the following descriptors were used: 1) *tobacco use cessation and perioperative period*; 2) *tobacco use cessation and wound healing*.

After reading the abstracts and applying the inclusion and exclusion criteria, 12 studies were selected in the MEDLINE database; 18 were excluded because they were in languages other than those selected for this study and 51 did not address the duration of smoking cessation in order to avoid healing complications (Figure 1).

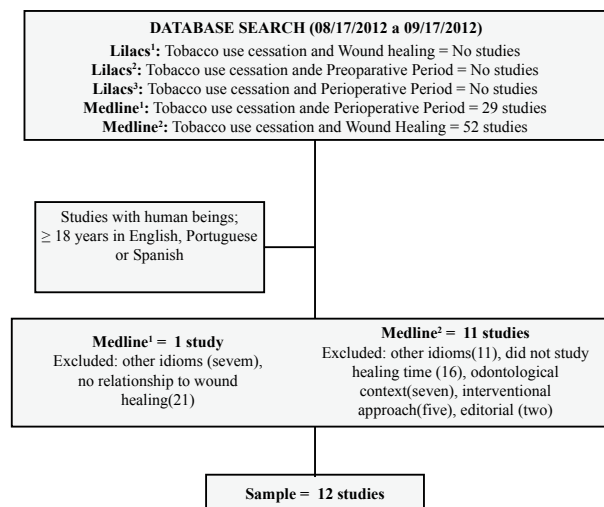


Figure 1 - Flowchart of article identification, exclusion and selection

For extraction of data from the articles included, a previously validated data collection instrument⁽¹³⁾, organized in five items, was used: 1) study identification data (publication title, journal title, indexed database, authors, country, idiom, year of publication, institution hosting the study and publication type); 2) introduction and objective (description and critical assessment); 3) methodological characteristics (analysis of study design, sample, data collection

technique and data analysis); 4) results (description and critical analysis of the results); 5) conclusions (description and critical analysis of data and level of evidence of the study).

Once the research designs were analyzed, the studies were categorized as experimental, quasi-experimental and non-experimental studies⁽¹⁴⁾. The level of evidence was classified according to the literature⁽¹⁵⁾: I. Evidence from systematic review or meta-analysis of all relevant randomized controlled trials, or from clinical guidelines based on systematic reviews of randomized controlled clinical trials; II. Evidence obtained from at least one well-designed randomized controlled clinical trial; III. Evidence obtained from well-designed non-randomized clinical trials; IV. Evidence obtained from well-designed cohort and case-control studies; V. Evidence obtained from systematic review of descriptive and qualitative studies; VI. Evidence obtained from a single descriptive or qualitative study; VII. Evidence obtained from opinion of authorities and/or report from a committee of experts.

RESULTS

Of the 12 articles assessed, three were published in 2012, two in 2010, two in 2006, two in 2005, one in 2011, one in 2009 and one in 2003. All articles were published in the international literature and in the MEDLINE database.

Regarding journals, four studies were published in surgery journals (*Annals of Surgery*, *Archives of Surgery and Surgery*), three anesthesia journals (*Canadian Journal of Anaesthesia and Anaesthesiology*), two in general medical area (The American Journal of Medicine and *Annals of Plastic Surgery*), one in a journal about wound healing (*Wound Repair and Regeneration*), one in the area of otorhinolaryngology (*Archives of Otolaryngology Head & Neck Surgery*) and one in the area of and gynecology and obstetrics (*American Journal of Obstetrics and Gynecology*).

Regarding the research design, the following studies were identified: one meta-analysis, three systematic reviews, three experimental, three non-experimental and two narrative reviews of the literature. Most were not classified with a strong level of evidence: there were four studies with level of evidence I, three with level of evidence II, three with level of evidence IV, and two with level of evidence VII.

Ten studies showed that smoking cessation for a minimum period of four weeks is beneficial in reducing complications of surgical wound healing, four studies classified as level of evidence I (three meta-analyses and one systematic review) (Chart 1), three with level of evidence II (experimental studies) (Chart 2), two with level of evidence IV (non-experimental studies) and one with level of evidence VII (narrative literature review) (Chart 3).

Chart 1 -Meta-analyses and systematic reviews that studied the period of smoking cessation required to reduce surgical wound healing complications (level of evidence I)

REFERENCE	METHOD	RESULTS and CONCLUSIONS
Sorensen (2012) ⁽⁹⁾	Systematic review performed in PubMed and EMBASE databases. Studies analyzed: 178	Smoking cessation restored tissue oxygenation and metabolism; Within four weeks, the cellular inflammatory response was partly reversed, whereas the proliferative response remained impaired; Nicotine did not affect the tissue, but appeared to impair inflammation and stimulate proliferation.
Wong et al., (2012) ⁽⁷⁾	Systematic review and meta-analysis performed in MEDLINE, EMBASE and Cochrane databases Studies analyzed: 25	Risk of developing surgical wound healing complications was two times higher in smokers than in nonsmokers (RR: 2.08, 95%CI: 1.60 to 2.71, p<0.00001); Risk of surgical wound healing complications was lower in smokers who stopped smoking for more than four weeks compared to smokers (RR: 0.69, 95% CI: 0.56 to 0.84).
Sorensen (2012) ⁽⁸⁾	Systematic review and meta-analysis performed in CENTRAL, MEDLINE and EMBASE databases Individuals abstaining from cigarettes for 4 weeks before surgery were considered ex-smokers. Studies analyzed: 140 Patients evaluated: 479,150	Higher incidence of surgical wound complications in smokers than in nonsmokers (OR: 2.06, 95% CI: 1.60 to 2.65); Higher incidence of necrosis, wound dehiscence, and surgical site infection in smokers than in nonsmokers (OR: 3.61, 95% CI: 2.78 to 4.68 and OR: 2.86, 95% CI: 1.49 to 5.49 and OR: 2.12, 95% CI: 1.56 to 2.88, respectively); Smoking abstinence for at least four weeks significantly reduced surgical site infection and hence surgical wound healing
Mills et al., (2011) ⁽¹¹⁾	Systematic review and meta-analysis performed in the following databases: Amed, Embase, Central, CINAHL, Cochrane, Development and Reproductive Toxicology, Hazardous Substances Databank, Medline, PsycINFO, TOXNET, and Web of Science Studies analyzed: 21.	Reduction of complications in surgical wound healing among nonsmokers compared to smokers (RR: 0.73, 95% CI: 0.61 to 0.87, p = 0.0006); Smoking cessation for a short period (less than four weeks) compared with a period longer than four weeks resulted in 20% reduction in the relative risk of total complications (RR: 0.80, 95%CI: 3-3, p = 0.02); Each additional week of smoking cessation generated a significant impact on postoperative complications.

Chart 2 - Experimental studies that approached the period of smoking cessation required to reduce surgical wound healing complications (level of evidence II).

REFERENCE	METHOD	RESULTS and CONCLUSIONS
Sorensen et al., (2010) ⁽¹⁶⁾	48 smokers randomized into groups: G1: smoking; G2: smoking abstinence and use of transdermal nicotine patch; G3: smoking abstinence and placebo. Nonsmokers also participated in the study (n=30). Surgical wound assessments were made at 1 st , 4 th , 8 th and 12 th weeks of follow-up.	Vitamin C was lower in smokers than in those who were never smokers (average of 54.13 and 110.6, respectively, p<0.01); After smoking cessation, there were increased levels of vitamin C ($\beta = 2.23 \pm 0.86$, p=0.01); Four-week cigarette abstinence was needed to restore the levels of vitamin C and collagen in the body, improving the inflammatory cell response.
Sorensen et al., (2010) ⁽¹⁷⁾	78 patients were divided into two groups: smokers (n=48) and nonsmokers (n=30). Smokers were randomized into three groups: 1: smoking; 2: smoking abstinence and use of transdermal nicotine patch; 3: smoking abstinence and placebo. Biopsy was performed in all patients and histopathological measurements were made in the 1 st , 4 th , 8 th and 12 th weeks.	Macrophages and fibroblasts were reduced in smokers (0.28 [0.14 to 0.58] [OR, 95% CI], p=0.01 and 0.37 [0.19 to 0.70] p<0.01) when compared to nonsmokers; There was a significant increase in vitamin C after smoking cessation ($\beta = 2.23 \pm 0.86$, P=0.01); Smoking abstinence reduced inflammation and the surgical site infection, but did not affect proliferation; The inflammatory phase of wound healing was slower in smokers and could be reversed within four weeks of smoking abstinence.
Sorensen et al. (2003) ⁽¹⁸⁾	The study included 48 smokers and 30 nonsmokers. In the first week, smokers used 20 cigarettes per day. In the second week, they were randomized into three groups: G1: smoking; G2: smoking abstinence and use of transdermal nicotine; G3: smoking abstinence and placebo. Four 5-mm incisions were made in the sacral region and then evaluated in the 4 th , 8 th and 12 th weeks	The incidence of wound infection was 12% in smokers and 2% in nonsmokers (p<0.05); After four weeks, infection was lower in the group of abstinent smokers when compared to the group of continuous smokers; Wound dehiscence occurred in 12% of smokers and none of the nonsmokers (p<0.05); Four weeks of smoking abstinence reduced wound infections at a similar level to that of nonsmokers.

Chart 3 - Non-experimental studies and narrative reviews of the literature that approached the time necessary for smoking cessation to reduce surgical wound healing complications (levels of evidence IV and VII).

REFERENCE	OBJECTIVE	METHOD	RESULTS and CONCLUSIONS
Wein (2009) ⁽¹⁹⁾	To explore the duration of smoking cessation before surgery to reduce postoperative complications in head and neck surgery.	Narrative review of the literature. The author did not mention the databases or the descriptors used.	Smoking cessation for the prevention of pulmonary complications must occur four to eight weeks before surgery and, for wound healing benefits, more than four weeks.
Chan et al., (2006) ⁽¹⁰⁾	To determine whether there was a significant relationship between cigarette smoking and surgical wound healing complications.	Non-experimental study that evaluated records of patients undergoing breast reduction (65 smokers and 104 nonsmokers). Smokers were divided into three groups: A) quit smoking >4 weeks (n=15); B) quit smoking < 4 weeks (n=19); C) continued smoking (n=31).	42% of patients had some healing complication; Smokers had 1.6 times higher chance of developing healing problems than nonsmokers (P<0.05); Group C showed a higher complication rate (67.7%) compared to groups A (33.3%) and B (52.6%); Preoperative smoking cessation should be stimulated for a period of four weeks or longer.
Warner (2006) ⁽⁶⁾	To update the knowledge about how the period of smoking cessation affects the perioperative risk.	Narrative review of the literature. The author does not mention the databases and the descriptors used.	The duration of preoperative smoking cessation to avoid or reduce healing complications remains unknown.

Continued...

REFERENCE	OBJECTIVE	METHOD	RESULTS and CONCLUSIONS
Kuri et al., (2005) ⁽⁶⁾	To assess the preoperative duration of smoking cessation to reduce the incidence of healing complications in patients who underwent reconstructive surgery of head neck.	Non-experimental study. 188 patients were divided into five groups: G1: smokers (n=28); G2: ex-smokers (smoked 8-21 days ago - n=34); G3: ex-smokers (smoked 22-42 days ago - N= 0); G4: ex-smokers for more than 43 days - n=66); G5: nonsmokers (n= 40).	Incidence of healing complications was lower in the groups of ex-smokers (G3: 55%, G4: 59.1%) and nonsmokers (G5: 47.5%) compared to the group of smokers (G1-85, 7%) (p <0.05, 95% CI); Significant correlation found between smoking reduction and degree of healing complications (Spearman - 0.233, p = 0.001); Smoking cessation for less than three weeks before surgery was a risk factor for healing complications.
Moore et al., (2005) ⁽²⁰⁾	To determine whether perioperative smoking cessation reduced postoperative complications of urogynecology surgery.	Non-experimental study. G1: 233 smokers who participated in a smoking cessation program (one month before and one month after the surgery), G2: 654 nonsmokers.	No statistically significant difference in the complication of surgical wound healing (G1: 12/61, 19.6% and G2: 34/172, 19.7%, chi-square p=0.75); Smoking cessation for one month before surgery reduced healing complications in urogynecology surgery.

One study concluded that smoking cessation for a period of less than three weeks was a risk factor for complications of surgical wound healing (level of evidence VII, narrative review) and another showed that the duration of preoperative smoking abstinence to prevent or reduce healing complications remains unknown (level of evidence IV, non-experimental study) (Chart 3).

DISCUSSÃO

Smoking is the most important risk factor for the development of postoperative complications and for the need for a postoperative intensive care unit⁽¹⁹⁾. Several studies have confirmed the impact of smoking on the development of postoperative wound healing complications, in addition to the fact that the incidence of these complications is significantly higher in smokers than in nonsmokers^(7,10-11,16,18-20).

The mechanism of wound healing involves a cascade of interconnected cellular and molecular events for the occurrence of resurfacing and tissue reconstruction. Cigarettes have vasoconstrictor substances, which may impair the patient's circulation, since it reduces the diameter of vessels, restricting blood supply, which can trigger the death of some cells. The presence of this condition may predispose the individual to be infected and therefore have his hospital discharge delayed, which leads to increased personal and institutional costs⁽²¹⁾.

Inhalation of cigarette components increases blood flow to the coronary artery, raising the heart rate, forcing an increase in myocardial work, blood pressure and the force of myocardial contractility. Nicotine, a major component of cigarettes, acts on the body by impairing the transport of oxygen by red blood cells due to the high concentration of carbon monoxide. Carbon monoxide not only binds to the red cells, reducing the oxygen-carrying ability, but it also prevents the release of oxygen by hemoglobin, in addition to inhibiting migration of fibroblasts,

which end up on the edges of the wound. Therefore, it takes longer to heal⁽⁶⁾.

Surgical tissue trauma reduces blood and oxygen supply to the tissue. Hypoxia can facilitate tissue colonization by bacteria, which multiplies the consumption of oxygen and glucose. Increased consumption of molecular oxygen may also occur, resulting in superoxide production by macrophages that migrate to the damaged tissue to phagocyte bacteria causing oxidative death of these cells. During the initial phase of healing, the level of inspired oxygen, tissue temperature, hydration and extrinsic factors, such as smoking and excessive pain, can increase tissue hypoxia and damage the mechanism of oxidative killing of bacteria, making the tissue vulnerable to infections⁽⁹⁾.

Respiration releases a series of reactive oxygen species, which are chemical compounds resulting from the reduction of molecular oxygen. Most of the reactive oxygen is derived from some of the major constituents of cigarette smoke, such as superoxide, nitric oxide, hydrogen peroxide and radical hydroxyl, which can also alter cell function and cause damage to the matrix of cellular components and tissues, directly interfering in normal wound healing and triggering proinflammatory toxins. The damaging effect of reactive oxygen species released by cigarettes on the role of systemic inflammatory cells includes an increased number of neutrophils that confer defense and immunity to the cell, higher reactivity and chemotaxis, attenuating the migration of neutrophils and monocytes, responsible for the protection of tissues and oxidative mechanisms to fight bacteria⁽⁹⁾.

In smokers, the level of antioxidants is reduced, especially vitamin C, essential for the synthesis of collagen, a key protein in the formation of the extracellular matrix of connective tissue. Collagen is synthesized in small portions intracellularly and exported out of the cell where, through the actions of polymerizing enzymes, it is molded in the structure of triple-helix collagen. Each of these three

helices of protein is almost entirely composed of glycine, proline and lysine and by two other amino acids that are modified after being placed by ribosomes: hydroxyproline and hydroxylysine. The latter two are respectively derived from proline and lysine, using enzymatic processes that are dependent on vitamin C⁽⁹⁾. Prolonged restriction of vitamin C leads to poor production of collagen, because the collagen molecules produced outside the cells are defective and recognized as damaged and destroyed, which hinders the healing process⁽⁹⁾.

Most of the analyzed studies found that smokers who abstained from smoking for more than four weeks before surgery had fewer complications regarding wound healing compared to those who continued smoking⁽⁷⁾.

Preoperative smoking cessation for four weeks or longer has several benefits to the patient, because it significantly reduces surgical site infections, delays in healing, suture dehiscence, hernias and fistulas^(6,8). Some physiological factors may be involved: inadequate blood supply to the tissue, which can lead to necrosis; decreased inflammatory response and healing damage through oxidative mechanisms^(6,8); deficiency in the proliferative phase of wound healing; and, altered collagen metabolism⁽⁸⁾.

One study found that smoking cessation two weeks before colorectal surgery did not reduce the incidence of healing complications⁽¹⁸⁾. Another study showed that three weeks of smoking cessation reduced the incidence of impaired wound healing in patients undergoing head and neck surgery, however the number of smokers in the study sample was very low⁽⁵⁾.

Four weeks after smoking cessation, endothelial progenitor cells are restored, suggesting reduction of injury and of endothelial dysfunction. Deficiency of vitamin C decreases as a function of elapsed time and cigarette abstinence, and it can be reversed within four weeks of cessation. Four week abstinence leads to an increase in positive

macrophage migration in inflammatory cells, a factor that influences the reduction of infectious complications, such as surgical site infection^(8,11).

Several studies included in this review assessed smoking in the preoperative period through patient self-report instruments, a technique that can lead smoking and nonsmoking subjects to not properly record their smoking habits. More reliable techniques to assess the use of cigarettes could have been used; for example, biological monitoring of the concentration of carbon monoxide and nicotine. In other studies, researchers have not measured the smoking habit after surgery, a situation that can lead to complications of surgical wound healing.

The present investigation is limited because it includes only articles in Portuguese, English and Spanish. There is need for further randomized controlled trials addressing other populations with representative samples to explore the theme, evidencing and improving the instruments used to assess the evolution of surgical wounds and forms of smoking measurement.

CONCLUSION

The period required for preoperative smoking cessation was at least four weeks for the restoration of oxygen levels in the tissues, decreased oxidative stress, reduction of the negative impact on the function of macrophages and increased levels of vitamin C and collagen.

This study contributes to updating knowledge about the consequences of smoking on physiological responses of surgical healing, supporting the prevention of postoperative wound healing complications. Nurses play a key role in preoperative patient education, planning and executing effective nursing interventions, and assisting patients in finding effective strategies for smoking cessation.

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