A THERMAL MONITOR OF METABOLISM IN THE NEONATE

J.S. Ultman, Department of Chemical Engineering, Pennsylvania State University, University Park, PA, 16802, and K.H. Marks, Si Do, D.J. Mujsce, M.A. Wood, Department of Pediatrics, Hershey Medical Center, Hershey, PA, 17033, USA

The aim of this research was to develop a thermal monitor for incubator-nursed infants, and to compare data obtained with the monitor to metabolic rate determined by indirect calorimetry.

A conventional Ohmeda Intensive Care Incubator was instrumented with an ambient and five wall temperature probes and an ambient humidity meter. The infant being monitored was fitted with heel and abdominal skin temperature probes and an esophageal probe. An Apple IIe microcomputer sampled analog output voltages from these sensors, and components of the metabolic energy balance were calculated at half-minute intervals as follows: insensible heat loss across the skin was the product of a-water transfer coefficient and the skin-to-ambient vapor pressure difference; sensible heat loss from the skin was the product of a total heat transfer coefficient and the mean skin-to-environmental temperature difference; and respiratory heat loss was inferred from energy and water balances around the lungs.

Six infants (no O$_2$ requirements, gavage feedings, 28-33 weeks gestation, 7-40 postnatal days, 1.0-1.8 kg in weight) were each studied for 12 hours, with environmental temperature systematically altered in steps of 0.5-1.0°C every three hours. Values of total heat loss (THL) and sensible heat loss (SHL) computed by the thermal monitor were correlated with the metabolic rate (MR) inferred from concurrent respiratory $\dot{V}O_2/\dot{V}CO_2$ measurements performed while the infants were asleep.

For the pooled data set, values of THL decreased from 54 to 16 W/m$^2$ and SHL declined from 46 to 7 W/m$^2$ as environmental temperatures rose from 29.6 to 34.7°C. THL and SHL values were equally well-correlated with MR:

THL = 1.59 MR - 6.28 ($r^2 = 0.689$)

SHL = 1.65 MR - 16.60 ($r^2 = 0.668$)

However, the mean value of SHL more closely corresponded to the mean MR than did the mean THL:

mean MR + s.d. = 24.3 + 5.0 W/m$^2$

mean THL + s.d. = 31.6 + 9.5 W/m$^2$

mean SHL + s.d. = 23.0 + 10.0 W/m$^2$

Thus, the inclusion of insensible heat loss in the thermal computations, although theoretically superior to the use of sensible heat loss alone, leads to an overestimation of MR as compared to indirect calorimetric measurement of MR.

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COMPUTERS IN A NEONATAL INTENSIVE CARE UNIT

Dubois O., Rajagopalan C.
NICU, Centre Hospitalier D'Arras, France

Computerised data and patient management in a Neonatal Intensive Care Unit and its advantages are described.

The reason for the admission of the neonate, postnatal behaviour, mode of transfer, problems or treatment administered if any at birth, mode of delivery, data regarding labour, evolution of pregnancy, genetics and familial antecedents are available at admission. Data resulting from the clinical, radiological and biological examinations are immediately acquired. These data are entered in a coded form on a simple numerical keypad thus eliminating typing errors while at the same time speeding up acquisition. Data are taken into account according to a chronology of events, and their immediate processing can result in certain questions being skipped depending on the context thus reducing acquisition time.

Such a real time acquisition of data is being carried out since 1976 and about 9000 patient files are on line. The main objective of such real time acquisition and processing is the immediate verification and validation of data in order to make available at the earliest results for further analysis.

As a decisional aid, biological data are immediately compared to norms established making use of several data (gestational age, sex, birth weight, mode of delivery, etc...). Computer aided management of mechanical ventilation leads to a more effective care of neonates with respiratory failure. Planning of enteral and parental nutrition can also be carried out.

Routine tasks like the calculation and surveillance of growth rate parameters, automatic print out of the patients' data file as well as output resumes letters indicating appointments for future consultations, etc..., are performed. The main benefits of a computerised neonatal unit are:

' Improvement in the quality of information collected by the physician as the precise and unambiguous language of the computer encourages clear and more accurate communication.

Reexamination of the diagnostic process along formalised lines obliging one to reflect on "why" and "how" medical decisions are decided.

References:
Auditory Brainstem Response (ABR) has been documented as an effective, objective tool for the assessment of auditory function and for the evaluation of physiological development of the acoustic pathway in the newborn. The response consists of a series of waves representing bioelectrical activity deriving from stimulation of the eighth nerve and brainstem nuclei: usually there are seven scalp-positive waves which occur within the first 10 msec following acoustic stimulation by transient signals (clicks). Each test represents the mean response to 2000 stimuli, amplified, filtered and computer-averaged.

I-V wave interpeak latency (I-V IPL) represents the stimulus conduction-time along the acoustic pathway from the eighth nerve to the inferior colliculus. The latency of each wave varies according to the stimulus intensities: as these increase, a decrease in latencies is observed. Wave V latency and I-V IPL decrease in relation to CNS physiological maturation: in newborns wave latencies and IPLs are longer than in the adults. The acoustic pathway maturation proceeds until the second year of life, when ABR latencies reach the same values as in the adult. In premature subjects - where physiological maturation is not complete - the latencies are longer than in full-term babies.

We studied a group of preterm babies (18 cases), born between the 27th and the 37th week (gestational age). Our purpose has been the screening of deafness and the evaluation of differences in the maturation of the acoustic pathway between two subgroups: the first has been composed by at-risk preterm babies (who showed neonatal pathologies, respiratory distress, hyperbilirubinemia or asphyxiation or treated with potentially ototoxic drugs); the second subgroup has been composed by healthy preterm babies.

No case of deafness has been found in the two subgroups. According to several Authors, prolonged latencies should be constantly found in all preterm subjects. In our material no significant difference has been found between the two subgroups, except for one single case of severe neonatal pathology (agenesis of the corpus callosum). In this patient, I, III and V wave showed latencies of 3.10, 5.50 and 7.75 msec, with a I-V IPL of 4.65 msec at 50 dB. These latencies were more prolonged than in the controls (healthy preterm babies) and exceeded them more than 2 SD. I, III and V wave showed in the controls latencies of 2.63+/−0.11, 4.93+/−0.27 and 6.90+/−0.15 msec, with a I-V IPL of 4.28+/−0.11 msec. These results are discussed.

REFERENCES
INTERACTIVE PARENTERAL NUTRITION PROGRAM FOR NEWBORNS

Brian D. Udell, M.D., Jean Crouch M.P.H., R.D., Roger Medel, M.D.
South Florida Neonatology Associates/Broward General Medical Center. Ft. Lauderdale, FL. USA

Introduction:

We wish to describe an interactive program for ordering Parenteral Nutrition (PN) used in a Newborn Intensive Care Unit. This 70 K program, written in Microsoft Basic, using a Macintosh interface format is simple to boot and use.

Methods and Materials:

The program runs on an Apple Macintosh (517K) and has the capacity for 100 patients. Stored data from the previous day and new data are used together to generate orders for tailored PN solutions, calculate admixture volumes for the pharmacy and compile nutritional summaries. A data sheet, including weight, actual 24 hour intake and output, significant laboratory values, blood gases, and pertinent medication is filled out daily for each patient receiving PN. As the program is run this data is entered by the nutritionist, physician, or ARNP who may choose to use the program's capacity to project newly tailored PN orders using standard clinical equations or further individualize a solution by overriding the program at various points.

Results:

We have used this program in more than 3000 patient days for infants who weigh 430 grams to 7.45 kilograms, from 2 days of life to 6 months, and from 24 weeks gestation onward. Discontinuation of a solution due to metabolic derangements is rare and there have been no cases of TPN-induced cholestatic jaundice. The program requires less than 5 minutes per patient. Additionally, the program provides the clinician with a summary of the infant's fluid balance, nutrient and electrolyte intake and nutritional breakdown for the upcoming day.

References

NEW NEONATAL RESPIRATORY MONITORING USING FREQUENCY ANALYSIS

T. Kubo, Y. Sagara
Department of Obstetrics/Gynecology, Kochi Medical School Hospital, Kochi, Japan

PURPOSE: Recently many neonatal monitoring devices have been developed but these data were not fully available for the analysis of the neonatal pathophysiology. Therefore it is very important to process and to analyse quantitatively that. So we have developed a new computer system to analyse the condition of high risk neonates with respiratory distress using frequency analysis.

METHOD: The analog respiratory waves measured by impedance method were taken to the instrumentation tape recorder (Song Magnescale Inc, A-49) and noises were removed in the 5Hz low pass filter. These analog data were converted to digital data with IBM 5560 and were processed by fast fourier transform using IBM 4381 and then were displayed with power spectrum less than 100b.p.m.

RESULT: (1) The sampling time is less than 100msec. (2) The frequency histogram divided by 5b.p.m. is useful to analyse the pathophysiology in high risk neonates with respiratory distress during respiratory care. (3) In the babies with transient tachypnea of the newborn, %IMU in the power spectrum was gradually decreased day by day.

CONCLUSION: Transforming the respiratory wave with frequency analysis, we have developed the new monitoring method by which we can evaluate the respiratory adaptation of the very low birth weight infant with respiratory distress.
USE OF A PC DATABASE MANAGEMENT SYSTEM FOR EPIDEMIOLOGIC ANALYSIS OF MEDICATION UTILIZATION IN A NEWBORN INTENSIVE CARE UNIT

George J. Peckham, M.D., Department of Pediatrics, University of Pennsylvania School of Medicine and The Children's Hospital of Philadelphia, Pennsylvania, USA.

Anne Gallagher and Robert Gallagher, Medical Data Systems, Wayne, Pennsylvania, USA.

Using the Neonatal Information System (R), data was collected on a daily basis by an experienced neonatal nurse at the bedside.

The query function of this system was used to delineate subpopulations of patients and define specific variables to be compared among the specific populations. Once the datasets were abstracted, the ASCII transfer function was used to move the data into Lotus 1-2-3 (R) for further statistical analysis.

An example of the utility of such functions of the Neonatal Information System is demonstrated by the case-control type of analysis of the use of theophylline for infants whose birthweights are less than 1500 grams and who were admitted to the infant intensive care unit of a children's hospital serving a large metropolitan population. The following results were obtained:

<table>
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<tr>
<th></th>
<th>Theophylline</th>
<th>Non-Theophylline</th>
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<tbody>
<tr>
<td>Birthweight</td>
<td>930.0</td>
<td>939.0</td>
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<tr>
<td>Gestational Age</td>
<td>28.2</td>
<td>28.0</td>
</tr>
<tr>
<td>Apgar at 5 minutes</td>
<td>6.8</td>
<td>6.8</td>
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<tr>
<td>Age at Admission</td>
<td>64.4</td>
<td>16.3</td>
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<tr>
<td>Length of Stay</td>
<td>51.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Bronchopulmonary Dysplasia</td>
<td>38 (59%)</td>
<td>2 (2%)</td>
</tr>
<tr>
<td>Respiratory Distress Syndrome</td>
<td>29 (45%)</td>
<td>45 (55%)</td>
</tr>
<tr>
<td>Patent Ductus Arteriosus</td>
<td>8 (13%)</td>
<td>9 (11%)</td>
</tr>
<tr>
<td>Intraventricular Hemorrhage</td>
<td>7 (11%)</td>
<td>10 (12%)</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>9 (14%)</td>
<td>21 (26%)</td>
</tr>
<tr>
<td>Pulmonary Interstitial Emphysema</td>
<td>6 (9%)</td>
<td>24 (29%)</td>
</tr>
</tbody>
</table>

Theophylline

<table>
<thead>
<tr>
<th>Admission Age</th>
<th>Theophylline</th>
<th>Non-Theophylline</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 28 Days</td>
<td>n=32</td>
<td>n=32</td>
</tr>
<tr>
<td>Birthweight</td>
<td>996.0</td>
<td>865.0</td>
</tr>
<tr>
<td>Gestational Age</td>
<td>28.4</td>
<td>27.9</td>
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<tr>
<td>Apgar at 5 minutes</td>
<td>7.0</td>
<td>6.6</td>
</tr>
<tr>
<td>Age at Admission</td>
<td>6.2</td>
<td>122.5</td>
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<tr>
<td>Length of Stay</td>
<td>61.0</td>
<td>40.0</td>
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<tr>
<td>Bronchopulmonary Dysplasia</td>
<td>15 (47%)</td>
<td>23 (72%)</td>
</tr>
<tr>
<td>Respiratory Distress</td>
<td>22 (69%)</td>
<td>7 (22%)</td>
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<tr>
<td>Patent Ductus Arteriosus</td>
<td>5 (16%)</td>
<td>3 (9%)</td>
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<tr>
<td>Intraventricular Hemorrhage</td>
<td>4 (13%)</td>
<td>3 (9%)</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>9 (28%)</td>
<td>0</td>
</tr>
<tr>
<td>Pulmonary Interstitial Emphysema</td>
<td>6 (19%)</td>
<td>0</td>
</tr>
</tbody>
</table>

The case and the control populations were the same in terms of the pretreatment criteria except for the age at the times of admission. The use of theophylline appeared to be highly selective in terms of its therapeutic rationale since the majority of the infants with bronchopulmonary dysplasia (BPD) were in the theophylline treatment group although the groups were comparable in terms of other adverse conditions. It was also interesting to note that when the infants treated with theophylline were admitted within 28 days their total hospital stay was 67 days as compared to 163 days for those admitted at an average of 122 days.
COMPUTERIZED ON LINE NEONATAL MONITORING

J. Kiszel, I. Machay, I. Seri, C. Gáspár, J. Kégl
1st Department of Obstetrics an Gynaecology, Perinatal Intensive Centre, Semmelweis University Medical School, Budapest, Hungary

In our program the analogous signals are taken from a neonatal monitor /ECG, signal of the respiration/ and the tcpO₂ and tcpCO₂ monitors.

The main function of the computer program is to display the beat to beat heart rate, the variability indices, the F+ and F- values /indicators for the accelerations and decelerations of heart rate/, the respiratory rate and the actual values of tcpO₂ and tcpCO₂. The program also contains an algorhythm for apnoea detection and alarming. An effort has also been made to reduce the modulating effects of accelerations and decelerations on the variability indices by creating a new mathematical definition for the interval index, and short term, long term and total variability.

The measured and calculated parameters can be printed in every four - or as indicated more - seconds. In cases of detected apnoea the printing process of the above parameters is substituted by that of the instantaneous heart rate and tcpO₂ in every second. Following the cessation of the apnoea the latter printing process keeps going on for 30 seconds in order to give the possibility for the evaluation of apnoea-related bradycardia and fall in the oxygen delivery. This is of utmost importance in establishing the adequate therapeutical processes.

References: