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# Nonpharmacologic Interventions For Neonatal Abstinence Syndrome: A Systematic Review Of The Literature

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**NONPHARMACOLOGIC INTERVENTIONS FOR  
NEONATAL ABSTINENCE SYNDROME: A SYSTEMATIC  
REVIEW OF THE LITERATURE**

**Honors Thesis**

**Presented in Partial Fulfillment of the Requirements  
For the Degree of Bachelor of Science in Nursing**

In the College of Health and Human Services  
at Salem State University

By

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Commonwealth Honors Program  
Salem State University  
2019

## NEONATAL ABSTINENCE SYNDROME INTERVENTIONS

**Abstract**

The incidence of Neonatal Abstinence Syndrome (NAS) is increasing due to the current opioid epidemic. The foundation of NAS treatment has been pharmacotherapy but nonpharmacologic interventions are increasingly used to alleviate symptoms, reduce the amount of pharmacotherapy needed, and decrease the hospital length of stay (LOS). A systematic review of the literature was performed to identify nonpharmacologic interventions (NPI) that effectively improve NAS treatment outcomes and to identify gaps in current knowledge about NPI.

Eight NPI were used as key words in literature searches: infant massage, parental presence, breastfeeding, Reiki, vibrotactile stimulation, acupuncture, non-nutritive sucking, and auditory stimulation. Results found nine studies that met the inclusion criteria: one study investigating the effect of infant massage, three studies on outcomes of parental presence, two studies on the effects of breastfeeding, one study on outcomes of Reiki, one study on vibrotactile stimulation, and one study on laser acupuncture. No studies assessed non-nutritive sucking or auditory stimulation interventions. NPI found to be effective in reducing NAS symptoms were infant massage (one study), parental presence (one study), and breastfeeding (one study). Decreased LOS was associated with parental presence (three studies), breast feeding (one study), and laser acupuncture (one study). Laser acupuncture also reduced the length of time the infant required medication (one study). Parental presence and breastfeeding each had one study where decreased amounts of medication were needed. Reiki and vibrotactile stimulation were not found to be effective interventions. A gap identified is the scarcity of research on the effectiveness of NPI.

*Keywords:* neonatal abstinence syndrome, nonpharmacologic interventions, breast feeding, infant massage, rooming-in, acupuncture, vibrotactile stimulation, Reiki therapy

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### **Introduction**

Neonatal abstinence syndrome (NAS) is a medical diagnosis given to newborns who were exposed to opioids in utero. After birth, these infants can show signs of opioid withdrawal that include tremors/jitteriness, crying, difficulty sleeping and eating, sneezing, yawning, fevers, loose stools, emesis, and respiratory distress (Hahn, Lengerich, Byrd, Stoltz, Hench, Byrd, & Ford, 2016). Hospital clinical guidelines for NAS treatment involve admitting opioid exposed newborns to the neonatal intensive care unit (NICU) immediately for observation and pharmaceutical treatment with oral morphine, methadone, phenobarbital, or tincture of opium if necessary (Mehta, Forbes, & Kuppala, 2013). These infants typically spend a significant amount of time in the hospital, and due to their withdrawal symptoms require hands-on care beyond medication administration.

Nonpharmacologic interventions play a significant role in the care nurses provide to NAS infants to reduce opioid withdrawal symptoms, and current literature shows some of these interventions have been associated with less severe symptoms and improved outcomes for infants with NAS. Nine recent studies exploring nonpharmacologic interventions and their potential benefits for infants with NAS will be discussed to determine which nonpharmacologic interventions have been found effective for NAS treatment. The nonpharmacologic interventions discussed in these studies include infant massage, rooming-in, laser acupuncture, breastfeeding, vibrotactile stimulation, and Reiki therapy.

NAS is a significant problem in the United States as the opioid epidemic continues. Infants requiring observation and treatment for NAS require intensive nursing care and longer hospital stays compared with non-NAS newborns, leading to higher health care costs. Learning

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how nonpharmacologic interventions can improve NAS outcomes can lead to changes in NAS care with decreased hospital length of stay and improved patient to nurse ratios.

### **Research Question**

Which nonpharmacologic interventions does the current literature identify as effective for improving outcomes for infants with NAS?

### **Methods**

The Cumulative Index of Nursing and Allied Health Literature (CINAHL) and PubMed databases were searched for research studies on nonpharmacologic interventions for NAS. The article criteria were free full-text, quantitative and qualitative studies published between 2013-2018 in the English language.

All database searches included the primary term *neonatal abstinence syndrome* and the secondary search term varied with each search. The secondary search terms included *rooming in, breast feeding, acupuncture, infant massage, skin to skin, kangaroo care, auditory, auditory comfort, comfort sounds, auditory stimulation, shusher, baby shusher, shushing, tactile input, swaddling, bouncing, swing, swinging, tactile comfort, touch, nonnutritive sucking, and pacifier*. Each search was completed on both databases. Table 1 in the appendix lists the keywords used in each search, the results of these searches, and which articles were ultimately included in the systematic review. Studies were excluded if they were literature or systematic reviews, if they were not related to NAS, or if they were not research articles.

A summary of studies table is listed on table 2 in the appendix. The summary of studies table includes information about the design, target population, sample size, location, interventions, outcome/aims, results, limitations, and nursing implications of each study. These nine articles are explored in this project to answer the research question in a systematic review.

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The goal is to determine which nonpharmacologic interventions current literature find to be effective in managing NAS.

### **Results**

Nine research studies met the criteria for inclusion in the review. These studies examined the effects of infant massage, rooming-in or parental presence, breastfeeding, laser acupuncture, vibrotactile stimulation, and Reiki therapy on NAS outcomes.

#### **Infant Massage**

A qualitative study conducted by Hahn et al., 2016, explored the effects of infant massage on the behavior of infants with NAS as well as how massage impacts the relationship between the mother and infant. The mothers were trained in infant massage and then were interviewed at two different intervals to collect data about their experience with infant massage. Of the mother-infant pairs that were studied, all of the mothers said that infant massage was a positive experience and most indicated they saw positive changes in the behavior of their infants. The researchers found that infant massage can increase mother-infant bonding and can help alleviate NAS withdrawal symptoms (Hahn et al., 2016). However, since this was a qualitative study with a small sample size (eight mother-infant pairs) the findings cannot be generalized. This study found that infant massage is beneficial and effective at reducing NAS withdrawal symptoms, however further research needs to be completed before infant massage can be considered an effective nonpharmacologic intervention for NAS (Hahn et al., 2016).

#### **Rooming-in or Parental Presence**

Three of the included studies investigated the effects of rooming-in programs or parental presence for infants diagnosed with NAS. A study conducted by Holmes, Atwood, Whalen, Beliveau, Jarvis, Matulis, and Ralston, 2016, looked at how implementing a rooming-in program



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for opioid dependent mothers and their infants with NAS could not only improve outcomes for these infants but also could lower hospital costs. The researchers started a program for infants with NAS where these infants were admitted and treated on the pediatric unit after birth, instead of in the NICU, which allowed for their mothers to room in with them (Holmes et al., 2016). Outcomes were measured by assessing the number of infants who required treatment with morphine and phenobarbital, the amount of morphine needed to treat NAS symptoms, the infant length of stay, and hospital costs for NAS treatment and care.

The researchers studied infants who were born with NAS who were otherwise healthy over a three-year period. The first year of the study was considered a baseline or pre-intervention year, the second year was intervention year 1, and the third year was intervention year 2. In the baseline (pre-intervention) year 54 infants were studied, 61 infants in intervention year 1, and 48 infants in intervention year 2. The researchers found that the number of infants requiring treatment with morphine decreased from 46% to 27%, and the number of infants requiring adjunctive treatment with phenobarbital or clonidine decreased from 13% to 2% (Holmes et al, 2016). The amount of morphine needed to treat the infants decreased from 13.7 mg (pre-intervention year) to 6.6 mg (intervention year 2). The length of stay for the infants who were receiving pharmacological therapy decreased from 16.9 to 12.3 days, and the mean hospital costs for these newborns decreased from \$19, 737 to \$8,755 (Holmes et al., 2016). The findings of this study indicate that involving the mother and family in the care of NAS infants is beneficial.

Howard, Schiff, Penwill, Si, Rai, Wolfgang, Moses, and Wachman, 2017, also studied the impact of parental presence on NAS infant outcomes. The researchers studied 86 pairs of mothers and infants over a thirteen-month period, assessing outcomes of length of stay in the hospital, length of opioid therapy, and Finnegan scores. This study suggests that parental

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presence and nonpharmacologic care through breastfeeding, skin-to-skin contact, and bonding between parent and infant is significantly associated with better outcomes for NAS infants.

Findings showed that 100% parental presence during the infant's hospitalization was associated with a shorter length of stay in the hospital (9 days shorter), shorter length of opioid therapy (8 fewer days), and lower mean Finnegan score (1 point lower) (Howard et al., 2017). This study also discusses barriers that prevent parents from being with their infants throughout the entirety of their treatment, which is a suggested area for future research (Howard et al., 2017).

The third study which focused on the effects of rooming-in on infants with NAS was conducted by Newman, Davies, Dow, Holmes, Macdonald, McKnight, and Newton, 2015, at a tertiary care hospital in Ontario, Canada. The goal of this study was to see if allowing opioid-dependent mothers to stay with their infants, and providing uninterrupted time between them with a rooming-in program, could decrease the severity of NAS. The researchers looked at 24 women and infant pairs starting thirteen months prior to the rooming-in approach being implemented. These infants were admitted to the NICU immediately after birth, which was the usual practice at this hospital. The researchers compared the outcomes of the NICU group of infants to 21 women and infant pairs studied for thirteen months after the rooming-in approach was implemented (Newman et al., 2015). The women and infant pairs participating in the study had private rooms on the pediatric unit rather than the infants being admitted to the NICU. The severity of NAS was measured by the need for pharmacotherapy and the length of hospital stays (Newman et al., 2015).

The researchers found that the infants from the rooming-in group required significantly less oral morphine therapy than those in the NICU group, only 14.3% of the rooming-in group needed pharmacotherapy, while 83.3% of the NICU group required pharmacotherapy (Newman

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et al., 2015). The researchers also found that the length of stay in the hospital for the rooming-in group was significantly shorter than the length of stay of the NICU group. The rooming-in group had a mean length of stay of 7.9 days and the NICU group had a mean length of stay of 24.9 days (Newman et al., 2015). The researchers in this study concluded that using a rooming-in approach for the management of NAS decreases the amount of medication needed to manage NAS symptoms and the hospital length of stay.

### **Breastfeeding**

The use of breastfeeding as a nonpharmacologic intervention for NAS was studied by two groups of researchers. One of these studies was conducted by Liu, Juarez, Nair, and Nanan, 2015, at two birthing units in Sydney, Australia. The researchers studied 194 pairs of methadone-maintained mothers and their infants. The infants were categorized into three groups based on how they were being fed during the first two days of life: breastfed (32 infants), expressed human breast milk fed (12 infants), and formula fed (150 infants). The onset of NAS symptoms was the measured outcome. The researchers found that infants who were predominantly breastfed for the first two days of life had a delayed onset of NAS compared to the other two groups (Liu et al., 2015). The researchers found no significant effect of feeding method on the rates of NAS requiring treatment, so although breastfeeding over the first two days of life was shown to delay the onset of NAS, it was not found to have a significant effect on whether an infant developed NAS and required treatment (Liu et al., 2015).

The researchers suggest that based on these results infants who are exposed to methadone in utero have a similar chance of developing NAS regardless of their feeding method. Infants who are breastfed may potentially have a delayed onset of NAS symptoms though, so monitoring this population for the first few days of life is important to initiate NAS treatment at an

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appropriate time. The researchers concluded that methadone-maintained women should continue to breastfeed their infants, because although breast feeding was not found to prevent the onset of NAS, it can have other positive effects (Liu et al., 2015). This study had a fairly small sample size so further research should be conducted to determine if there are additional advantages to breastfeeding for infants with NAS.

Another included study discussing the benefits of breastfeeding for infants with NAS was conducted by Mehta et al., 2013 through a survey sent to 179 medical directors and charge nurses at NICUs across the United States. This study was conducted to assess the way NAS is managed in hospitals across the United States. This survey covered many areas other than breastfeeding, however this area of the study specifically applies to nonpharmacologic interventions which is the focus of this systematic review. The researchers found that of the 179 NICUs surveyed, only 74.1% recommend breastfeeding, which means that more than 25% of providers in NICUs do not recommend breastfeeding in this population even though the current recommendation by the American Academy of Pediatrics states that mothers on methadone maintenance should breastfeed if there are no other contraindications (Mehta et al., 2013). The researchers stated that, “In addition to promoting positive early infant attachment, breastfeeding has been shown to reduce NAS scores, treatment duration and dose, and duration of hospitalization” (Mehta et al., 2013). The researchers in this survey study suggest that more hospitals should encourage mothers of infants with NAS to breastfeed since the benefits of breastfeeding with NAS have been shown and because the American Academy of Pediatrics supports mothers on methadone maintenance breastfeeding their infants.

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### **Laser Acupuncture**

The impact of laser acupuncture as a nonpharmacologic intervention for NAS was studied by Raith, Schmolzer, Resch, Reiterer, Avian, Koestenberger, and Urlesberger, 2015, at a hospital in Austria. The goal of this study was to investigate if combining pharmacological therapy with laser acupuncture reduces the length of therapy for infants with NAS in comparison to treating only with pharmacological therapy. Infants with NAS were randomly assigned to a group receiving laser acupuncture and pharmacological therapy (morphine and phenobarbital) or to a control group which only received pharmacological therapy. The laser acupuncture was performed at five ear and four body acupuncture points bilaterally daily until the morphine was discontinued. The duration of oral morphine therapy was the primary outcome the researchers measured (Raith et al., 2015).

The researchers looked at 28 infants with NAS, 14 in each group. Findings showed that the duration of oral morphine therapy was significantly shorter in the acupuncture group (28 days) than in the control group (39 days). The length of hospital stay was also significantly decreased for the acupuncture group (35 days) compared to the control group (50 days) (Raith et al., 2015). The researchers concluded that laser acupuncture therapy combined with pharmacological therapy significantly decreased the length of treatment with morphine necessary for infants with NAS. Although this study was conducted with a small sample size, the results are promising and suggest that laser acupuncture could be a beneficial addition to the management of NAS.

### **Vibrotactile Stimulation**

Vibrotactile Stimulation is another nonpharmacologic intervention which was studied by Zuzarte, Inac, Barton, Paydarfar, Bednarek, and Bloch-Salisbury, 2017, at the University of

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Massachusetts Medical Center Neonatal Intensive Care Unit and Newborn Nursery. This study was conducted to determine if stochastic vibrotactile stimulation (SVS) could reduce symptoms of NAS. The researchers specifically looked at symptoms of hyperirritability, which they measured by movement activity, and pathophysiological instabilities including heartbeat, respiration, and temperature (Zuzarte et al., 2017). The 26 infants included in the study had a gestational age of at least 37 weeks and were being pharmacologically treated for NAS. To collect their data, the researchers used a specially constructed mattress which delivered low level SVS which they alternated in 30-minute intervals between continuous vibration (ON) and no vibration (OFF) over a 6 to 8-hour period (Zuzarte et al., 2017). Movement activity, heart rate, respiratory rate, axillary temperature, and blood oxygen saturation were measured separately during the ON intervals (with continuous vibration) and OFF intervals (without vibration). This data was used to compare the effects of SVS to no stimulation, and to do this each infant served as their own control.

After conducting the study, the researchers found that the Finnegan scores were not significantly different between the day before the study, the day of the study, and the day after the study (Zuzarte et al., 2017). The researchers did find that with SVS turned on there was a significant reduction in movement (14.6%), heart rate (2.6 bpm), and respiratory rate (5.6 breaths/min). The researchers concluded that SVS reduced prolonged movement activity and improved cardiac and respiratory function in infants diagnosed with NAS (Zuzarte et al., 2017).

The limitations of this study include being a single session study with a small sample size. The researchers suggest that additional studies are necessary to further determine the effectiveness of SVS and its benefits for infants with NAS. They specifically suggested that longitudinal studies with a larger sample size would be beneficial to determine if a regimen of

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SVS could be used to reduce the amount of medication and length of hospitalization necessary to treat these infants and improve outcomes for them (Zuzarte et al., 2017).

### **Reiki Therapy**

Reiki therapy was the focus of a pilot study conducted by Radziewicz, Wright-Esber, Zupancic, Gargiulo, and Woodall, 2018. This study was conducted to determine the safety and feasibility of Reiki therapy as a potential intervention for newborns who are at risk for NAS. The researchers studied 30 newborns with a gestational age of 37 weeks or more who weighed at least 2 kilograms and were undergoing NAS symptom scoring (Radziewicz et al., 2018). The researchers and nurses who performed the Reiki therapy were certified as Reiki Masters. Each newborn participating in the study received one 30-minute Reiki therapy session in a quiet room.

During the Reiki session, each newborn had a new pulse oximeter probe applied in order to monitor their heart rate and pulse oximetry, which were measured at three points during the session: right before beginning, fifteen minutes in, and immediately following the Reiki therapy session (Radziewicz et al., 2018). Performing the Reiki therapy involved the Reiki master, "...placing their hands lightly on or above the newborns head and eyes, upper body from neck to pelvic area, arms and legs for the duration of the therapy" (Radziewicz et al., 2018). The researchers then compared the heart rate and oxygen saturation data from before, fifteen minutes in, and after the therapy sessions, as well as the infant's NAS scores from before and after the Reiki therapy session to see if there were potential effects on NAS symptoms.

The researchers found that there were statistically significant changes in the newborns' heart rates before, during, and after the Reiki therapy. They found that this decrease in the heart rate could also be clinically significant because a decrease from 138 to 130 beats per minute may be therapeutic for infants experiencing symptoms of NAS (Radziewicz et al., 2018). The

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researchers did mention that this decrease in heart rate could potentially be related to other factors besides the Reiki therapy, such as simply bringing the infants to a quiet room away from the noise of the nursery. The oxygen saturations of the newborn fluctuated slightly between the 3 points at which they were measured, however these changes were not found to be statistically significant. There was also a slight change in the mean NAS scores before and after Reiki therapy, but this was not found to be statistically significant (Radziewicz et al., 2018). These findings suggest that Reiki therapy is a safe intervention for newborns at risk for NAS, however further research needs to be done to determine how effective Reiki therapy actually is in the treatment of NAS.

This study did have some limitations including a small sample size and a pilot study design. This study was also only conducted at one location, which might impact the generalizability of the findings. The researchers concluded that additional studies with larger sample sizes are necessary to learn more about the potential benefits of Reiki therapy as an intervention for newborns at risk for NAS (Radziewicz et al., 2018).

### **Discussion**

Nine research studies identified six nonpharmacologic interventions that impact NAS outcomes. One study found infant massage to be effective in reducing NAS symptoms and promoting mother-infant bonding (Hahn et al., 2016). Three studies looked at the impact of parental presence or rooming-in, and found this intervention to be beneficial for NAS infants. Holmes et al, 2016, Howard et al, 2017, and Newman et al., 2015, all found that NAS infants who roomed with parents required less pharmacotherapy to manage NAS symptoms, and also had shorter hospital stays. The study conducted by Holmes et al., 2016, found that with the rooming-in program infants required a decreased amount of pharmacotherapy and a decreased



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length of stay in the hospital (Holmes et al., 2016). Howard et al., 2017, had similar findings. They concluded that 100% parental presence during the infant's hospitalization was associated with a shorter length of stay in the hospital, a decreased length of opioid therapy, and lower mean Finnegan scores (Howard et al., 2017). Lower mean Finnegan scores indicates that parental presence is effective in reducing NAS symptoms. Newman et al., 2015, also found that infants in the rooming-in group required less oral morphine therapy and a decreased length of stay in the hospital compared to the NICU (control) group (Newman et al., 2015).

The two studies which focused on breastfeeding had different findings. Liu et al., 2015 found that infants who were predominantly breastfed for the first two days of life had a delayed onset of NAS, however, predominant breastfeeding did not have a significant effect on whether an infant developed NAS or required treatment. The researchers concluded that methadone-maintained women should continue to breastfeed their infants, because although breastfeeding does not prevent NAS, it is still beneficial in other ways (Liu et al., 2015). Mehta et al., 2013, found that more than 25% of NICUs in the United States do not recommend that mothers of infants with NAS breastfeed, even though breastfeeding for methadone-maintained women is recommended by the American Academy of Pediatrics unless there are other contraindications. The researchers discussed how breastfeeding has been shown to reduce NAS scores, decrease treatment duration and dose, and decrease the hospital length of stay for the infants (Mehta et al., 2013). So although these two breastfeeding studies looked at different factors and had different findings, they both indicate that breastfeeding is beneficial in this population.

One study looked at the effectiveness of laser acupuncture in the treatment of NAS. Raith et al., 2015, concluded that laser acupuncture therapy combined with pharmacological therapy significantly decreased the length of treatment with morphine necessary for infants with NAS,

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and decreased the length of stay in the hospital for these infants compared to the control group (Raith et al., 2015).

One study investigated the effect of vibrotactile stimulation on NAS outcomes. Zuzarte et al., 2017, found that vibrotactile stimulation led to a reduction in movement, heart rate, and respiratory rate in the infants with NAS. However, the researchers concluded that the Finnegan scores were not significantly different for the infants when they were measured before the study, the day of the study, and the day after the study. This indicates that vibrotactile stimulation is not an effective intervention for NAS (Zuzarte et al., 2017).

One study focused on the impact of Reiki therapy on NAS infants. Radziewicz et al., 2018, found Reiki therapy did not statistically change the mean Finnegan scores of NAS infants, and thus is not an effective nonpharmacologic intervention for NAS. This study looked at the safety and feasibility of Reiki therapy as an intervention for newborns at risk for NAS. Their findings regarding changes in the mean NAS scores of the infants were not statistically significant, which indicates that Reiki therapy is not an effective nonpharmacologic intervention for NAS (Radziewicz et al., 2018).

There were no studies that met the inclusion criteria in current literature about non-nutritive sucking and auditory stimulation in terms of NAS, so these topics could be potential areas of future research. All studies discussed in this systematic review had small sample sizes, so further research should be done to confirm the effectiveness of these interventions.

### **Nursing Implications**

This systematic review is relevant to nursing practice because it discusses specific interventions nurses can incorporate into the everyday care of this population. NAS is a common diagnosis in NICUs, and nurses provide hands on care to NAS infants every shift. Nurses are not

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given provider orders for NAS infant care beyond pharmacological treatment though, so it is imperative nurses be aware of nonpharmacologic interventions that are effective and appropriate for NAS. This systematic review identifies interventions nurses can independently initiate to promote infant outcomes. For instance, infant massage, parental presence or rooming-in programs, and breastfeeding are beneficial interventions for reducing NAS symptoms. Rooming-in or parental presence, breastfeeding, and laser acupuncture are associated with decreased lengths of stay in the hospital. Laser acupuncture was found to reduce the length of time infants required medication, and rooming-in or parental presence, and breastfeeding were shown to decrease the amount of medication required to treat NAS infants. These findings could potentially contribute to improving the care of NAS infants because incorporating more effective interventions could help nurses provide the best care possible for these patients and could lead to improved outcomes.

### **Limitations**

One limitation of this project is that only two databases, PubMed and CINAHL Plus, were used to conduct the systematic review of literature. It is possible that a limited number of studies were found in the current literature because additional articles may only be accessible through other databases. Another potential limitation is that not all of these studies were conducted specifically by nurses so their findings are not exclusively related to nursing care. A final limitation is that opioid use during pregnancy is a sensitive topic, and some women may hesitate to participate in studies related to NAS because they fear being judged by the researchers.

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### **Conclusion**

These nine studies from the current literature indicate that nonpharmacologic interventions are a crucial component of the management of infants with NAS. Based on the findings from these studies, current literature indicates that infant massage, rooming-in programs or parental presence, and breastfeeding are nonpharmacologic interventions that are effective in reducing NAS symptoms. Rooming-in programs or parental presence, breastfeeding, and laser acupuncture are also associated with a decreased length of stay in the hospital for these infants. Laser acupuncture was found to be effective in reducing the length of time the infants required medication. Rooming-in programs or parental presence and breastfeeding were also shown to decrease the amount of medication needed to treat infants with NAS. Vibrotactile stimulation and Reiki therapy were not found to be effective interventions. Gaps in the current literature include a lack of research about nonpharmacologic interventions such as auditory stimulation and nonnutritive sucking. There is also a scarcity of research on the effectiveness of nonpharmacologic interventions in general. Six nonpharmacologic interventions were discussed in this paper, and there were only one to three studies found studying each intervention in the current literature. Future research should be conducted on these interventions in order to gain a full understanding of the benefits of including nonpharmacologic interventions in the plan of care for infants diagnosed with NAS.

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## Appendix

Table 1: Database Search

Search Terms/Parameters	Database	# of Results	Studies Meeting Criteria
<b>Search terms:</b> neonatal abstinence syndrome & rooming in <b>Parameters for all PubMed searches:</b> free full text & 5 years	PubMed	4 results	<b>3 STUDIES</b> (Holmes et al., 2016) (Howard et al., 2017) (Newman et al., 2015)
<b>Search Terms:</b> neonatal abstinence syndrome & rooming in <b>Parameters for all CINAHL Plus searches:</b> free full text, peer reviewed, research article, & 2013-2018	CINAHL Plus	4 results	1 study (already included from previous Pub Med search)
<b>Search Terms:</b> neonatal abstinence syndrome & breastfeeding	PubMed	14 results	<b>2 STUDIES</b> (Liu et al., 2015) (Mehta et al., 2013)
<b>Search Terms:</b> neonatal abstinence syndrome & breastfeeding	CINAHL Plus	10 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & acupuncture	PubMed	1 result	<b>1 STUDY</b> (Raith et al., 2015)
<b>Search Terms:</b> neonatal abstinence syndrome & acupuncture	CINAHL Plus	3 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & infant massage	CINAHL Plus	1 result	<b>1 STUDY</b> (Hahn et al., 2016)
<b>Search Terms:</b> neonatal abstinence syndrome & infant massage	PubMed	1 result	1 study (already included from previous CINAHL search)
<b>Search Terms:</b> neonatal abstinence syndrome & skin to skin	CINAHL Plus	3 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & skin to skin	PubMed	2 results	1 study (already included from a previous search about rooming in)
<b>Search Terms:</b> neonatal abstinence syndrome & skin-to-skin	CINAHL Plus	2 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & skin-to-skin	PubMed	2 results	1 study (already included from a previous rooming in search)
<b>Search Terms:</b> neonatal abstinence syndrome & kangaroo care	CINAHL Plus	2 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & kangaroo care	PubMed	0 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & auditory (also used: auditory comfort, comfort sounds, auditory stimulation, shusher, baby shusher, shushing)	CINAHL Plus	0 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & auditory (also used:	PubMed	0 results	0 studies

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auditory comfort, comfort sounds, auditory stimulation, shusher, baby shusher, shushing)			
<b>Search Terms:</b> neonatal abstinence syndrome & tactile input	CINAHL Plus	0 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & tactile input	PubMed	0 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & swaddling	CINAHL Plus	2 Results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & swaddling	PubMed	0 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & bouncing (also used: swing, swinging, tactile comfort, touch)	CINAHL Plus	0 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & bouncing (also used: swing, swinging, tactile comfort)	PubMed	0 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & touch	PubMed	2 results	<b>2 STUDIES</b> (Zuzarte et al., 2017) (Radziewicz et al., 2018)
<b>Search Terms:</b> neonatal abstinence syndrome & nonnutritive sucking (also used: pacifier)	CINAHL Plus	0 results	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & non-nutritive sucking	CINAHL Plus	1 result	0 studies
<b>Search Terms:</b> neonatal abstinence syndrome & nonnutritive sucking (also used: non-nutritive sucking, pacifier)	PubMed	0 results	0 studies



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Table 2: *Summary of Studies*

Citation Author(s)/ Year	Design	Target Population, Sample Size, Location	Type Intervention	Outcomes/Aims	Results	Limitations	Nursing Implications/Gaps
Hahn, J et al 2016	Qualitative design, Interviews (in person for the first interview, and a second interview by phone)	<b>Target population:</b> Opioid dependent mothers & infants with NAS <b>Sample size:</b> Eight infant-mother pairs <b>Location:</b> Hospital in Eastern US.	Mothers were trained in infant massage, then had the opportunity to use infant massage with their infants and were then interviewed about the experience. They were taught infant massage in the NICU treatment room, then the initial interview was conducted. Followed by another interview by phone 2 weeks after they were discharged from the hospital.	The aim of this study is to use interviews to explore how infant massage impacts the behavior of infants with NAS and how it impacts the mothers' relationships with their infants.	All of the participants said their experience was positive (learning to give infant massage and actually massaging their babies). Most participants found positive and meaningful changes in the behaviors of their babies. The researchers identified three themes having to do with infant massage and its effects on infant behavior and infant-mother relationships: empowerment, enjoyment and bonding, and calm and comfort. They found that infant massage can help with mother-infant bonding and it can help alleviate withdrawal symptoms of NAS.	The findings may not be fully generalizable, because it is a qualitative study with a small sample size	This study is important because it indicates that infant massage can be a beneficial and effective intervention. These findings suggest that further research with an experimental approach should be completed to learn more about infant massage as a nonpharmacologic intervention for NAS.
Holmes, A et al 2016	Quantitative design Implemented a program and measured the outcomes using statistical process control methods	<b>Target Population:</b> Newborns diagnosed with NAS <b>Sample Size:</b> 163 newborns diagnosed with NAS between March 2012 and February 2015 were observed or observed and treated for NAS. 54 in the preintervention year, 61 in intervention year 1, and 48 in intervention year 2. <b>Location:</b> Children's Hospital at Dartmouth-Hitchcock in NH	The researchers implemented an organized NAS program involving protocols for scoring, medications and weaning, and a calm rooming-in environment. They provided families with prenatal education, and increased family involvement in infant care, and treated the infants on a pediatric floor, to allow for rooming-in, instead of treating them in the NICU.	The aim of this study was to improve family-centered care and to decrease the hospital length of stay for infants with NAS and to lower hospital costs.	The number of infants being treated with morphine decreased from 46% to 27%. The use of phenobarbital decreased from 13% to 2%. The average length of stay for infants treated with morphine decreased from 16.9 days to 12.3 days. Hospital costs also decreased per treated infant from \$19737 to \$8755. The cumulative morphine dose decreased from 13.7 mg to 6.6 mg.	This study took place at a children's hospital within a larger hospital, so the findings might only be generalizable to similar settings. The 6 pediatricians that took part in this study were attending physicians in both the newborn nursery and inpatient pediatrics so it	This study is important because it indicates that involving family in the infant's care is beneficial for these infants. Nurses were trained in Finnegan scoring, and were trained to only score after on-demand feeds and during skin-to-skin contact to prevent crying for other reasons, such as hunger and being woken up, to influence the scoring. This study has similar results to other studies looking at aspects of NAS.

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						<p>was simple for them to work together and handle changes. In a larger study with separate attending physicians it might be more difficult, and lead to different results.</p> <p>-The mother's in this area are primarily maintained with buprenorphine instead of methadone, and while rates of treatment for NAS are similar between these two drugs, length of treatment can be shorter when mothers take buprenorphine so this could impact the results.</p>	<p>It might be beneficial for a similar study to be conducted in a larger non-rural setting to see if similar results are found.</p>
Howard, M et al 2017	Quantitative Design, Retrospective, single-center cohort study	<p><b>Target population:</b> Infants treated pharmacologically for NAS and with a rooming-in program and their parents</p> <p><b>Sample Size:</b> 86 mother-infant pairs over a 13-month period (March 2015-April 2016) at Boston Medical Center</p> <p><b>Location:</b> Boston Medical Center</p>	<p>The researchers collected their data by using electronic medical records and doing a retrospective chart review. They collected demographic data for mothers and infants, parental presence. They looked at outcomes including length of stay, pharmacotherapy, and mean Finnegan score.</p>	<p>The aim of this study was to examine if there is an association between rates of parental presence and NAS outcomes.</p>	<p>Of the 86 mother-infant pairs, the mean parental presence during the study was 54.4% of the infant's hospitalization. Maximum parental presence (100%) was found to be associated with a shorter length of stay (9 days shorter), shorter length of opioid therapy (8 fewer days), and a lower mean Finnegan score (1 point lower). They also found a strong association of breast feeding with parental presence, which they found suggests that breastfeeding should be encouraged to improve</p>	<p>At the time of this study parental presence was a new metric nurses had to document, so on average parental presence was only documented 68% of the time. Also the way parental presence was documented did</p>	<p>This study indicates that parental presence is very strongly associated with better neonatal outcomes. Future research should be done on the barriers that prevent parents from being with their infants. This study indicates that parental presence and breastfeeding should be encouraged by the healthcare team during care of infants with NAS.</p>

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					<p>outcomes for infants with NAS. They also found several barriers that prevented parents from being able to be there with their infants 100% of the time including: transportation, additional child care responsibilities, off-site methadone dosing, residential substance use disorder treatment program requirements, and stigma and guilt women feel when watching their infants go through withdrawal.</p>	<p>not allow the researchers to assess the amount of time parents spent with their infant or how involved they were with their infants. It simply tells them that parents were present at the time the nurses were scoring. This hospital also has unique factors involved with how they care for these infants, which could impact the generalizability of this study.</p>	
Liu, A et al 2015	Quantitative design, Retrospective medical record review	<p><b>Target Population:</b> methadone-maintained mothers and their newborns  <b>Sample Size:</b> 194 mother-infant pairs between 2000-2006  <b>Location:</b> Two birthing units in Western Sydney, Australia</p>	<p>The infants were categorized into three groups based on their method of feeding during the first two days of life: breastfed (32 infants), fed expressed human breast milk (12 infants), or formula fed (150 infants). The onset of NAS symptoms was the measured outcome.</p>	<p>The aim of this study was to compare the impact of different feeding modalities on the onset of NAS.</p>	<p>The breastfed infants had a delayed onset of NAS compared to the other two groups. The researchers found no significant effect of feeding method on the rates of NAS requiring treatment, so although breastfeeding was shown to delay the onset of NAS it was not found to have a significant effect on whether the infants developed NAS and required treatment. The researchers concluded that methadone-maintained women should continue to breastfeed their infants, because although breast feeding was not found to prevent the onset of NAS it can have other positive effects.</p>	<p>The sample size is small, especially for the expressed breast milk group. The mothers also self-reported the specifics of their drug use, so polydrug misuse could be a contributing factor to the development of NAS in these infants.</p>	<p>These findings suggest that the advantages breastfeeding has for infants with NAS cannot be confirmed in a small cohort study, but these findings do not indicate that breastfeeding should be discouraged.</p>

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Mehta, A et al 2013	Qualitative design, anonymous electronic survey	<b>Target population:</b> Medical directors and charge nurses at NICUs <b>Sample Size:</b> 179 medical directors or charge nurses responded to the survey <b>Location:</b> NICUs across the United States	The researchers created an anonymous 26 question electronic survey and sent it to medical directors or charge nurses at 338 NICUs and received 179 responses.	The aim of this study was to assess the current status of NAS management from prenatal counseling to post discharge follow up care.	Of the many topics in this survey breastfeeding was the significant topic related to this systematic review. They found that breastfeeding is recommended by 74.1% of respondents. Surprisingly only 74.1% of respondents recommend breastfeeding for these mothers even though the AAP recommends it and other studies have shown that breastfeeding benefits these infants. The researchers concluded that more institutions should advocate breastfeeding for these mothers	Only 47% of those who received the survey responded, so the results are not a complete representation of US NICUs. Not all respondents answered each question which limited the sample size. The study used a non-validated questionnaire, which may limit the study's reproducibility.	This study's findings about breast feeding support the benefits of breastfeeding in infants with NAS. Nurses play a major role in caring for these infants and educating parents, so encouraging them to breastfeed could be beneficial.
Newman, A et al 2015	Quantitative design, implemented a program and measured outcomes. Also conducted a survey	<b>Target population:</b> Opioid dependent mothers and their infants <b>Sample size:</b> 45 mother-infant pairs (24 pairs NICU group, 21 pairs in rooming-in group) over the 13 months prior to the rooming-in program was implemented and the 13 months after the rooming-in program was implemented <b>Location:</b> Kingston General Hospital Ontario, Canada	The researchers looked at the 24 mother-infant pairs who were admitted to the NICU immediately after birth which was the usual practice at the hospital. They compared the infants in the NICU group's outcomes to the outcomes of the infants who were allowed to stay with their mothers and were put in a private room with them, the rooming in group. They measured the severity of NAS by the need for pharmacotherapy and the length of hospital stays.	The aim of this study was to determine if allowing opioid dependent mothers to stay with their infants and providing uninterrupted time between them, could decrease the severity of NAS.	The researchers found that the infants from the rooming-in group required significantly less oral morphine therapy than those in the other group, only 14.3% of the rooming-in group and 83.3% of the NICU group. They also found that the length of stay in the hospital for the rooming-in group was significantly shorter than the length of stay of the NICU group. The rooming-in group had a mean length of stay of 7.9 days, and the NICU group had a mean length of stay of 24.9 days. The women who participated in the study had the option of completing an anonymous survey after discharge. 14 of the 21 women completed the survey, and 100% rated their overall experience as a 4 or higher (1-5 scale, 5 being the most satisfied). The researchers in this study concluded that using a rooming-in approach for the	The NAS scoring tool that was used to determine NAS severity relies to some extent on subjective judgement, so it could potentially be a source of bias. The researchers tried to limit this by using the same tool in both groups, and using the same criteria for initiating pharmacotherapy in both groups.	The researchers concluded that using a rooming-in approach for the management of NAS is extremely beneficial. They suggest further research looking at medium and long term outcomes for the infants to learn more about the benefits of rooming-in. This research suggests that more hospitals should consider incorporating rooming-in programs for the management of NAS.

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					management of NAS is extremely beneficial.		
Raith, W et al 2015	Quantitative design, randomized controlled trial	<b>Target population:</b> Newborns diagnosed with NAS after maternal opioid substitution therapy <b>Sample Size:</b> 28 infants with NAS (14 in each group) <b>Location:</b> Division of Neonatology, University Hospital of Graz, Austria	The researchers randomly split the 28 infants into two groups of 14 each. One group received laser acupuncture and pharmacological therapy, while the control group only received the pharmacological therapy. The acupuncture group received daily laser acupuncture treatments which were performed at 5 ear and 4 body acupuncture points bilaterally. The primary outcome measured was the duration of oral morphine therapy. They also looked at highest single Finnegan score, time to highest single Finnegan score, maximum amount of oral morphine solution, time to maximum oral morphine solution, and length of stay in the hospital.	The aim of this study was to assess whether a combination of laser acupuncture and pharmacological therapy reduces the duration of therapy in newborns with NAS compared with pharmacological therapy alone.	The researchers found that duration of oral morphine therapy was significantly lower in the acupuncture group (28 days) than in the control group (39 days). They also found that there was a significantly decreased length of stay in the hospital for the acupuncture group (35 days) than there was in the control group (50 days). The researchers concluded that laser acupuncture therapy combined with pharmacological therapy significantly decreased the length of treatment with morphine necessary for these infants.	This study was a pilot study with a small sample size, and since Austria has a low incidence of NAS they had a limited population to work with. It is possible that with a larger number of subjects the statistical significance found in this study might not be reproduced.	This study indicates that laser acupuncture could be a promising nonpharmacologic intervention for infants with NAS. Further research needs to be conducted to continue to determine its level of effectiveness as an adjunctive therapy.
Zuzarte et al 2017	Quantitative Design; Prospective, within subjects single-center study	<b>Target Population:</b> Opioid exposed newborns (> 37 weeks) hospitalized since birth and treated pharmacologically for NAS <b>Sample Size:</b> 26 opioid exposed newborns <b>Location:</b> University of Massachusetts Medical Center Neonatal Intensive Care Unit and Newborn Nursery (Worcester, MA)	The researchers collected their data by using a specially constructed mattress which delivered low level SVS alternated in 30-minute intervals between continuous vibration (ON) and no vibration (OFF) over a 6-8-hour session. They then measured the movement activity, heart rate, respiratory rate, axillary temperature, and blood oxygen saturation of the infants separately with the vibration and without the vibration. They compared the effects of SVS to no stimulation, and each infant served as his or her own control. On the day of the study all of the infants were receiving morphine for withdrawal (administered orally every 3-4 hours), eight of the infants were also being treated for withdrawal with phenobarbital (but phenobarbital	The aim of this study was to determine if stochastic (random) vibrotactile stimulation (SVS) has therapeutic potential as a complementary non-pharmacological intervention for withdrawal in opioid-exposed newborns. The researchers wanted to see if SVS would reduce symptoms of NAS including a reduction in hyperirritability	The researchers found that their Finnegan scores were not significantly different between the day preceding, the day of, or the day following the study session. However, they could not assess the direct effect of SVS on the Finnegan scores. They found no difference in total condition between the OFF and ON periods of the study. They found that valid non-movement condition time was significantly reduced for the OFF period compared to the ON period, because of a 35% relative reduction in movement period with stimulation. The mean incidence of eupneic breaths (> or = to 30 and < 60 breaths/min) was significantly greater for ON than OFF. Incidence of tachypneic breaths (> or = 60 and < or = 200	According to the researchers a limitation of this study is that full-polysomnography was not used to assess sleep states. Another limitation is that this was a single session study with a small sample group.	The researchers found that additional studies with longer stimulation intervals completed concurrently with Finnegan assessments are needed to determine if there are optimal SVS duration and phases of withdrawal in which SVS could be most effective. Additional studies are necessary in order to determine variables that could optimize the effects of SVS. The researchers suggested that longitudinal studies with more infants are necessary to determine if a regimen of SVS therapy will reduce withdrawal symptoms

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			was not administered during the study period).	(measured by movement activity) and reduction of pathophysiological instabilities including heartbeat, respiration, and temperature.	breaths/min) was reduced with SVS. The group mean RR was still above normal newborn range, but was on average 6 breaths/min lower with SVS. There was a large decrease, relative 36.6% in the incidence of tachycardic heart beats and a significant increase in the incidence of eupneic heart beats with SVS, which the researchers concluded likely contributed to a the small but statistically significant reduction in heart rate (< 3 bpm. Heart rate variance was also significantly decreased with SVS. SVS had no effect on SaO2. Mean axillary temperature was similar between both conditions with little variability observed. So there was a significant reduction in movement (14.6%), heart rate (2.6 bpm), and respiratory rate (5.6 breaths/min) in ON compared to OFF. So the important findings of this study is that SVS reduced prolonged movement activity and improved cardiac and respiratory function in infants diagnosed with NAS. Since prolonged movement periods were significantly reduced with SVS it indicates that SVS may reduce arousal and improve sleep duration and organization.		sufficiently to allow lower doses and shorter durations of medications, reduce hospitalizations, and lead to improved outcomes in this population. The findings of this study suggest that SVS may be a safe complementary therapeutic intervention for reducing movement activity, improving cardiac and respiratory function, and reducing symptoms of withdrawal in infants with NAS.
Radziewicz et al, 2018	Quantitative design; A prospective cohort pilot study	<b>Target Population:</b> Included newborns who were at least 37 weeks' gestational admitted to the newborn nursery weighing at least 2 kg and receiving NAS scoring for monitoring of	The researchers were certified as Reiki Masters and they performed the Reiki therapy on the newborns. The researchers scheduled the Reiki sessions at a time that would not interfere with feedings, routine tests, or procedures. The Reiki master, mother, and nurse caring for the newborn all agreed on the timing	By conducting this study, the researchers aimed to determine the feasibility of administering Reiki therapy in a neonatal nursery for	The researchers found that there were statistically significant changes in the newborns' HR before, during, and after Reiki therapy. They found that the decrease in HR may also be clinically significant because a decrease from 138 to 130 bpm may be therapeutic and overall	This study had a small sample size which is a limitation. Its pilot study design was also a limitation. It was more of a preliminary study to	The researchers found that additional studies with larger sample sizes are necessary in order to learn more about the benefits of Reiki therapy on newborns with NAS. Future studies could also help focus on the

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		<p>withdrawal symptoms.  <b>Sample Size:</b> 30 newborns who met the inclusion criteria  <b>Location:</b> This study was conducted at an urban, academic public hospital with a level III NICU and a separate neonatal nursery where infants and postpartum mothers are cared for before being discharged</p>	<p>of the scheduled sessions. Each newborn received one 30-minute treatment in a quiet room. Each newborn had a new pulse oximeter probe applied in order to monitor HR and pulse oximetry immediately before, half way through the therapy, and immediately after the therapy. The Reiki master placed their hands lightly on or above the newborns head and eyes, upper body from neck to pelvic area, arms and legs for the duration of the therapy. They used the data from the HR and Oxygen saturation rates before, during, and after therapy to analyze the data.</p>	<p>newborns at risk for withdrawal and to determine the safety by measuring the immediate effects of Reiki therapy on the HR, pulse oximetry, and symptoms of NAS in the neonates.</p>	<p>beneficial for infants experiencing symptoms of NAS. However, it is possible that the decrease in HR was due to taking the newborn away from the distractions of the nursery and bringing them to a quiet room or other factors. The oxygen saturation rates fluctuated slightly between the 3 points at which they were measured, but they were non statistically significant changes. There was a slight change in mean NAS scores before and after Reiki therapy but they were not statistically significant changes. Their findings suggest that Reiki therapy is safe for newborns at risk for NAS.</p>	<p>determine the safety and feasibility of using Reiki therapy in this population. It was only performed at one location which might impact the generalizability of the findings.</p>	<p>frequency and duration of therapy in order to determine potential doses and dose response to Reiki Therapy. Future researchers could also look at other factors in relation to Reiki therapy, such as the type of drugs the newborn is exposed to and whether or not the infant is being medicated for NAS in order to explore the effectiveness of Reiki therapy in these situations. These findings show that it might be worth exploring Reiki therapy more in depth in order to determine its benefits on infants with NAS.</p>
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