

Phototherapy

FOR THE TREATMENT OF NEONATAL JAUNDICE

Condition

Hyperbilirubinemia occurs when elevated concentrations of bilirubin, a neurotoxin, accumulate in neonates. If untreated, it can result in kernicterus (permanent brain damage or death).

Mechanism of Action

Phototherapy lowers the concentration of bilirubin by enabling it to be more easily excreted. Blue light (430 to 490nm) matches the absorption spectrum of bilirubin and drives a photoreaction, transforming bilirubin into water-soluble products which can be excreted in urine and bile. A baby is typically exposed continuously over the course of one or more days. Efficacy depends on irradiance (light intensity); the American Academy of Pediatrics (AAP) intensive phototherapy standard is 30 $\mu\text{W}/\text{cm}^2/\text{nm}$. Any light source that can provide the required color and power can be used, even filtered sunlight.

Current use in high-resource settings

LED-based systems have become increasingly popular in high-resource settings for their intensive irradiance and low maintenance requirements. If phototherapy fails, exchange blood transfusions are used as a last resort. In the US fewer than 1% of neonatal hyperbilirubinemia patients require more than phototherapy alone.

Application in low-resource settings

In resource limited settings, fluorescent devices are commonly used and are often locally produced. When new, these models may be efficacious. However, fluorescent bulbs need frequent replacement. In practice such devices often have burnt out bulbs, or have bulbs that have been replaced with low irradiance white light. Low cost LED units offer 10 year bulb lives while meeting the AAP intensive phototherapy standard. More radical, ultra low cost treatments under development include blue filters for use under direct sunlight.

REPRESENTATIVE DEVICES

MAKE	MODEL	PRICE*	TECH	STATUS	NOTES
Natus	neoBLUE	\$3,500	LED	Marketed	Standard of care in US
Olympic	Bili-Lite	\$2,300	Fluorescent	Marketed	American made tube light
GE	BiliSoft	\$>2,000	LED+Fiber	Marketed	Flexible "blanket" illuminates baby
D-Rev	Brilliance	\$400	LED	Marketed	Sold in India via Phoenix Medical
DtM	Firefly	\$350	Blue light	Marketed	Field testing in Vietnam
Phoenix	CFL-101	\$300	Fluorescent	Marketed	Array of 6 CFL bulbs
Delta	TL	\$200	Fluorescent	Marketed	Lowest cost Indian option
Stanford	Prototype	TBD	Sunlight	Benchtop	Thermal control challenges

* Prices are approximated. Actual pricing can, and will vary by marketplace and market conditions.

TREATMENT

PREVENTION DIAGNOSTIC TREATMENT



Representative Product

DEATHS ASSOCIATED WITH NEONATAL JAUNDICE

Hyperbilirubinemia, an infrequent cause of mortality during the first month of life, is a major cause of neonatal morbidity.

CHARACTERISTICS OF REPRESENTATIVE PRODUCT (D-REV BRILLIANCE)

	TECHNOLOGY CHARACTERISTICS	OPERATIONAL PARAMETERS	POTENTIAL OPPORTUNITIES FOR IMPROVEMENT
SKILLS REQUIRED	Intended end user	Physician, nurse/midwife	A simple mechanism to indicate proper distance between a phototherapy device and baby would facilitate effective treatment by low skill level medical workers. However, these distance-indicating mechanisms are occasionally misplaced. Errors in placement can under or over-dose the neonate.
	Training required	Hours	
	Time required per use	1-3 days	
ENVIRONMENT / INFRASTRUCTURE	Power required	30 W	Reduction in power requirement would enable low-cost battery backup. This would facilitate phototherapy treatment in clinics with intermittent electrical power.
	Waste collection	None	
	Complementary technologies required	Eye & gonad covers, bassinet and warmer	
	Temperature and storage	0 to 40°C	
	Maintenance	Bulb life of 10 yrs	
COST	Device Cost (Approx)	\$400	Further development in high efficiency LED technology could significantly reduce the device cost, as LEDs are the greatest component cost.
	Cost/course (Approx)	Variable depending on local cost of power, <\$1	
OTHER	Portability	<500g	
	Regulatory		
	Efficacy	Irradiance meets 2004 AAP intensive phototherapy standard	

Additional devices required for impact: hyperbilirubinemia diagnostic and eye and gonad covers

Sources: Maisels MJ, McDonagh AF. Phototherapy for neonatal jaundice. N Engl J Med. 2008;358:920–928.

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