ORIGINAL ARTICLE

Single step Gastric Aspirate shake test as a Screening Procedure for Predicting the risk of Neonatal Respiratory Distress

by

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Abstract

Predicting the occurrence of Neonatal Respiratory Disttress or IRDS in peripheral areas before symptoms and signs develop is of utmost importance, since an appropriate treatment and management can be performed only in a well-equipped hospital. Many diagnostic methods are used for the prediction of IRDS, yet they reguire elaborate and sophisticated instrumens and technical experts which usually are not available in the front-line medical centres.

In this study, the single-step gastric aspirate shake test of Tanswell et al., (1977) proves to be an extremely valuable method which should be incorporated into the armamentarium of diagnostic tests in the first line medical centres, as to enable a more well-directed referral system.

Despite the small number of our IRDS cases, our patients show clinical pictures similar to those observed by many other investigators. However, further studies for a more conclusive result are certainly justifted.

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Introduction

The Idiopathic Respiratory Distress Syndrome (IRDS) or Hyaline Membrane Disease is a syndrome of neonatal respiratory distress mainly affecting premature infants. It is the most common cause of death in their first days of life (Auld, 1973; Klaus and Fanaroff, 1973). Stahlman (1975) stated that Hyaline Membrane Disease (HMD) is associated with 30 percent of all neonatal death in the United States and with 50 - 70% of premature deaths. Predicting its occurrence in peripheral areas before any symptoms or signs manifest is of utmost importance in a referral system, since the survival is largely dependent on early application of appropriate and sophisticated care which can be performed only in a better equipped hospital.

It is now generally accepted that surfactant deficiency and pulmonary immaturity are causally implicated in the pathogenesis of IRDS. Most of the methods in the prediction of IRDS are based on these important findings: the Lecithin - Sphingomyelin ratio as described by Gluck et al. (1971; 1974), foam stability test for amniotic fluid of Clements and associates (1972), fluorescence polarization of amniotic lipids (Shinitzky et al., 1976) etc. Recently cardiothymic: thoracic ratio is also considered to be useful in predicting the development of IRDS (Gewolb et al., 1979).

However, all these need elaborate and sophisticated instruments and technical experts which in most developing countries are not available, especially in those front-line medical centres. Tanswell et al. (1977) of Canada have developed a very simple modification of Clements' method (Clements et al., 1972) that can be used as a bedside predictor of neonatal pulmonary maturity, which in our opinion is suitable for those caring newborn infants in rural areas, e.g. the Community Health Centres (Puskesmas).

This paper is to report the assessment of the singlestep gastric aspirate shake test introduced by Tanswell et al. (1977) in our neonatal ward, Child Health Department Dr. Soetomo Hospital/Medical School, University of Airlangga, Surabaya, Indonesia. The clinical pattern of IRDS patients will also be briefly discussed.

Materials and methods

Newborn infants admitted to the neonatal ward of Child Health Department Dr. Soetomo Hospital/ Medical School, University of Airlangga, Surabaya, Indonesia, between January 20, 1979 until June 30, 1979 were taken at random for this study. Gastric aspirate samples were obtained within one hour after birth. Care was taken as to have the gastric aspirate free from blood and/or meconium contamination. And the volume of gastric aspirate should be minimally one ml.

The gastric aspirates were obtained by passing a no. 10 Fr. polyethylene

suction catheter with a mucus trap (Terumo Safeed De Lee suction catheter with a mucus trap) through one of the nostrils into the stomach.

Half a ml of gastric aspirate was pipetted into a clean 10 × 110 mm test tube containing 0.5 ml 0.9% saline and 1 ml 95% ethyl alcohol. The tube was corked with a clean rubber stopper and shaken vigorously for 15 seconds by the clock and then placed vertically in a test tube rack for 15 minutes before reading. The airliquid interface was examined for the precence of small bubbles. The method of interpretation was done according to Tanswell et al. (1977).

Bubbles covering greater than two-third of the liquid surface was interpreted as a positive test, one-third to two-third an intermediate test, and one-third or less a negative test. The method and interpretation are shown in Figure 1.

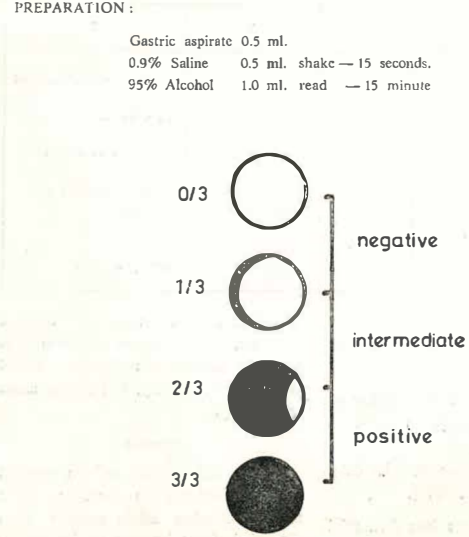

FIGURE 1 : *Single dilution shake test. Method and interpretation. (Adapted from Tanswell et al. Arch. Dis. Childh. 52 : 541 - 544, 1977)*

Gestational age was estimated by clinical assessment of Dubowitz et al., (1970), and classification of low-birth weight was assessed using
rine growth chart of Lubchenco et al., (1972).

The diagnosis of IRDS was made if the infant satisfied all of the following five criteria (modification of Baden et al., 1972) :

1. Respiratory rate > 60 per minute.
2. Intercostal and/or substernal retraction scored more than 4 according to Silverman and Andersen (1956).
3. Decreased inspiratory breath sound.
4. Cyanosis in room air.
5. Chest X ray compatible with IRDS.

The severity of the disease was classified after the criteria of Downes et al., (1970) (Table 1).

TABLE 1 : *Clinical Respiratory Distress Scoring System*

S C O R E	0	1	2
Respiratory rate (per min.)	60	60 — 80	> 80 or apneic episode
Cyanosis	None	In air.	In 40% 02
Retractions	None	Mild	Moderate to severe
Grunting	None	Audible with stethoscope.	Audible without stethoscope
Air entry * (crying)	Clear	Delayed or decreased	Barely audible

The IRDS score is the sum of the individual scores for each of the five observations.

Air entry represents the quality of inspiratory breath sounds as heard in the mid-axillary line.

(Adapted from Downes et al., Clin. Pediatr. 9 : 325 - 331, 1970).

Score equal to or less than 5 ... mild
6 — 7 ..... moderate.
8 — 10 ..... severe.

Statistical analysis using Fisher's exact test and Chi-square test were done for the relationships between IRDS and mode of delivery, and Apgar score respectively.

Results

Totally 103 gastric aspirate samples were obtained for the single-step shake test examination. Eight samples were discarded either because of inadequate samples (less than 1 ml) or because of contamination with blood and/or me-

conium, as recommended by Clements et al., (1972).

The total number reliable for analysis was therefore from 95 newborn infants, consisting of 52 males and 43 females, with gestational ages ranging from 28 to 41 weeks.

Figure 2 shows the single-step gastric aspirate shake test results from 95 newborn infants, plotted against the gestational age and clinical outcome. There were 26 infants with gestational age equal to or less than 32 weeks. Of these none of the 13 infants with a positive test developed respiratory distress; so did one infant with an intermediate shake test. All 12 infants with a negative shake test developed respiratory distress syndrome (IRDS). All those with gestational ages of more than 33 weeks (69 infants) showed a positive shake test and none suffered from respiratory distress syndrome.

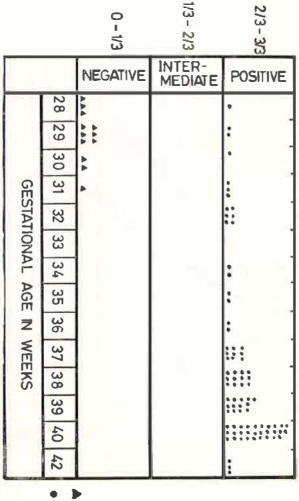

FIG.2: *Shake test results with clinical outcome in 95 newborn infants*

△ IRDS.
□ Non — IRDS.

TABLE 2 : *Clasification of prematurity of infants whose gestational ages were less than 32 weeks*

Infants	AGA	SGA
IRDS	12	0
NON IRDS	14	0

All infants whose gestational ages were less than 32 weeks, either IRDS or non-IRDS were preterms and were AGA (Appropriate for Gestational Age) (Table 2).

Fig. 3 shows the distribution of the gestational ages of IRDS and non-IRDS infants by plotting them in the intrauterine growth chart of Lubchenco et al., (1972).

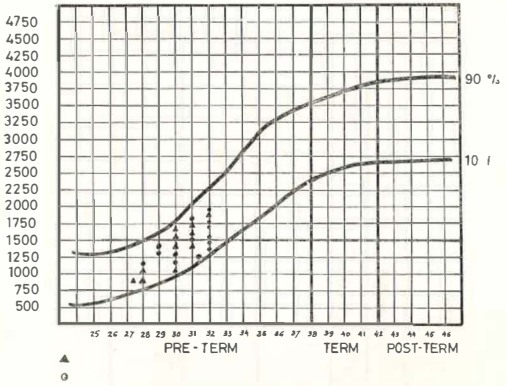

FIG. 3 : *Distribution of gestational age of IRDS and non-IRDS on the intrauterine growth chart of Lubchenco et al (1964)*

Eight of the IRDS infants were males, and 4 females; whereas the sex ratio of the 14 non-IRDS was 7 males to 7 females. (Table 3).

TABLE 3 : *Classification of infants with gestational ages less than 32 weeks according to sex*

Infants	♂	♀
IRDS	8	4
Non IRDS	7	7

Five of the 12 IRDS infants were physiologically delivered (Vertex, Occiput Anterior
to 11 of the 14 infants of the non-IRDS (Table 4).

Seven of the pathologicallly delivered IRDS infants consisted of 2 cesarean cesarean sections and 5 breach deliveries.

TABLE 4 : *Mode of delivery of infants whose gestational ages were less than 32 weeks*

Infants	Delivery	
	Normal	Abnormal
IRDS	5	7
Non IRDS	11	3

Fisher's exact test : $p > 0.05$

There was a striking difference between those IRDS and non-IRDS infants with regard to their Apgar scores. Nine of the IRDS infants had an Apgar score equal to or less than 5 in the first minute, on the contrary, only 5 non-IRDS infants had an Apgar score equal to or less than 5, and the Apgar score of the other 9 were more than 6 in the first minute (Table 5).

TABLE 5 : *Apgar Scores of infants with gestational ages less than 32 weeks*

Infants	First minute Apgar score	
	$\leqslant 5$	> 6
IRDS	9	3
Non IRDS	5	9

Chi-square test : DF = 1 $p > 0.05$

The Downes score of each IRDS infants was equal to or more than 7. All died except one whose Downes' score was 7. The distribution can be seen in Table 6.

TABLE 6 : *Downes' scores of the 12 IRDS infants and their mortality*

Downes' Score	Number of cases	Died
7	4	3
8	2	2
9	5	5
10	1	1

Discussion

The results from this study and previous studies (Cowett et al., 1975; Evans, 1975; Mukherjee et al., 1974; Sproule et al., gastric aspirate shake test and its modifications are very useful in assessing lung maturity in preterm infants, thereby in the prediction of the occurrence of IRDS. Not only that this singlestep gastric aspirate shake test enhances the simplicity of the method, it also retains the reliability. This is very important in peripheral areas where laboratory facilities and technical experts are scarce, while the treatment and management of IRDS need an immediate and appropriate care which only a well-equipped medical centre could provide. In the early prediction of IRDS in preterm infants in one hand, and the need to select them as either not to burden the parents or to prevent unnecessary motherbaby separation on the other, this single-step gastric aspirate shake test indeed may play a very important and decissive role.

All 12 infants with negative shake tests developed respiratory distress syndrome, and no respiratory symptoms developed in all the other 82 infants (Fig. 2). This shows the exactness and reliability of this simple test. The only one infant with an intermediate shake test shows no respiratory symptoms. Intermediate shake test indicates a substantial probability that the infant will experience some respiratory difficulty (Clements et. al., 1972). Evans and Glass (1976) stated that an intermediate shake test is associated with IRDS in about one-half of the cases. It is therefore recommenled to keep premature infant with an intermediate shake for a close clinical observation, and not to be referred immediately. The single-step gastric aspirate shake test, in the authors' opinion, is for the time being the simplest, easiest, rapid and most inexpensive procedure which should be incorporated into the armamentarium of diagnostic test in those first-line health centres to enable a more well-directed referral system.

The technique is very simple, and the equipments are not difficult to be prepared in a front line health centre like Community Health Centre or Puskesmas. With little practice it is not too difficult to insert the polyethylene suction tube into the infant's stomach. The suction of the gastric aspirate requires more effort and skill. It should be done very gently and carefully. If after several attempts the gastric aspirate fails to come up, it would be better to wait for a few minutes rather than to suck forcefully. While awaiting, put the infant on his left or right lateral position before trying again. Notwithstanding all these, with practice, patience, and gentle hands, it would not be too difficult to obtain the gastric aspirate.

Although this single-step gastric aspirate shake test is very simple, the technique is extremely important. There are several conditions under which the test

should not be used. According to Clements et al., (1972) who invented the original foam stability test of the amniotic fluid from which this test is derived, a number of factors deserve careful consideration :

1. The final concentration of alcohol is critical and the volume used must be carefully measured.
2. Commercially isotonic saline used must be supplied in screwcapped bottles.
3. The glass tube must be clean, without remnants of soap, serum or biologic fluids.
4. Evaporation from the foam could decrease the stability in a hot dry room. The clean rubber stopper used is to minimize this evaporation.
5. It is essential not to move the tube after the foam is produced.
6. If readings are missed, do not attempt to retrieve results by shaking the tube for the second time.
7. The test should not be used when meconium is present in the gastric aspirate or when there is blood in it.

Each of the 12 IRDS infants had a gestational age of less than 32 weeks. This is inaccordance with the results of many investigators (Taylor, 1971; Miller and Frutakul, 1968; Schaffer and Avery, 1977), who observed that the incidence of IRDS increases progessively with decreasing gestational age, especially when it is below 34 weeks gestation. It has been stated that IRDS develops only in infants who are of gestational ages less than 270 days (38½ weeks) (Usher in Auld et al., 1972). The overall incidence of IRDS in Usher's neonatal ward ranged from 1 - 2% of all live birth, 20% of all low-birth-weight infants and 35% of low-birth-weight infants of appropriate weight for gestational age. In our neonatal ward, the incidence is about 2.8% of all low-birth-weight infants (Sarwono, 1979).

All of our infants whether the IRDS or non-IRDS are preterm infants belonging to the AGA. None belongs to the SGA infants (Small for Gestational Age) (Fig. 3). It is not easy to explain why almost the same number of preterm infants in this study did not suffer from IRDS. Cook (1975) stated that the appearance of surfactant can be accelerated by certain intrauterine stresses such as infections, and pharmacologic agents e.g. heroin, corticosteroids and thyroxin. Naeye et al., (1971) were of the opinion that intrauterine infection appears to give protection against IRDS. Stahman (1975) considered that chronic type of stress appears to be associated with a low incidence of HMD, perhaps as a result of prematurely induced lung maturation. We suggest that factors ascribing to chronic intrauterine infections which in developing countries are not rarely encountered might be the explanation. Racial factors might also be one of the reasons for the low incidence of IRDS in our preterm infants. This opinion has also been put forward by Schaffer and Avery (1977).

Evans and Glass (1976) and Taylor (1971) observed a predilection of IRDS for males. According to Schaffer and Avery (1977) IRDS is found nearly twice as common in males as females. Despite the small number of our IRDS patients males are exactly twice as many females.

The risk of HMD ascribed to cesarean section is still controversial at the present. Casearean section is considered to be associated with an increased incidence of IRDS (Graven et al., 1966; Usher et al., 1964; Usher in Auld et al., 1972). This is probably related to certain underlying indication for the operation, such as maternal hemorrhage or fetal hypoxia. Inadvertant hypotension caused by maternal anesthesia may also play a role, (Evans and Glass, 1976). Auld (Auld et al., 1972) himself did not think that cesarean section, per se, predisposes an infant to IRDS. Only 2 of the 7 abnormal deliveries in our IRDS infants were delivered by cesarean section. The difference between abnormal and normal deliveries
and non-IRDS in this study is not statistically significant ($p > 0.05$).

Hypoxia, asphyxia and acidosis are considered to predispose to the development of IRDS (Auld. 1973; Bada et al., 1977; Evans and Glass, 1976; Linderkamp et al., 1978; Schaffer and Avery, 1977; Taylor, 1971). If only marginal amounts of the surface active compounds are present, production is apparently significantly decreased by various forms of cellular injury including hypoxia, acidosis etc, This situation is found in the preterm infants with low Apgar scores, and is clearly illustrated in our IRDS infants. Nine of the 12 IRDS infants show first minute Apgar scores of less than 5.

However, the difference between the Apgar scores of IRDS and non-IRDS in our study is not statistically significant ($p > 0.05$). Further study comprising a large number of cases seems to be justified.

On classssifying the 12 IRDS infants using Downes' score, all belong to severe IRDS (score equal to or more than 7). Downes et al., (1970) stated that at 12 to 18 hours of age, the score provided an estimate of prognosis. Infants who have scores of 8 or more suffered a 100% mortality. No infant who scored less than 6 died, but several did exhibit severe IRDS with scores of 7 or more during the subsequent one to two days. This is the prognosis in a wellequipped hospital. The mortality of our cases is accordance with the results of Downes et al., (1970).

Since all infants with negative single-step gastric aspirate shake tests in this study developed severe respiratory distress syndrome (Downes' score of 7 or more), it is suggested that premature infant with a negative
be immediately referred without delay. It is therefore conceivable that the result of single-step gastric aspirate shake test alone is enough for the doctor in peripheral areas to decide whether an infant should

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REFERENCES

1. AULD, P.A.M. : Hyaline membrane disease (idiopathic respiratory distress syndrome); in Behrman, R.E. : Neonatology, pp 360 - 368 (Mosby, Saint Louis 1973).
2. AULD, P., HODSON, A. and USHER, R. : Hyaline membrane disease. J. Paediatr. 80 : 129 - 140 (1972).
3. BADA, H.S., ALOJIPAN, L.C. and ANDREWS, B.F. : Premature Rupture of Membranes and Its Effect on the Newborn. Ped. Clin. N. Amer. 24 : 491 - 500 (1977).
4. BADEN, M., BAUR, C.R., COLLE E., KLEIN, G., TAEUSCH, H.W. and STERN, L. : A Controlled Trial of Hydrocortisone Therapy in Infants with Respiratory Distress Syndrome. Pediatrics 50 : 526 - 534 (1972).
5. COOK, C.D. : Development of the Respiratory System and Initiation of Respiration. In Nelson Textbook of Pediatrics, 10th ed. pp. 923 - 924 (Saunders, Philadelphia/London/Toronto/Igaku Shoin Tokyo 1975).
6. CLEMENTS, J.A., PLATZKER, A.C.G., TIERNEY, D.F., HOBEL, C.J., CREASY, R.K., MARGOLIS, A.J., THIBEAULT, D.W., TOOLEY, W.H. and OH, W. : Assessment of the Respiratory-distress Syndrome by A Rapid Test for Surfactant in Amniotic Fluid. New Engl. J. Med. 286 : 1077 - 1081 (1972).
7. COWETT, R.M., UNSWORTH, E.J., HAKANSON, D.O., WILLIAMS, J.R. and OH, W. : Foam-stability Test on Gastric Aspirate and the Diagnosis of Respiratory-distress Syndrome. New Engl. J. Med. 293 : 413 - 416 (1975).
8. DOWNES, J.J., VIDYASAGAR, D., MORROW, G.M., BOGGS, T.R. Jr. : Respiratory Distress Syndrome of Newborn Infants. Clin. Pediatr. 9 : 325 - 331 (1970).
9. DUBOWITZ, L.M.S., DUBOWITZ, V. and GOLDBERG, C. : Clinical assessment of gestational age in the newborn infant. J. Pediatr.
10. EVANS, J.J. : Prediction of Respiratory Distress Syndrome by Shake Test on Newborn Gastric Aspirate. New Engl. J. Med. 292 : 1113 - 1115 (1975).
11. EVANS, H.E. and GLASS, L. : Perinatal Medicine. Medical Department, pp. 92 - 100 (Harper and Row, Hagerstown/Maryland/New York/San Fransisco/London 1976).
12. GEWOLB, I.H., LEBOWITZ, R.L., and TAESCH. H.W. : Thymus size and its relationship to the respiratory distresss syndrome. J. Pediatr. 95 : 108 - 111 (1979).
13. GLUCK, L., KULOVICH, M.V., BORER, R.C Jr., BRENNER, P.H., ANDERSON, G.G. and SPELLACY, W.N. : Diagnosis. of the respiratory distress syndrome by amnio-centesis. Am. J. Obstet. Gynec. 109 : 440 - 445 (1971).
14. GLUCK, L., KULOVICH, M.V., BORER, R.C. Jr., KEIDEL, W.N. : The interpretation and significance of the lecithin/sphyngomyelin ratio in amniotic fluid. Am. J. Obstet. Gynec. 120 : 142 - 155 (1974).

15. GRAVEN, S.N., OPITZ, J.M., HARRISON, M. : The respiratory distress syndrome. Risk related to maternal factors. Am. J. Obstet. Gynec. 96 : 969 - 976 (1966).

16. KLAUS, M.H. and FANAROFFF, A.A. : Care of the High-risk Neonate, pp. 128 - 141 (Saunders, Philadelphia/London/Toronto 1973).

17. LINDERKAMP, O., VERSMOLD, H.T., FENDEL, H., RIEGEL, K.P. and BETKE, K. : Association of Neonatal Respiratory Distress with Birth Asphyxia and Deficiency of Red Cell Mass in Premature Infants. Europ. J. Pediatr, 129 : 167 (1978).

18. LUBCHENCO, L.O., SEARLS, D.T. and BRAZIE, J.V. : Neonatal mortality rate: Relationship to birth weight and gestational age. J. Pediatr. : (1972).

19. MILLER, H.C. and FRUTAKUL, P. : Birth weight, gestational age, and sex as determining factors in the incidence of respiratory distress syndrome of prematurely born infants. J. Pediatr. 72 : 628 - 635 (1968).

20. MUKHERJEE, T.K., RAJEGOWDA, B.K., GLASS, L.L., AUERBACH, J. and EVANS, H.E. : Amniotic fluid shake test versus lecithin/sphyngomyelin ratio in the antenatal prediction of respiratory distress syndrome. Am. J.Obstet. Gynec. 119 : 648 - 652 (1974).

21. NAEYE, R.L., HARCKE, H.T. and BLANC, W.A. : Adrenal gland structure and the Development of Hyaline Membrane Disease. Pediatr. 47 : 650 - 657 (1971).

22. SARWONO, E. : Annual Report of Neonatalogical Subdivision, Child Health Department, Dr. Soetomo Hospital, Surabaya, Indonesia (1979).

23. SCHAFFER, A.J. and AVERY, M.E. : Diseasess of the Newborn. 4th Ed. pp. 134 - 141 (Saunders, Philadelphia/London/Toronto 1977).

24. SHINITZKY. M., GOLDFISHER, A., BRUCK, A., GOLDMAN, B., STERN, E., BARKAI G., MASHIACH, S. and SERR, D.M. : A New Method for Assessment of Fetal Lung Maturity. Br. J. Obstet. Gynec. 83 : 838 - 844 (1976).

25. SILVERMAN, W.A. and ANDERSON, D.H. : A Controlled Clinical Trial of Effects of Water Mist
Respiratory Signs, Death
ropsy Findings among Premature Infants. Pediatrics 17 : 1 - 10 (1956).

26. SPROULE, W.B., GREENE, M.E., WHITFIELD, C.R. : Amniotic fluid bubble stability test as a screening procedure for predicting the risk of neonatal respiratory distress. Am. J. Obstet. Gynec. 119 : 653 - 656 (1974).

27. STAHLMAN, M.T. : Acute Respiratory Disorders in the Newborn. In Avery's : Neonatalogy: Pathophysiology and Management of the Newborn, pp. 221 - 249 (Lippincott, Philadelphia/Toronto, 1975 .

28. TANSWELL, A.K., SHERWIN, E. and SMITH, B.T. : Single-step gastric aspirate shake test. Bedside predictor of neonatal pulmonary morbidity. Arch. Dis. Child. 52 : 541 - 544 (1977).

29. TAYLOR, P.M. : Respiratory Distress in the Newborn. Clin. Obstet. Gynec. 14 : 763 - 789 (1971).

30. USHER, R., McLEAN, F., MAUGHAN, G.B. : Respiratory distress syndrome in infants delivered by cesarean section. Am. J. Obstet. Gynec. 88 : 806 - 815 (1964).