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Home Phototherapy: Challenges, Faults, and Outcomes

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ABSTRACT

Background and Objective: Failure to follow the standard guidelines in the selection and monitoring of infants before and during home phototherapy can result in unfavorable outcomes. The present study was conducted to determine the performance and complications of failure to follow the standard guidelines in infants undergoing home phototherapy in Mashhad, Iran.

Methods: In this cross-sectional study, a total of 202 infants who were referred to neurology clinic or hospitalized at the emergency or neonatal wards due to acute or chronic outcomes of home phototherapy were included in 2020-2021. Gestational age, gender, birth weight, age at jaundice onset, age and duration of phototherapy, weight on admission, etiology of jaundice, referrer, phototherapy service providing center, type of breastfeeding, hyperthermia incidence, serum or skin bilirubin levels at the beginning and end of phototherapy, hematocrit, direct and indirect Coombs test, reticulocyte count, TSH, T4, G6PD, maternal age and blood type, parity, type of delivery, and pregnancy and delivery problems were recorded.

Findings: The mean age of infants was 7.7±7.6 days, birth weight 2746±707 gr, admission weight 2601±771, bilirubin before home phototherapy 15.58±3.7 mg/dl, bilirubin on admission 17.5±5.8 mg/dl, and home phototherapy duration was 2.5±0.7 days. The frequency of causes of jaundice was as follows: ABO incompatibility (n=30), Rh incompatibility (n=22), urinary tract infections (n=13), fever and dehydration (n=19), hypothyroidism (n=7), biliary atresia (n=5), galactosemia (n=2), and etc. Thirty infants had pathologic weight loss, six had kernicterus, and three needed exchange transfusion.

Conclusion: According to the findings of the present study, it seems that the non-compliance with the guidelines and standards for the selection of babies eligible for home phototherapy along with the lack of monitoring of the health status and serum bilirubin of these infants lead to serious consequences (dehydration and pathological weight loss, need for exchange transfusion and kernicterus) in them. It is necessary to closely review and monitor the process of diagnosis and referral of babies with jaundice who need phototherapy and treatment to phototherapy centers at home or hospital.

Keywords: *Neonatal Jaundice, Neonatal Hyperbilirubinemia, Phototherapy, Home Phototherapy, Outcomes.*

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Introduction

Neonatal jaundice is a common and usually benign problem in most cases. It is among the most common causes of referral to neonatology clinics during the first two weeks of life. Increased bilirubin level above the 95% percentile in almost 10% of neonates needs further evaluation and treatment (1). Inappropriate treatment can result in dangerous complications like kernicterus and hence, lifelong disability (1-3).

Prevention, early diagnosis, and appropriate treatment can decrease the problems and complications of jaundice. Phototherapy is the most common and effective treatment for neonatal jaundice. It is a noninvasive, available and effective method in decreasing indirect bilirubin. Exchange transfusion along with phototherapy is the main treatment in cases with phototherapy-resistance, Kernicterus, or when the bilirubin exceeds the dangerous level (3, 4). Phototherapy was widely used as the principal treatment of choice for hyperbilirubinemia after numerous clinical trials following its invention in 1950s (4, 5).

Phototherapy is basically used in hospitals; however, it can be used at home if there is indication and the appropriate equipment, back up, and monitoring of the neonate are provided. Home phototherapy has been available in the United States as the alternative treatment for hospital phototherapy since almost 25 years ago (6). With the expansion of health care centers, home phototherapy is widely used to treat neonatal jaundice. Due to family preference, home phototherapy can be done before or after phototherapy in the hospital. Treatment at home has potential benefits over hospital treatment (7). Home phototherapy can be a suitable and effective alternative in the treatment of mature healthy neonates with indirect jaundice with bilirubin levels lower than the threshold for hospitalization provided it is performed in a standard way under the supervision of experienced medical and nursing staff (8).

According to the guidelines of home phototherapy by the American Academy of Pediatrics (AAP) Committee on Fetus and Newborn and the Iranian Society of Neonatology, the indications for home phototherapy include: term infant (gestational age over 37 weeks) with good general condition and normal examinations, serum total bilirubin level above 14 and less than 18 mg/dl, age of three days or more, weight above 2500 g, no direct bilirubin increase, no risk factor for jaundice (blood type or Rh incompatibility), G6PD deficiency, abnormal weight loss, hematoma, prematurity, jaundice on the first day of birth, symptomatic jaundice (lethargy, being reluctant to breastfeed, fever, polycythemia, anemia), history of jaundice in the previous siblings who needed hospitalization, jaundice in need of hospital phototherapy, possibility of monitoring the serum bilirubin level, and parental consent for treatment with home phototherapy (9). Considering the lack of association between skin bilirubin at covered areas of neonate body and serum bilirubin level, skin bilirubin cannot be alternatively used for serum bilirubin (10).

Lower costs, no mother-child separation, and no feeling of baby illness are the benefits of home phototherapy from the parents' point of view (8). In the study of Golshan Tafti et al., the cost and duration of treatment in home phototherapy have been reported to be significantly lower (11). Disruption in breastfeeding and parent-infant bonding are minimized with home phototherapy.

Home phototherapy can also have serious drawbacks. In addition to poor supervision and nursing, the reasons for opposing home phototherapy include: corneal damage due to improper eye protection, severe weight loss due to inadequate breastfeeding, changes especially in body temperature, and inadequate

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reduction of bilirubin. Adherence to the guidelines provided by the neonatal scientific associations can reduce these complications. Hyperbilirubinemia guidelines by the American children's association should only be considered if the total infant serum bilirubin level is 2-3 mg/dL below the treatment threshold (9).

High socioeconomic pressures for early discharge of infants from hospital after delivery have led to the widespread use of home nursing services including phototherapy. Home phototherapy has become very popular and welcomed by parents due to its ease of use in recent years. However, based on the experience of recent years, the necessary standards for phototherapy including indications, management of the infant under phototherapy, and follow-up of jaundice during and after home phototherapy in Mashhad need revision because several complications such as dehydration and even neurological complications have unfortunately been witnessed. Therefore, in this study, we seek to evaluate the indications and complications of home phototherapy.

Methods

A total of 202 neonates who had undergone home phototherapy and needed visits at neonatal neurology clinics or hospitalized in Ghaem, Imam Reza, or Akbar hospitals in 2020-2021 in Mashhad were enrolled in this cross-sectional study after approval by the ethics committee of Mashhad University of Medical Sciences with the code IR.MUMS.MEDICAL.REC.1398.936.

The gestational age, gender, birth weight, age at jaundice onset, age of start and duration of phototherapy, and weight at the time of referral were recorded. The reason for start, referral and phototherapy center, type of breastfeeding, hyperthermia and serum or skin bilirubin levels at the beginning and end of home phototherapy, hematocrit, direct and indirect Coombs, reticulocyte count, G6PD, T4, and TSH were also recorded for each infant if hospitalization or further examinations were needed. In addition, mother's age and blood type, parity, delivery method, pregnancy problems and delivery were recorded. Children who were referred to the neurology clinic due to kernicterus or neurological complications of jaundice were also included in the study and their auditory brainstem responses were recorded.

Data analysis was performed using SPSS software version 23. The description data were expressed as frequency and mean±SD using the appropriate tables and graphs.

Results

More than half of the infants were referred from health centers, about 25% from physicians' clinics and 25% from hospitals to the neonatal care centers to rent phototherapy systems. The mean skin bilirubin before phototherapy at home was 15.6±3.7 (Figure 1). The mother's blood type in 46% of infants undergoing home phototherapy who were presented with complication was O or Rh negative (Figure 2). In total, 25.8% of infants had blood type and Rh incompatibility as the most common cause of jaundice in home phototherapy-treated infants (Figure 3). Of all referred patients, 14 infants were presented with direct jaundice. Home phototherapy in 12% and 20% of infants was performed on the second day of life and after ten days, respectively (Figure 4). Failure to follow the standards and guidelines of home phototherapy has been associated with serious complications in these infants. Thirty infants (15%) developed pathological weight loss and dehydration following home phototherapy. Exchange transfusion in hospital was performed for three (1.5%) infants and six infants (3%) developed kernicterus.

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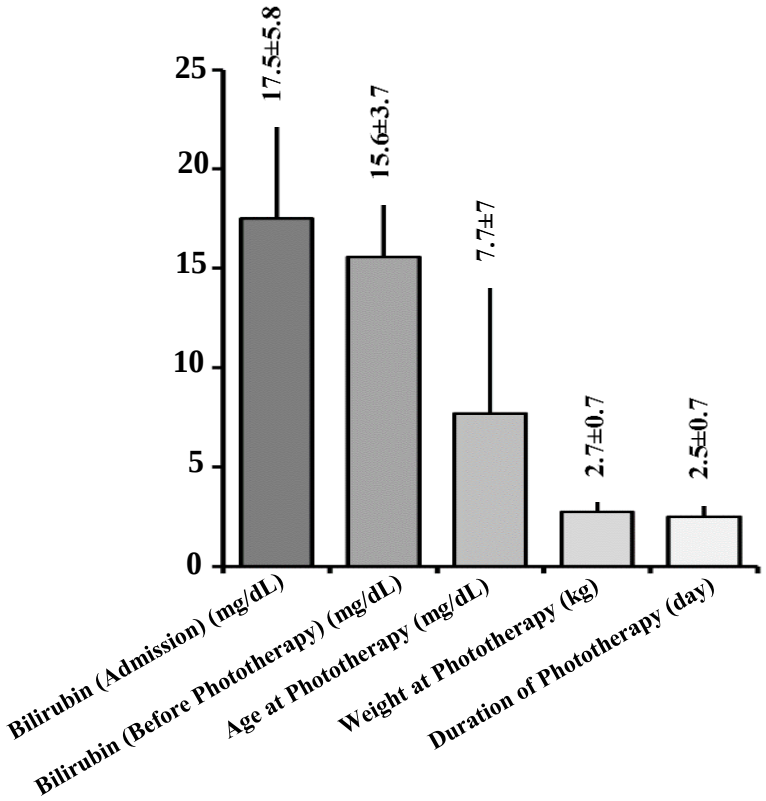


Figure 1. The characteristics of neonates undergone home phototherapy

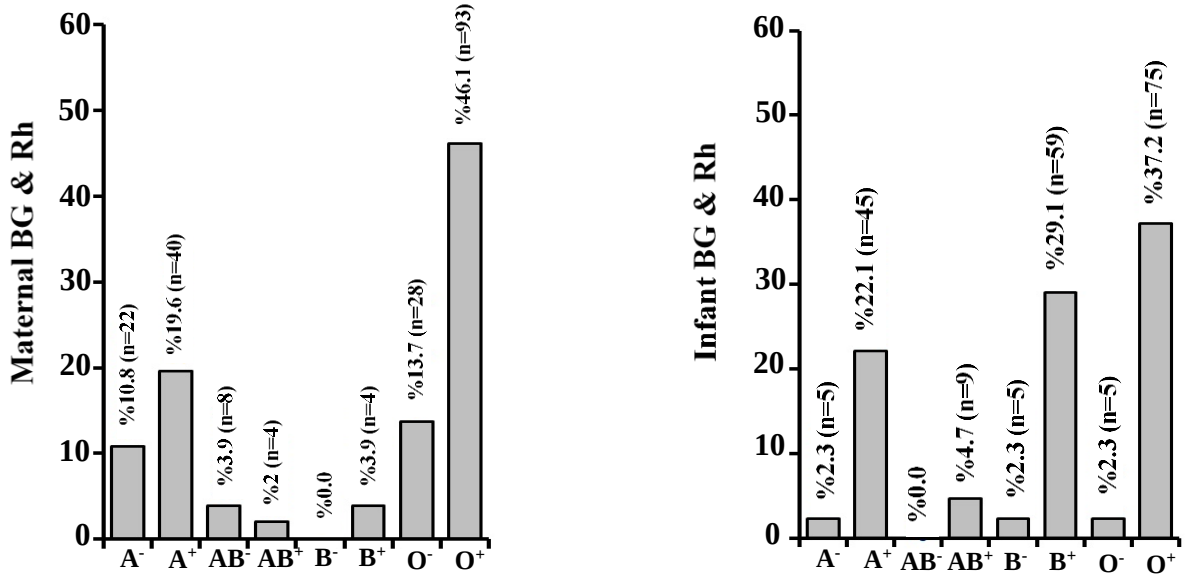


Figure 2. Distribution of blood type and Rh in infants undergone home phototherapy and their mothers

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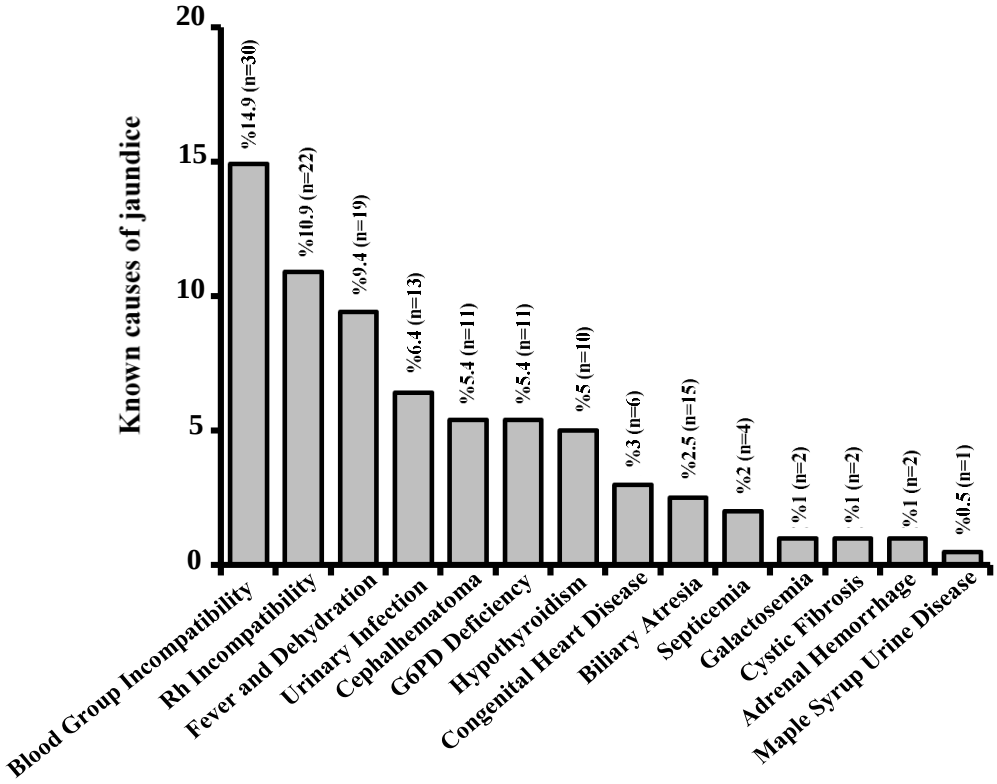


Figure 3. Known causes of jaundice in infants undergone home phototherapy

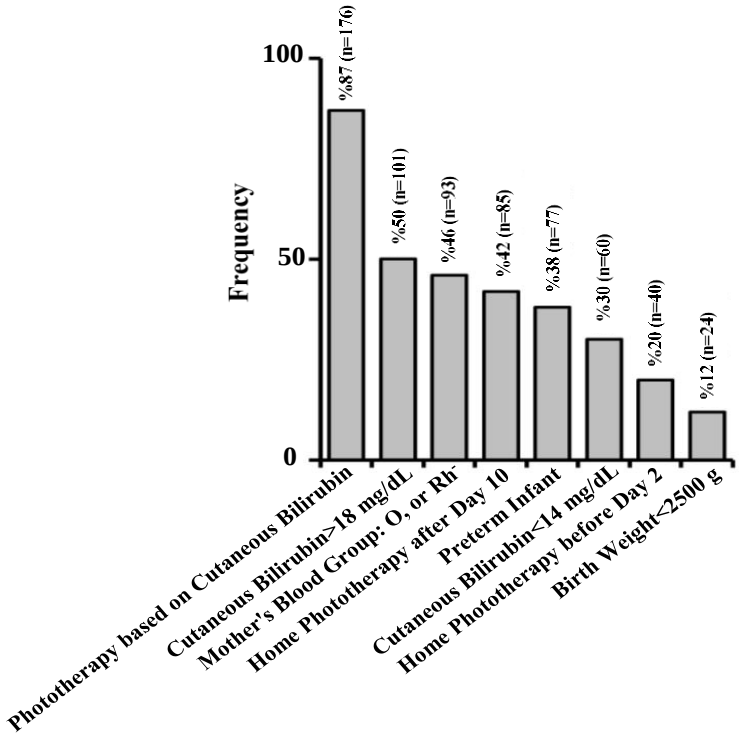


Figure 4. Frequency of cases without indication of home phototherapy (some cases overlapped)

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Discussion

Only 13% of the infants in this study had undergone home phototherapy according to their serum bilirubin results, and the cause of jaundice in 87% of the infants was not investigated and they did not have a serum test, and only the skin bilirubin was measured. However, half of the neonates had cutaneous bilirubin above 18 mg/dL and had to be treated in hospital. In addition, 46.1% of mothers of these infants had blood type O and 28.4% of mothers were Rh negative. Due to the lack of serum testing, unfortunately, the incompatibility was not confirmed or rejected before home phototherapy. Among these infants, 42% weighed less than 2,500 g and 38% were premature according to their mothers. In addition, 30% of these infants had no indication of phototherapy with cutaneous bilirubin below 14 mg/dL. Home phototherapy in one-fifth of infants had been started before the second day.

As home phototherapy in previous studies has been performed based on scientific indications, no adverse results similar to those reported in our study were observed and therefore, their outcomes are not comparable with the results of the present study.

In this study, the main causes of jaundice in infants treated with home phototherapy were blood type and Rh incompatibility, hyperthermia, dehydration, urinary tract infection, cephalhematoma, G6PD deficiency, hypothyroidism, congenital heart disease, and biliary duct atresia. Most of these infants had indications for hospitalization and further care; however, the causes of jaundice were unfortunately not examined due to lack of laboratory examination, they were not weighed before phototherapy, or their general condition was not examined. The most common known causes of jaundice in a previous study included blood type incompatibilities, infections, G6PD deficiency, hypernatremic dehydration, polycythemia, congenital heart disease, and occult bleeding (12). According to the results of this study, many infants had undergone home phototherapy contrary to the instructions. The method of selection, referral, diagnosis of jaundice, treatment indications, proper education of parents, necessary precautions during home phototherapy, and follow-up after phototherapy have not been based on the standards and a serious need for monitoring and correction is felt. In other words, many of these infants either had no indication for home phototherapy or needed phototherapy and other additional measures in the hospital.

In a prospective study by Khatami et al. on 108 infants, the success rate of home phototherapy was 92.6% and only two infants with hypothyroidism and G6PD deficiency had lower bilirubin reduction rates, and only one infant with hyperthermia required hospitalization. Nearly 20% of infants receiving home phototherapy had been hospitalized due to pathological weight loss and dehydration (8), which either indicates the poor control of infant during home phototherapy by parents or lack of proper recommendations to parents for frequent breastfeeding and infant weight control by the centers providing phototherapy devices.

Infant weight loss can exacerbate jaundice. Decreased milk intake and consequently reduced calorie intake reduces gastrointestinal motility, intensifies the enterohepatic cycle, and delayed maturation of bilirubin-conjugating enzyme. These two factors are effective in exacerbating jaundice caused by breastfeeding in the first week of life. On the other hand, phototherapy exacerbates weight loss through increased invisible water excretion (13, 14).

Dehydration was not observed in home phototherapy group in a study by Golshan Tafti et al. and only two cases had diarrhea (11). Frequent breastfeeding can prevent the exacerbation of jaundice and reduce the side effects of phototherapy through adequate hydration. The wrong concept of not taking the infant out of

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the phototherapy device for breastfeeding exacerbates the infant's problems. The mother should breastfeed the infant whenever needed to prevent weight loss.

Due to the wide range of manifestations of kernicterus syndrome, no reliable estimate of its frequency is available in our society; however, in various studies, this frequency has been reported around 1 in 100,000 to 2% (15, 16). Observing six cases of kernicterus in our study was very surprising. As these neonates were referred to neurologists due to neurological symptoms, the possibility for investigating their etiologies was low; however, two of them were G6PD deficient, one was referred for cochlear implant, two were referred with seizures, and two were hospitalized for exchange transfusion. In a clinical trial by Pettersson et al. only 4% of patients undergoing home phototherapy were hospitalized and no infant required exchange transfusion (17). Unfortunately, lack of monitoring of serum bilirubin levels before, during and after phototherapy, failure to investigate the cause of jaundice, and lack of specialized evaluation of jaundice in these infants had caused those aforementioned irreversible problems.

One-fifth of infants undergoing home phototherapy in our study had no indications for phototherapy. Although no serious side effects have been reported for home phototherapy in previous studies, the possibility of serious side effects such as increased risk of phototherapy-induced cancers has been a concern in recent years. It seems that unnecessary and unsupervised cases may increase serious complications such as cancers (18-20).

No precise evidence of rejecting or supporting home phototherapy for uncomplicated neonatal jaundice was reported in two review articles focusing on comparison between home and hospital phototherapy in the treatment of term neonates with uncomplicated jaundice (21, 22).

Due to the retrospective nature of the present study and considering that the total number of infants who have received home phototherapy is unknown, assessing the prevalence of home phototherapy complications is not possible and this is one of the limitations of the present study. The results of this study show that all cases of home phototherapy need to be indicated according to the standards and proper monitoring by neonatologists.

Our results showed that failure to follow the standards and guidelines and implication of home phototherapy based on cutaneous bilirubin and without having the serum bilirubin results, cutaneous bilirubin higher than 17 or less than 13 mg/dL, blood type O or maternal Rh negative, prematurity and birth weight below 2.5 kg, and phototherapy before the second day of birth led to serious complications in 39 infants (30 cases of pathological weight loss and dehydration, 3 cases of exchange transfusion in hospital, and 6 cases of kernicterus).

A serious revision seems necessary for the diagnosing and referring process of infants with jaundice requiring phototherapy and treatment to home phototherapy providing centers or hospital. Giving the permission for home phototherapy to the family means granting part of the responsibility for treating the infant. It is important to give the family the necessary advice on the importance of identifying the signs of danger and failure in phototherapy and the need for immediate hospital contact whenever necessary. Providing written and verbal information to people who tend to use home phototherapy in order to reduce readmission and avoid dangerous complications is recommended.

Conflict of interest: The authors declare no conflict of interest regarding this manuscript.

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