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Incidence of neonatal hypothermia at birth in hospitals of Islamic Republic of Iran: A review

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ABSTRACT

Hypothermia is an important cause of neonatal morbidity and mortality especially in low-income settings. To control this problem in countries such as Iran a full knowledge of the situation is of great importance.

A review was performed both in Persian and English, including international databases. Totally 934 articles were reviewed and finally five articles were selected. The incidence of neonatal hypothermia in different parts of Iran was reported between 7.48 to 53.3 percent.

The prevalence of neonatal hypothermia is a matter of concern and further studies are needed to determine this prevalence in all parts of Iran. Furthermore, performing more etiological investigations are recommended.

Introduction

Hypothermia is an important cause of mortality and serious morbidity in neonatal period.[1] Hypothermia has been defined by World Health Organization (WHO) as body temperature below the normal range (36.5 ^{oc}- 37.5 ^{oc}) and has been sub-classified into three grades: mild (36 ^{oc}- 36.5 ^{oc}), moderate (32 ^{oc}- 35.9^{oc}), and severe (<32 ^{oc}) hypothermia.[2]

A newborn is suddenly faced with wet and cold environments immediately after birth. In the absence of thermal protection, the baby may lose significant amounts of body heat. Actions such as delaying the drying,

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inappropriate thermal protection of the newborn and bathing immediately after birth are the causes of neonatal hypothermia.[3]

Although the exact incidence of the condition is unknown it is a common phenomenon in low resource settings and is estimated that 17 million newborns develop hypothermia annually in low income countries.[2, 4]

Hypothermic newborns are susceptible to peripheral vasoconstriction, decreased peripheral perfusion, ischemia, metabolic acidosis and increased basal metabolic rate.[5] Low body temperature may result in worsening of respiratory distress and can predispose neonates to pulmonary hemorrhage and disseminated intravascular coagulation.[5,6]

Control of body temperature in newborns is achieved by some mechanisms in hypothalamus and mediated by endocrine pathways.[7] Fetal temperature is maintained by maternal thermogenesis and generation of heat by fetal cellular respiration during pregnancy.[8, 9, 10] Drop in body temperature occurs after birth because the temperature of the delivery room is lower than intrauterine environment. On the other hand, the rate of body surface area to body weight of a newborn is approximately three times than that of an adult. Thus, heat loss in newborns occurs approximately four times more compared with adults.[11] Peripheral vasoconstriction followed by heat generation is the first reaction to hypothermia.[12] Release of catecholamine, cortisol and other stress hormones in response to hypothermia occurs which could lead to wasting of fat, carbohydrate and proteins.[13] Effect of hypothermia on serum electrolytes such as hypokalemia in moderate hypothermia due to intracellular shift of potassium has been shown in some studies.[14, 15]

Low body temperature in neonates inhibits the release of central excitatory amino acid neurotransmitters in the nucleus solitaries and may lead to reduction in ventilation.[16] Hypothermia increases blood pH and decreases arterial PCo2.[17] Several studies have shown lower platelet count and abnormal coagulation in cooled newborns.[13,14,16,18] Hypothermic neonates are susceptible to bacterial infection because of white blood cell dysfunction resulting from impaired phagocytosis, delayed cytokine release and decreased neutrophil chemotactic activity .[19,20,21] In prolonged hypothermia fall in cardiac output may be observed and bradycardia may occur which is usually refractory to sympathomimetic drugs.[22,23] Risk of developing necrotizing enterocolitis (NEC) is increased by neonatal hypothermia due to reduction of blood flow to the intestines.[24,25] However, a study recently described that hypothermia may have a protective effect on NEC.[26] Hypothermia decreases cerebral blood flow[17] and brain stem reflexes disappear at core temperature of lower than 28^{oc}.[27] The effects of hypothermia on kidneys are not known yet and a study on newborn rabbits showed a decrease in renal perfusion and glomerular filtration rate.[28] Therefore, further studies are needed to establish the effects of hypothermia on neonatal kidney.[29] While all aforementioned causes can lead to neonatal death and associated with neonatal hypothermia the direction of causality is unclear.[30]

Complications related to this event can place a heavy burden on limited health resources. Some local reports from different parts of Iran revealed neonatal hypothermia amongst major health problems, yet there is not adequate information about this health problem in Iran.[31] Also, no adequate global

statistics are available on the prevalence of neonatal hypothermia. Results of a study in Iran showed that nursing care related to prevention of neonatal hypothermia is far from standards. This can be attributed to carelessness of health providers, deficiency of training and shortage of facilities and equipments.[32]

This review consolidated the findings of research on prevalence of neonatal hypothermia in Iran for the purpose of guiding future policy and research efforts.

Materials and Methods

In this study all Iranian articles from 2000-2013 were reviewed in three Persian databases including IranMedex, SID, IranDoc and two international databases including PubMed and Google scholar. Keywords of search were "Neonatal" or "Newborn", "hypothermia" or "low body temperature", "Prevalence" or "Incidence" and combination of these and "Iran or Iranian". Articles in either English or Persian were considered for inclusion. Descriptive or cohort studies were also selected if the prevalence of neonatal hypothermia in Iran was reported in. Studies on the incidence of hypothermia outside hospital or after first day of life were excluded. Accordingly studies were selected in a two-stage process. First the articles were searched by title then two of the authors independently reviewed the titles and abstracts of the electronic database searches for any paper that appeared to match the inclusion criteria. In this review five articles were selected from 934 searched papers, since the others were somewhat irrelevant or we found duplication of citation in different databases (Fig.1).

Results

From five selected final articles (6491 cases) one was prospective cohort and the others were descriptive (cross-sectional – longitudinal). All articles investigated the prevalence of hypothermia in newborns admitted to hospitals. None reported the prevalence of community based neonatal hypothermia. Different factors related to neonatal hypothermia were mentioned in three of the articles. Variables included birth weight, gestational age, Apgar score, multiparity, temperature of environments and the need to neonatal resuscitation (Table1).

Discussion

The studies reviewed here reported a prevalence of neonatal hypothermia between 7.48% and 53.3% in Iran. The exact incidence of neonatal hypothermia in Iran is not known because of paucity of studies on the subject in different regions of Iran and lack of community based studies. However, data collected from few hospitals based studies in Iran showed a high prevalence, although there were variations in different regions (Table 1). In Ahwaz (a city in south of Iran) a prevalence rate of 7.48% was reported in first day of life of newborns while a study in another part of Iran (Tehran) revealed the incidence rate of about 53% among newborn population.[33,34,35,37]

Zayeri et al in a study which was conducted in 10 provinces of Iran assessed the incidence rate and factors associated with hypothermia in Iranian newborns in university teaching hospitals. They found that approximately one third of newborns developed hypothermia immediately after birth. In the regression analysis, prematurity, low Apgar scores, low birth weight, multiple pregnancies, the need to cardiopulmonary resuscitation were amongst the factors increasing the risk of hypothermia. In addition, they found that

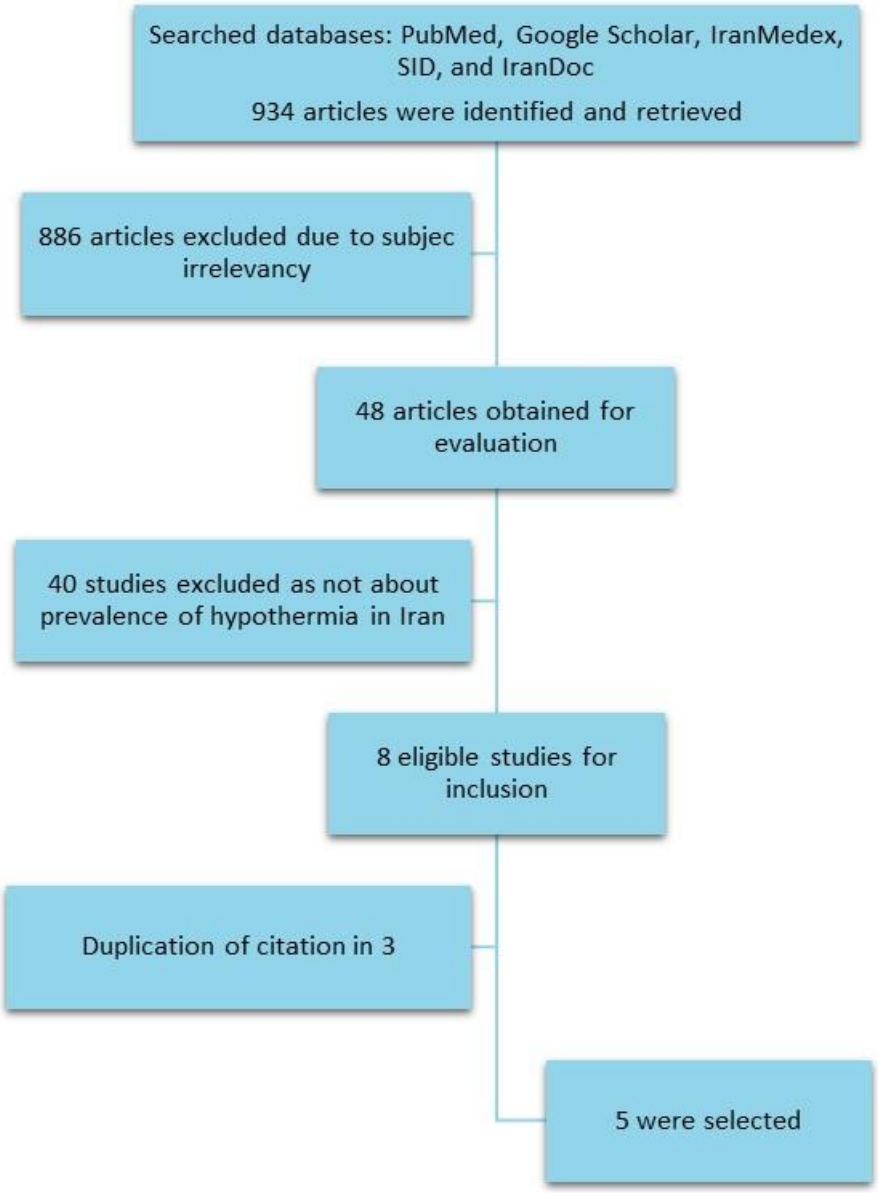

Figure1. Study selection for review of prevalence of hypothermia in Iranian newborns

Table 1. Prevalence of neonatal hypothermia in Iranian studies from 2000-2013 (continued…)

Author/ Year	Study type	City/ Center	Definition of hypothermia (°c)	Time of measurement	Prevalence	Method of temperature measuring	Sample size	Risk factors	P-Value	OR , CI 95%	Complications	P-Value	OR , CI 95%
[33] **Nayeri/ 2005**	Descriptive	Tehran/ Valiasr Hospital	<36.5	On admission	53.2%	rectal	898	*LBW prematurity	0.000 0.000		Death <35 °c 35-36 °c >36.5 °c		 26.7(8.9-79.4) 3.03(1.5-6.06) 0
[34] **Nayeri/ 2006**	Prospective cohort	Tehran/ Imam Khomeini hospital	<36.5	On admission	53.3%	rectal	940				Death Metabolic acidosis Jaundice Respiratory distress Hypoglycemia	0.0001 0.0001 0.0001 0.0001 0.052	3.65(1.85-8.18) 2.83(1.75-4.59) 2.02(1.45-2.8) 2.12(1.53-2.94) 1.38(1.00-1.91)
[35] **Dehdashtian/ 2008**	Descriptive Cross-sectional	Ahwaz/ Imam Khomeini hospital	<36.4	Different hours in first day of life	7.48%	Axillary	1801						
[36] **Zayeri/ 2005**	Descriptive	10 Provinces in Iran	<36	Immediately Few minutes 1 3 6 (hours after birth)	33.8% 9.5% 1.5% 0.5% 0.2%	rectal	1952	prematurity *LBW low Apgar score (<8) Multiparity Resuscitation	<0.001 <0.001 0.002 0.001 <0.001	3.18 3.41 2.58 2.09 2.54	Death Metabolic acidosis Jaundice Respiratory distress Hypoglycemia Lung hemorrhage		3.10(1.86-5.19) 7.30(4.08-13.0) 3.30(2.39-4.56) 3.18(2.33-4.34) 1.83(1.33-2.50) 2.97(1.05-8.38)

Table 1. Prevalence of neonatal hypothermia in Iranian studies from 2000-2013 (continued…)

Author/ Year	Study type	City/ Center	Definition of hypothermia (°C)	Time of measurement	Prevalence	Method of temperature measuring	Sample size	Risk factors	P-Value	OR , CI 95%	Complications	P-Value	OR , CI 95%
[37] **Zayeri/ 2007**	Descriptive	Tehran/ 5 hospitals	<36.5	Immediately On admission	53.3%	rectal	900	*LBW	<0.001		Mortality rate		
				1	13.6%			Low Apgar score (<8)	0.031		Immediately On admission	<0.001	
				2	2.7%						1	<0.001	
				4	0.5%			Prematurity	<0.001		2	0.001	
				(hours after birth)	0.3%			CPR	0.001		4 (hours after birth)	0.004	
								Multiparity	0.009				
								Low environmental temperature	<0.001				

*LBW: Low Birth Weight

neonatal hypothermia increased the risk of metabolic acidosis, jaundice, respiratory distress, hypoglycemia, pulmonary hemorrhage and death regardless of gestational age or weight of newborns.[36] Sodemann et al reported neonatal hypothermia among 8% of neonates during 12 hours after birth in Guinea-Bissau.[38] Prevalence of neonatal hypothermia within 90 minutes postpartum was 79% in Uganda.[39] In Nigeria and Zimbabwe this rate was 68% and 85%, respectively upon admission of newborns.[40,41] The incidence of neonatal hypothermia is not similar to developed and developing countries. In developed countries this problem is only seen in high risk neonates and outborns[36]. A study in Canada revealed 11.5%-12.5% of very low birth weight infants with moderate to severe hypothermia.[36.42]

In developing countries hypothermia is common even in healthy full term infants. Kathmandu et al reported that 85% of newborns had a rectal temperature of below 36^{oc} two hours after delivery.[30, 43]

Different cut offs for definition of hypothermia has been used in different studies which attributed to varying prevalence report among studies. This factor leads to difficulty in comparing the results.

Elements such as seasonality, method of measuring the temperature (axillary vs. rectal), gestational age, weight and community or hospital born are other factors considered for heterogeneity of studies.

For example, in a large population based study in Southern Nepal 92% of babies were born at home and 21,459 of 23,240 babies (92.3%) had low body temperature even in the hottest season of the year and almost one–fifth of the babies were hypothermic.[2, 44]

In our study, the lower incidence of hypothermia in Ahwaz compared to other areas of Iran could be due to warm weather in that region. It is noteworthy that this study which has been published in Persian, unlike other studies, measured the newborns' temperature not only at birth but also at different hours of the first day of life.[35]

However, it is well known that hypothermia is a risk factor for neonatal morbidity and death even in warm climates[30]. Our review showed that low body temperature in newborns is a health problem in maternity hospitals of Iran. In addition, hypothermia even after stabilization and transport to referral hospitals had been reported in some studies.[45]

Prevention is preferable to treatment for reduction of this health problem. WHO introduced a practical strategy for controlling the newborns hypothermia in developing countries.[46]

Different methods were used for prevention and treatment of hypothermia. One of the most effective treatments and available methods is Kangaroo Mother Care (KMC). Mumbai et al in a randomized controlled trial observed the significant effect of KMC in reducing the prevalence of hypothermia (from 37% to 5.9%).[47]

Another prevention method especially in low birth weight infants is wrapping the neonates in a polyethylene plastic bag. Results of a randomized controlled trial carried out in Iran showed that wrapping the preterm infants in Zip-Kif plastic bags which are easily available and inexpensive positively influenced hypothermia on admission.[48]

Methods of prevention or treatment of hypothermia are strongly associated with traditional beliefs and medical resources in each country.[37]

All the aforesaid techniques were usually used for premature newborns but the problem in Iran includes even healthy full term and normal birth weight infants. Additionally, there has been limited progress in identifying

the optimal approaches in preventing hypothermia in low resource settings.[2]

Training programs for nursing personnel and mothers, implementing KMC care, and paying particular attention to WHO clinical guidelines are some practical steps which can play important role in controlling this health problem.[36]

Conclusion

Neonatal hypothermia soon after birth is a common problem in many countries including Iran and is seriously related to mortality and morbidity. Lack of studies in Iran reveals that the extent and importance of this problem are not fully recognized here. Therefore, further studies are needed in different parts of Iran to enhance the awareness of all levels of neonatal care workers.

Conflict of Interest

None declared.

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References

1. Hackman PS. Recognizing and understanding the cold-stressed term infant. Neonatal Netw. 2001; 20(8):35-41.
2. Mullany LC. Neonatal hypothermia in low-resource settings. Semin Perinatol. 2010; 34(6):426-33.
3. Akbarzadeh Baghban A, Jambarsang S, Pezeshk H, Nayeri F. The effects of temperature and birth weight on the transition rate of hypothermia in hospitalized neonates using Markov models. Tehran Univ Med J. 2012; 70 (5) 70 (5): 282-288.
4. Mathur NB1, Krishnamurthy S, Mishra TK. Evaluation of WHO classification of hypothermia in sick extramural neonates as predictor of fatality. J Trop Pediatr. 2005; 51(6):341-5.
5. LeBlanc MH: The physical environment. In Neonatal-Perinatal medicine. Volume 1. 7th edition. St Louis, Missouri: Mosby; 2002: 512-524.
6. Loughead MK1, Loughead JL, Reinhart MJ. Incidence and physiologic characteristics of hypothermia in the very low birth weight infant. Pediatr Nurs. 1997; 23(1):11-5.
7. Knobel R1, Holditch-Davis D. Thermoregulation and heat loss prevention after birth and during neonatal intensive-care unit stabilization of extremely low-birthweight infants. J Obstet Gynecol Neonatal Nurs. 2007; 36(3):280-7.
8. Baumgart S, Harrsch SC, Tauch SM. Thermal regulation.in : Avery GB, Fletcher MA, Mac Donald MG, editors. Neonatology: Pathophysiology and Management of newborn. 6th edition. Philadelphia: Lippincott Williams and Wilkins: 2005: 446-57.
9. Power GG, Schröder H, Gilbert RD. Measurement of fetal heat production using differential calorimetry. J Appl Physiol Respir Environ Exerc Physiol. 1984; 57(3):917-22.
10. Morishima HO, Yeh MN, Niemann WH, James LS. Temperature gradient between fetus and mother as an index for assessing intrauterine fetal condition. Am J Obstet Gynecol. 1977; 129(4): 443-8.
11. Carlo WA. The newborn infant. In: Kliegman RM, Stanton BF, St.Geme JW, Schor NF, Behram RE, editors. Nelson textbook of pediatrics. 19th Ed. Philadelphia: Elsevier Saunders; 2011.p.26-30.
12. Kumar V, Shearer JC, Kumar A, Darmstadt GL. Neonatal hypothermia in low resource settings: a review. J Perinatol. 2009; 29(6): 401-12.
13. Eicher DJ1, Wagner CL, Katikaneni LP, Hulsey TC, Bass WT, Kaufman DA, et al. Moderate hypothermia in neonatal encephalopathy: safety outcomes. Pediatr Neurol. 2005; 32(1):18-24.
14. Azzopardi D1, Robertson NJ, Cowan FM, Rutherford MA, Rampling M, Edwards AD.

Pilot study of treatment with whole body hypothermia for neonatal encephalopathy. Pediatrics. 2000; 106(4):684-94.

15. Tokutomi T1, Miyagi T, Morimoto K, Karukaya T, Shigemori M. Effect of hypothermia on serum electrolyte, inflammation, coagulation, and nutritional parameters in patients with severe traumatic brain injury. Neurocrit Care. 2004; 1(2):171-82.
16. Gunn AJ, Bennet L (2002) Hypothermia in the management of hypoxic-ischemic encephalopathy. NeoReviews 2002; 3: e116–e122.
17. Groenendaal F1, De Vooght KM, van Bel F. Blood gas values during hypothermia in asphyxiated term neonates. Pediatrics. 2009; 123(1):170-2.
18. W.H. Zhou, X.M. Shao, Y. Cao, C. Chen, X.D. Zhang. Safety study of hypothermia for treatment of hypoxic–ischemic brain damage in term neonates. Acta Pharmacol Sinica, 2002; 23 (S): 64-68.
19. Salman H, Bergman M, Bessler H, Alexandrova S, Beilin B, Djaldetti M. Hypothermia affects the phagocytic activity of rat peritoneal macrophages. Acta Physiol Scand. 2000; 168(3):431-6.
20. Kimura A, Sakurada S, Ohkuni H, Todome Y, Kurata K. Moderate hypothermia delays proinflammatory cytokine production of human peripheral blood mononuclear cells. Crit Care Med. 2002; 30(7):1499-502.
21. Clardy CW, Edwards KM, Gay JC. Increased susceptibility to infection in hypothermic children: possible role of acquired neutrophil dysfunction. Pediatr Infect Dis. 1985; 4(4): 379-82.
22. Zanelli S, Fairchild K. Physiologic and pharmacologic effects of therapeutic hypothermia for neonatal hypoxic ischemic encephalopathy. Newborn and Infant Nursing Reviews 2009; 9:10-7.
23. Edelstein JA, Li J, Silverberg MA, Decker W. Hypothermia. Available on the internet at http://www.emedicine.medscape.com/article/770542, accessed on 6/02/2012.
24. Powell RW, Dyess DL, Collins JN, Roberts WS, Tacchi EJ, Swafford AN Jr et al. Regional blood flow response to hypotermia in premature, newborn and neonatal piglets. J Pediatr Surg 1999; 34: 193-198.
25. Yu VY, Joseph R, Bajuk B, Orgill A, Astbury J. Perinatal risk factors for necrotizing enterocolitis. Arch Dis Child. 1984; 59(5): 430-4.
26. EF Wijdicks. The diagnosis of brain death. N Engl J Med, 344 (2001), pp. 1215–1221.
27. Battin MR, Penrice J, Gunn TR, Gunn AJ. Treatment of term infants with head cooling and mild systemic hypothermia (35.0 degrees C and 34.5 degrees C) after perinatal asphyxia. Pediatrics. 2003;111(2):244-51.
28. Onalo R. Neonatal hypothermia in sub-Saharan Africa: a review. Niger J Clin Pract. 2013; 16(2):129-38.
29. Lunze K1, Bloom DE, Jamison DT, Hamer DH. The global burden of neonatal hypothermia: systematic review of a major challenge for newborn survival. BMC Med. 2013 Jan 31;11:24.
30. Lunze K, Bloom D, Jamison DT, Hamer DT: The global burden of neonatal hypothermia - systematic review of a major challenge for newborn survival. BMC Med 2013, 11:24-25.
31. Zayeri, F., Kazemnejad, A., Khanafshar, N., and Nayeri, F. Modeling repeated ordinal responses using a family of power transformations: application to neonatal hypothermia data. BMC Medical Research Methodology 2005; 5(1): 29.
32. Najafipur Sh, Rassouli M, Masoumpur A, Kavousi A. Auditing of preventive nursing care regarding neonatal hypothermia at Shahid Beheshti Medical Sciences University selected hospitals in 2011. Modern Care J, 2012; 9(2): 104-113.
33. Nayeri F, Nili F, Amini E, Khanafshar N, Zayeri F, Palizian P et al. Neonatal hypothermia in Tehran,Iran:Incidence, severity and death rate. Medical Journal of The Islamic Republic of Iran (MJIRI) 2005; 19(1): 23-27.
34. Nayeri F, Nili F. Hypothermia at birth and its associated complications in newborns: a

follow up study. Iranian Journal of Public Health 2006; 35(1): 48-52.

35. Dehdashtian M, Bayat MS, Memari A. Evaluation of hypothermia frequency in first 24 hours of life in alive neonates in Ahvaz Imam Khomeini hospital. SMJ 2009; 7(4): 450-454.
36. Zayeri F1, Kazemnejad A, Ganjali M, Babaei G, Khanafshar N, Nayeri F. Hypothermia in Iranian newborns. Incidence, risk factors and related complications. Saudi Med J. 2005; 26(9): 1367-71.
37. Zayeri F,Kazemnejad A, Ganjali M, Babaei Gh, Nayeri F. Incidence and risk factors of neonatal hypothermia at referral hospitals in Tehran, Islamic Republic of Iran. Eastern Health Mediterranean Health Journal 2007;13(6):1308-17
38. Sodemann M, Nielsen J, Veirum J Jakobsen MS, Biai S, Aaby P. Hypothermia of newborns is associated with excess mortality in the first 2 months of life in Guineo-Bissau, West Africa. Trop Med Int Health 2008;13:980-6
39. Byaruhanga R, Bergstrom A, Okong P. Neonatal hypothermia in Uganda: prevalence and risk factors. J Trop Pediatr 2005;51:212-15
40. Ogunlesi TA, Ogunfowora OB, Ogundeyi MM. Prevalence and risk factors for hypothermia on admission in Nigerian babies <72h of age. J Perinat Med 2009;37(2):180-4
41. Kambarami R, Chidedo O. Neonatal hypothermia levels and risk factors for mortality in a tropical country. Cent Afr Med 2003;49:103-6
42. Hazan J, Maag U, Chessex P. Association between hypothermia and mortality rate of premature infants -revisited. Am J Obstet Gynecol 1991:164(1): 111-12
43. Johanson RB, Spencer SA, Rolfe P, Jones P, Malla DS. Effect of post-delivery care on neonatal body temperature. Acta Pediatri 1992;81:859-63
44. Mullany LC, Katz J, Khatry SK, LeClerq SC, Darmstadt GL, Tielsch JM. Neonatal hypothermia and associated risk factors among newborns of Southern Nepal. BMC Med 2010;8:43
45. Nakhshab M, Vosughi E. The condition of neonatal transport to NICU in Mazandaran. J Mazand Univ Med Sci 2010;20(78):50-57
46. Thermal control of the newborn: A practical guide. Maternal Health and Safe Motherhood Programme. Geneva, World Health Organization, 1993 (WHO/FHE/MSM/93.2).
47. Suman RP, Udani R, Nanavati R: Kangaroo Mother Care for low birth weight infants: a randomized controlled trial. Indian Pediatr 2008;45(1):17-23
48. Farhadi R, Naderi M, Rahmani Z, Ghaffari V, Khalilian A. Effect of "ZIPKIF" Plastic Bag on Prevention of Hypothermia in Preterm Infants: A Randomized Controlled Trial. J Mazand Univ Med Sci 2012; 22 (93):19-27.