THE GUNN RAT - A MODEL FOR PHOTOTHERAPY

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For more than 15 years, neonatologists, a pediatric neurologist, illumination engineers as consultants and later on a pediatrician, formerly trained in mathematics and chemistry - are using in our hospital the Gunn rat strain as a model. Phototherapy (PT) was one of the main topics. Today, the succeeding steps of research shall be listed in short and completed by new data.*

First of all, the question of the effectiveness of PT and of possible side-effects had to be answered.

The early observation that infant rats, which were illuminated together with a lactating dam, remained smaller than littermates kept in the dark was alarming. But subsequent gavage feeding, careful observations and analyses showed that the growth retardation was mainly due to irritation of the mother rats in the unaccustomed surroundings in PT units. This provoked reduced milk production. Retinal damage by fluorescent lights (without any changes in FiO₂) was marked and began already after a few hours of illumination in adult animals - but not so in infant rats so long as their eyelids were still closed.

*We have to stress that this work was continuously promoted by stimulations and fruitful discussions with many researchers from different parts of the world. We would like to express our thanks to all of them.
As for effectiveness it was not difficult to demonstrate the light induced decline of the serum bilirubin concentration (SBC). Soon it became evident that shaving or depilation of weanling and adult rats was not necessary. The fur is no essential light trap. More convincing was the proof of a protection by the lights against the detrimental effect of sulfonamides in homozygous infant Gunn rats.

Basic studies on the influence of hyperbilirubinaemia on cerebella growth, histological grading of kernicterus within the cerebellum, evaluation of neurological tests in vivo - came next - in parallel to studies on the photobiologically most effective radiant energy as well as calculations on dose/response relationships. It became clear that the effectiveness of PT even greatly depended on the initial SBC. With high irradiances SBC can be brought down almost to zero. The effect of different fluorescent tubes was compared. Taking the spectral energy distribution of the lamps into consideration, it was then possible to construct a special radiometer which graduates spectral energy according to its biological efficiency. Digital measurements give the effective irradiance \( E_{\text{bili}} \) in mW/cm\(^2\). The peak sensibility is set at 460 nm and half maximum sensitivities are at 435 and 488 nm. The spectral efficiency curve comes close to the bilirubin absorption curve. The Berlin radiometer differs not very much from the Olympic spectro-radiometer meanwhile developed for the control of PT.

Based on this experience we can disprove the recently published postulate of Italian investigators (4) that green light can replace fluorescent daylight lamps for PT of neonatal jaundice. Fig.1 shows the time course of SBC in a weanling Gunn rat during 48 h PT and the following rebound period. This rat was first illuminated with blue lights (Philips BAM blue 20 W/52) \( E_{\text{bili}} \) 2.6 mW/cm\(^2\), and a week later with the same blue lamps plus 4 green tubes (Osram L20W/63). On this 2nd trial a small part of the blue tubes was screened with black tapes to compensate for blue emission which is additionally present in green fluorescent tubes (i.e. the mercury peak at 436 nm). \( E_{\text{bili}} \) was quite the same in both trials. Fig.2 shows the same arrangement with white fluorescent tubes instead of the green ones. I cannot see a different PT effect in both figures. PRATESI, one of the authors of the Italian publication, confirmed in a personal communication that the 436 and 405 nm peaks in the Sylvania green fluorescent lamps used by them are almost identical to those of the green Osram tubes tested by us. He is at present trying to determine the contribution of these peaks to the photoconversion of bilirubin.

On the other hand, our experiment demonstrates that the addition of green does not diminish the effect of blue in the Gunn rat. ENNEVER, McDONAGH and SPECK (2), have recently shown that in vitro the bilirubin photoisomer is converted back to native bilirubin.