

## RESEARCH ARTICLE

## Integral assessment of the quality of medical care in Neonatal Intensive Care Units financed by Health Insurance for a New Generation of Mexico

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### ABSTRACT

**Background.** At the request of the program "Medical Insurance for a New Generation in Mexico" (SMNG), we evaluated the quality of care provided to infants with respiratory distress syndrome (RDS) in the neonatal intensive care unit (NICU) financed by SMNG.

**Methods.** There were 22 NICUs that were evaluated, with 19 structural indexes, 23 medical staff personnel, and 37 processes and outcomes measured by the mortality of RDS. The indexes were validated and qualified with the Likert metric or dichotomous scale. The average score of the qualifications were categorized as: "good" between 85 and 100 points, "average" between 60 and 84 points and "poor" ≤ 59 points. RDS as a tracer condition was evaluated from the birth of the newborn in level I or II NICU, during transportation and during hospital stay at level III.

**Results.** Below are some indexes in the "poor" categories in the following components: structure, 11 without gasometer in the NICU and eight in the supply of essential drugs. For medical staff, in 22 NICUs the staff had not read a medical article during the last month, and 17 staff members do not use evidence-based medicine. According to processes, 13 NICU (level I or II) did not administer surfactant to infants, in nine NICU they did not perform blood gas analysis, 12 physicians did not accompany the neonate during transport and several infants arrived at level III NICU with hypothermia. The latter were categorized as "poor" according to several aspects related to the administration of surfactant and in terms of mortality as the result component was higher at lower total score indexes.

**Conclusions.** The quality of care was poor or average in many NICUs, from the time of birth, during transportation and during the newborn's stay in Level III NICU.

**Key words:** Medical Insurance for a New Generation, Neonatal Intensive Care Unit, Quality of Care, Respiratory Distress Syndrome.

### INTRODUCTION

The Mexican government instituted the program "Medical Insurance for a New Generation" (SMNG) for every child born as of December 1, 2006 who was not protected by Social Security insurance. The aim of the program was to avoid catastrophic costs to families from diseases that require hospitalization and that are present from neonatal age up to 5 years of life, as well as to decrease mortality during those ages with particular emphasis on the neonatal stage.

In order to achieve this, and with the objective of guaranteeing that the existing neonatal intensive care units (NICU) were authorized to provide medical care for serious illnesses such as respiratory distress syndrome (RDS), aspiration of meconium, prematurity, septicemia, and congenital heart diseases, among others, the Ministry of Health implemented a procedure of accreditation of the NICU as an indispensable requirement so that they would be incorporated into the network of providers of the SMNG, a process coordinated by the Department of

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Received for publication: 5-21-13

Accepted for publication: 10-24-13

General Quality and Education for Health.<sup>1</sup> In addition, the SMNG elaborated and distributed in the accredited NICUs the Protocols of Medical Care, at that time for 116 diseases. Among these, RDS was included. Together these actions were directed towards an improvement in medical care and in achieving a greater decrease in neonatal mortality.<sup>2,3</sup>

All social programs administered by the Federal Government in Mexico, including that of the SMNG, require as a rule to evaluate their performance. In this case, the evaluation of the quality of health care services represents an indispensable task, not only due to the increase in health costs, but also because of the greater expectations of the population as well as the need to obtain better results with the resources used. For this reason, administrators responsible for the SMNG requested from the Hospital Infantil de México Federico Gómez (HIMFG) an evaluation of the quality of care provided at level III NICU authorized to care for neonatal illnesses that require hospital care, among which RDS is included.

In general, the quality of care studies could focus on the evaluation of the specific components of a program<sup>4,5</sup> or in those who provide better health services and that are accessible, timely or efficient, among others.<sup>6-9</sup> This can be done with different methodologies among which those of Donabedian stand out and include "structure", "processes", and "results"<sup>10,11</sup> and the tracer conditions of Kessner.<sup>12-14</sup> There were no publications found with respect to the quality of care evaluations of the NICU using a tracer condition. On the other hand, although rare, evaluations using the Donabedian methodology were found. However, they did not include all of its components because they evaluated only "structure" and "results", but not the "processes".<sup>15</sup>

In this study it was found that the neonates with very low birth weight, cared for in a level III NICU with greater "structure" than others, and using as measure of the "result" the mortality, showed a decrease of 11%.<sup>16</sup> With respect to the evaluation of the "processes" it appears that there one publication exists in which using the recommended guidelines for the administration of alveolar surfactant in neonates with RDS found that the quality of the NICU evaluated demonstrated wide variations, although those with higher quality were those with greater adherence to the guidelines.<sup>17</sup> Some publications unrelated with the use of the Donabedian or Kessner methodolo-

gies, directed at the evaluation of the quality of the NICU, are based on self-evaluations conducted by the heads of service of the NICU.<sup>18</sup> In others, the degree of adherence to some of the standards of care of the neonate by means of diagnostic-therapeutic guidelines was analyzed,<sup>19-29</sup> and others were related to the so-called "good clinical practices".<sup>30,31</sup>

At the request of the SMNG in order to determine the quality of the care provided in the NICUs that they accredited and because of the limited publications focusing on a complete evaluation of the quality of care in the NICU, in the present study the indices of "structure", "personal physician", "processes" and "results" were evaluated using RDS as a tracer disease. The objective was to determine the quality of care at level I and II NICUs from the time of birth of the neonate, during transport to level III NICU and hospital stay in the NICU using the mortality due to RDS as a "result" parameter.

## METHODS

Selection of the level III NICU financed by the SMNG requires, as a first step, that they be accredited to provide care to the neonates covered by the SMNG. It should be noted that in the study we did not include NICUs affiliated with and providing medical care to the Mexican Social Security System (IMSS, ISSSTE, PEMEX, SEDENA) or NICUs belonging to private hospitals. The size of the sample of the NICU was used for reasons of convenience because in most of the federal entities there is only one level III NICU accredited by the SMNG. Based on geographical and marginalization criteria established by CONAPO,<sup>32</sup> the northwest, northeast, central and southeast regions were comprised. From each region, in turn, four federal entities were selected. From the northwest region, Baja California Sur was excluded because it did not have an accredited NICU by SMNG at the time of the study. The central region had six entities. Of the sites selected by region, it was ensured, as much as possible, that they had similar characteristics from the point of view of marginalization. Once selected, it was decided to randomly evaluate 22 level III NICUs from a total of 45. The only requirement was that they were accredited to provide care for neonates with RDS. The majority were located in the state capitals and a few in cities with populations >100,000.

According to the Royal Academy of the Spanish language, quality is defined as “property or set of properties inherent to something that allows it to be appreciated as equal, better or worse than the rest of its species”. Indices were used for measurement of the quality of neonatal care of children with RDS rather than the construction of indicators. For construction of the indices we took into consideration as referential values those specified in medical care protocol for RDS elaborated by the SMNG,<sup>2</sup> diagnostic and treatment guidelines of RDS of Mexico and the standards relative to the physical, material and human resources of the NICU in the U.S. and England.<sup>19-29</sup> The indices, in turn, were grouped according to the area explored in “structure”, “personal physician” and “processes” of medical care for RDS using “mortality” of the cases analyzed in the medical records of each level III NICU as the “result” indicator.

Not included in the mortality or in the analysis of the “structure”, “personal physician”, and “processes” were those neonates who died in a level I or II NICU. The preparation of indices was performed initially by a neonatologist with extensive experience in the care of infants in the NICU. Subsequently, three additional neonatologists were included, also with extensive experience in neonatology in a level III NICU so that they would analyze and form an opinion on each index. Finally, in a meeting with the four neonatologists, five indices were eliminated. The remaining indices were corrected until reaching a unanimous consensus of the indices prepared.

In order to obtain the necessary information to score the indices, the actions listed below were carried out.

1. Development of a format to obtain information for the construction of indices of “structure”. This format was applied after verbal consent and voluntarily from each of the heads of the 22 NICUs evaluated. The information provided was then verified by documentary and visual inspection by an observer external to the NICU. Based on the responses, the indices corresponding to “structure” previously elaborated were classified depending on the findings.
2. In total there were 115 medical neonatologists in the morning shift ascribed to the 22 NICUs (average of four to five physicians per NICU). Once they verbally and voluntarily accepted, a questionnaire was applied to 98 physicians and that preserved the anonymity and

was different from that of the chiefs of service. Using this questionnaire, the indices corresponding to “medical personnel” were scored. On this occasion, neither medical residents nor nurses were included. Various aspects related with the Committee of Nosocomial Infections, the degree of availability of 15 indispensable medications for care of neonates with RDS and the criteria for the administration of alveolar surfactant were explored. In addition, information on their assistance activities, employment history, professional development, expectations and activities performed with the parents of hospitalized children were obtained. For each item explored, a pre-established score in its corresponding index was assigned.

3. To score each of the indices related to the health care “process”, for each level III NICU a random review of a minimum of 15 clinical records of neonates with RDS who had been hospitalized during the prior 6 months and that, as a prerequisite, in addition to having been treated in a level III NICU, had been born in another level I or II medical unit and then transferred to the level III NICU. A total of 330 cases were gathered. Of these, 37 were eliminated for not have the necessary information to score the indices. At the end there were 293 medical records evaluated and 13 to 14 cases by NICU. The indices included aspects related with place of birth, conditions at birth, gestational age, birth weight, Apgar score at 1 and 5 min, resuscitation maneuvers, treatment and procedures carried out in the first 12 h of life, conditions of the neonate at the time of the transfer, comorbidities, aspects related with the administration of alveolar surfactant (gestational age, age of administration, dosage, number of applications, type of surfactant), and mortality in NICU. RDS was used as a tracer disease because it is representative of a common disease and one of high mortality in the NICU in any part of the world and, because in the opinion of the authors, this disease allows the comprehensive evaluation of the quality of medical care from the time of birth up until cure of the condition or death of the neonate.

For each quality index, and depending on the case, we used a Likert-type metric or dichotomous scale. The Likert-type scale had a range of 100, 75 or 50 min. For the dichotomous variables, scores of 100 were assigned,

for the ideal and for the lowest in some cases of 100 to 75 points. The scores for the Likert-type or dichotomous scale indices were a function of its clinical significance and the potential impact for the patient. No zero score was assigned in any index because this alone is not directly responsible for patient deaths. The scores obtained were classified into three categories: *good* (85-100 points), *average* (60-84 points) and *poor* (<59 points).

The protocol with registration number HIM/2010/034 was accepted by the Committee on Research of the HIM-FG and the Research Ethics Committee. The study preserved the anonymity of the physicians surveyed as well as of the medical records. However, scores obtained for each NICU in the components of "structure", "personal physician" and "results" were disclosed in the report that was provided to the directive body of SMNG, both by federal entity as well as by NICU evaluated.

## STATISTICAL ANALYSIS

For each NICU evaluated, the sum and arithmetic mean was done of the total scores of the points obtained in the

corresponding index of each component that was evaluated ("structure", "personal physician" and "processes"). Afterwards, the average score of each component was correlated with the mortality obtained in each NICU using the Pearson coefficient.

## RESULTS

The scores by section for each of the 19 indices related with the "structure" (Table 1), the 23 corresponding to "personal physician" (Table 2) and the 37 indices relative to the "processes" of medical care (Table 3) can be seen. With respect to the "structure" it is shown that, for each of the indices evaluated, in the section of Personnel and the Committee of Nosocomial Infections the majority of level III NICUs were in the categories of *good* and some in the *average* (Table 4). However, the indices related with Medical Team and Physical Areas presented relevant problems, among which for the *poor* category there were 19 NICUs in the index of "number beds versus electrical outlets", 11 without facilities for blood gas analysis available within the NICU, nine in

**Table 1.** Quality indices of structure and evaluation

Quality indices	Evaluation of the indices		
	100	75	50
<b>Personnel and Committee</b>			
Number of neonatal morning shifts vs. number of beds	1-4	1-8	1-12
Number of neonatologists vs. number of pediatricians	1-0	1-1	1 -2
Number of resident neonatologists and pediatricians according to shift	3	2	1
Presence of social workers per shift	In 3	In 2	In 1
Working Committee for Nosocomial Infections	Always	Almost always	No function
<b>Medical equipment and physical areas</b>			
Number of beds vs. number of phototherapies	1-1	2-1	3-1
Number of ventilators vs. number of infusion	1-3	1-2	1 -1
Number of beds vs. number of electrical sockets	1 - ≥ 10	1 - ≥ 5	1 - ≤ 3
Number of incubators vs. number of heated cribs	1-3	1-2	1-1
Number of intensive care beds vs. number of ventilators	1-1	1-2	1-3
"Crash cart" in NICU	Yes	NA	No
Gasometry within NICU	Yes	NA	No
Hand washbasin before entrance to NICU	Yes	NA	No
Washes hands before entering NICU	Yes	NA	No
Storage area within the NICU	Yes	NA	No
Gowns used to access NICU	Yes	NA	No
Family access permitted	Yes	NA	No
Parents can be with their child	Yes	NA	No
<b>Indispensable medications for RDS<sup>(15)</sup></b>			
Level of availability	Always	Almost always	Sometimes

NICU, neonatal intensive care unit; NA, not applicable; RDS, respiratory distress syndrome.

**Table 2.** Quality indices of medical personnel and its evaluation

Quality indices	Evaluation of the indices		
	100	75	50
<b>Work history of the NICU physicians</b>			
Years working in the NICU	≥ 10	5-9	≤ 4
Other work outside the NICU	No	NA	Yes
Hours/day working in NICU	≥ 7	5-6	≤ 4
Follow-up consult offered	Yes	No	NA
<b>Professional development of the physician</b>			
Number of medical articles read in the past month	≥ 5	2-4	1
Practices EBM	Yes	NA	No
Frequency each month of using EBM in practice	≥ 3	2	1
How many academic events attended during the past year	≥ 3	2	1
Had given a conference in the past year	Yes	No	NA
<b>Physicians view of child's parents</b>			
Active participation	Cooperative	Average	Little
Attention to recommendations	Cooperative	Average	Little
Have confidence	Cooperative	Average	Little
Are cordial	Cooperative	Average	Little
Fluid communication	Cooperative	Average	Little
Are respectful	Cooperative	Average	Little
<b>Type of activities carried out with parents</b>			
Explains disease	Always	Casi siempre	Sometimes
Gives the child's diagnosis	Always	Casi siempre	Sometimes
Use of prescribed medications	Always	Casi siempre	Sometimes
Home care given to child	Always	Casi siempre	Sometimes
Quality of care given to the children	Very good	Good	Average
How satisfied are you with the care	Very satisfied	Satisfied	Unsatisfied
Offers health education	Yes	NA	No
Ability for health education	Yes	NA	No

NICU, neonatal intensive care unit; EBM, evidence-based medicine; NA, not applicable.

the “incubator versus number of radiant heat indices”, six in the “number of intensive beds versus number of ventilators”, six in the “number of beds versus number of phototherapy”, eight in the availability of medications required for treatment of RDS and five NICUs in which the personnel did not wash their hands before they entered the NICU.

With respect to the work history of medical personnel (Table 5), in 19/22 NICUs the physicians had another activity related with their specialty, but not in the installations of the NICUs evaluated. In professional development, the number of articles read each month related to neonatology is 1 in the 22 evaluated NICUs, and in 17 NICUs they do not use evidence-based medicine (EBM) in their daily routines. In six NICUs the physicians had only attended one

academic event outside the hospital during the entire year. In general terms, that which is related with the vision that the physicians have of the neonate's parents and type of activities they perform with the parents, including their personal satisfaction, were in the *good* to *average* categories.

The indices of site of birth in the medical units with level I and II NICU showed that the great majority were categorized as *good*. This was not the case for neonatal management during the first 12 h of life. Highlighting in the *poor* category was no alveolar surfactant being given in 13 NICUs and not having performed arterial blood gas analyses in nine NICUs (Table 6).

In the indices related with transfer of the neonate to a level III NICU, numerous level I or II NICUs were in the *poor* category, as was the case that the neonate was not

**Table 3.** Quality indices of the medical care process and its evaluation

Quality indices	Evaluation of the indices		
	100	75	50
<b>Place of birth</b>			
Referred to public hospital unit	Yes	No	NA
Born in public hospital with level I or II NICU	Yes	No	NA
Prenatal care in public referral hospital	Yes	No	NA
Trimester when prenatal care began	First	Second	Third
<b>Management in the first 12 h of life in hospital where born</b>			
Equipped with incubator or heated crib	Yes	NA	No
Arterial gasometry carried out	Yes	NA	No
Chest x-ray done	Yes	NA	No
Alveolar surfactant applied	Yes	NA	No
<b>Condition of the neonate during transport</b>			
In ambulance	Yes	NA	No
Transported in incubator	Transport	Standard	Heated crib
Accompanied by a physician	Yes	NA	No
Duration of transport (h)	≤ 3	3.1 a 6	≥ 6.1
Severity of RDS during transport	Stable	Serious	Very serious
Silverman evaluation	≤ 2	3 a 5	≥ 6
Oxygen delivered	Cooling helmet	CPAP	Ventilator
Glucose upon arrival at the NICU (mg/dL)	≤ 99	≥ 100	≤ 39
Body temperature upon arrival at NICU (°C)	36 - 37	> 37	< 36
<b>Ventilatory assistance and comorbidity</b>			
Protocol for endotracheal intubation	Yes	NA	No
Protocol for assisted ventilation	Yes	NA	No
Priority for management of ventilators	Yes	NA	No
Course(s) for pediatric or neonatal CPR	Yes	NA	No
Frequency of BPD >20%	No	NA	Yes
Frequency of pneumothorax in >20%	No	NA	Yes
<b>Activities of physicians of the NICU</b>			
Visting children (h/week)	≥ 10	5-10	≤ 4
Participation of certification courses (h/week)	0-2	3-5	≥ 6
Accompanied by residents during the visit (h/week)	10-15	5-9	≤ 4
Library sessions (h/week)	2	1	0
General hospital sessions (h/month)	2	1	0
Actividades administrativas (h/week)	0-2	3-4	≥ 5
<b>Response of physicians in regard to alveolar surfactant</b>			
Surfactant can be substituted in RDS	No	Yes	Sometimes
Evaluation of the use of surfactant in RDS	Good	Average	Bad
Protocol for administration	Yes	No	Unknown
Frequency of following protocol	Always	Almost always	Almost never
<b>Findings of surfactant in the clinical file</b>			
Gestational age at time of administration (weeks)	≤ 34	35-37	≥ 38
Age of administration of surfactant in the newborn (h)	≤ 2	3-12	≥ 13
Dose of alveolar surfactant applied (mL/kg)	4* or 2.5**	5* or 3.5**	≥ 6* or ≥ 4**
Number of doses applied	1-2	3-4	≥ 5

\* Survanta; \*\* Corosurf. NA, not applicable; BPD, bronchopulmonary dysplasia.

**Table 4.** Quality indices of “structure” according to category in the evaluated NICUs

Quality indices	Results according to category ( <i>n</i> )		
	Good	Average	Poor
<b>Personnel and Committee</b>			
Number of morning shifts versus number of beds	11	8	3
Number of neonatologists versus number of pediatricians	15	6	1
Number of neonatology residents and pediatricians per shift	22	0	0
Presence of social worker per shift	20	2	0
Functional Nosocomial Infection Committee	22	0	0
<b>Medical equipment and physical areas</b>			
Number of beds versus number of phototherapies	14	2	6
Number of ventilators versus number of infusion pumps	14	8	0
Number of beds versus number of electrical sockets	1	2	19
Number of incubators versus number of heated cribs	12	0	9
Number of intensive beds versus number of ventilators	9	7	6
Crash cart in the NICU	21	NA	1
Gasometry within the NICU	11	NA	11
Washbasin for hands before entering the NICU	21	NA	1
Handwashing before entering the NICU	17	NA	5
Storage access within the NICU	22	NA	0
Gowns used to access NICU	22	NA	0
Access for families	22	NA	0
Parents can be with their child	22	NA	0
<b>Necessary medications for RDS (15)</b>			
Level of availability	7	7	8

NICU, neonatal intensive care unit. Good: 85-100 points. Average: 84-60 points. Poor: ≤59 points. NA, not applicable..

accompanied by a physician (*n* = 12), having been sent with high Silverman scores (*n* = 12), having deficiencies identified on administration of oxygen (*n* = 10), presence of hypo- or hyperthermia (*n* = 10), being transferred under conditions of greater severity than RDS (*n* = 9) as well as prolonged transfer times (*n* = 9). With regard to the indices of ventilatory assistance and comorbidities in level III NICU, six units had a frequency of bronchopulmonary dysplasia >20% and in five the physicians did not master use of the ventilators. Of note is that within the activities of assistance, the time that the resident accompanied the physician in the medical visit was <4 h during the entire week in 22 of the NICUs, in 13 NICUs there were no bibliographic review sessions, and in 12 the physicians did not attend general meetings of the hospital where the NICU was located. The indices related with the response of the physicians to aspects related with the use of alveolar surfactant showed that in six NICUs it was considered that alveolar surfactant could be substituted in children with RDS, in five NICUs there was no protocol for its administration and the frequency in which the protocol is adhered

to was in the *poor* category in four NICUs. According to the medical review, with respect to the surfactant, there were deficiencies seen related with the postnatal age of its administration (*n* = 10), the dose administered (*n* = 5), gestational age when it was administered (*n* = 5) and the number of doses administered (*n* = 6).

There were significant differences between the total average scores corresponding to the sections of “structure” and “processes” (all scores obtained in each NICU in the total indices were included), and the mortality in each NICU (Figure 1). On the other hand, there were no statistically significant differences found with relationship to the variables related with “personal physician” vs. mortality. However, when adding the indices for “structure”, “processes” and “results” (A+B+C) versus mortality it was noted that a relationship existed with mortality with greater statistical significance (*p* <0.011).

## DISCUSSION

In the present study we were able to evaluate, with a comprehensive approach, the quality of medical care in

**Table 5.** Quality indices of “medical personnel” according to category evaluated in the NICU

Quality indices	Results according to category (n)		
	Good	Average	Poor
<b>Work history of NICU physicians</b>			
Years working in the NICU	2	18	2
Has other work outside of the NICU	3	NA	19
Hours/day working in the NICU	17	2	3
Follow-up consultation offered	16	6	NA
<b>Professional development of the physician</b>			
Number of medical articles read in the past month	0	0	22
Uses EBM in practice	20	NA	2
Monthly frequency of using EBM in practice	0	5	17
How many academic events attended in the past year	9	7	6
Has given a conference in the past year	13	9	NA
<b>View of parents by the child's physician</b>			
Active participation	19	3	0
Attention to recommendations	10	10	2
Has confidence	17	5	0
Is cordial	22	0	0
Fluidity in communication	20	2	0
Is respectful	21	1	0
<b>Type of activities carried out with the parents</b>			
Explains the disease	22	0	0
Gives the child's diagnosis	21	1	0
Use of prescription medications	20	2	0
Care to be given at the child's home	21	1	0
Quality of care given to children	19	3	0
How satisfied are you with the care given	18	2	2
Speaks to parents about health education	14	NA	3
Has training in health education	10	NA	12

NICU, neonatal intensive care unit. Good: 85-100 points. Average: 84-60 points. Poor: ≤59 points. EBM, evidence-based medicine; NA, not applicable.

the NICU according to the indices of “structure”, “personal physician”, “processes” and “results” using RDS as a tracer disease. This evaluation began from the time of birth itself of the neonate in level I and II NICUs, during transfer to level III NICU, and during the neonate’s stay in the unit. There were specific deficiencies found in the quality for each level III NICU analyzed, as well as those of level I and II that referred the neonates. The evaluations were submitted to the authorities of the SMNG and general recommendations were made for the total of the NICUs evaluated.

For the case of “structure” these were as follows:

1. Improve, in a good number of NICUs, the ratio of bed versus electrical outlets, which would allow the connection of a greater number of indispensable types of equipment for monitoring neonatal treatment.

2. Although not strictly indispensable, the acquisition of equipment for measuring blood gases was suggested that would be located within each NICU due to the importance of having acid-base status results and blood gases as soon as possible in order to perform necessary adjustments of the ventilator and of fluid infusions.
3. Increase the proportion of radiant warmers with respect to the incubators, which allows for a greater accessibility to carry out different procedures required by neonates with RDS.
4. Correct as soon as possible the deficiency of the availability of indispensable medications in the specific management of RDS.

With respect to “personal physician”, the recommendations are as follows.

**Table 6.** Quality indices of “processes” of medical care according to category in the NICU evaluated

Quality indices	Results according to category (n)		
	Good	Average	Poor
<b>Place of birth</b>			
Referred to public hospital unit	19	3	NA
Public hospital with level I or II NICU	19	3	NA
Prenatal care in referred public hospital	17	5	NA
Trimester when prenatal care began	15	3	4
<b>Managed in the first 12 h of life in the hospital where born</b>			
Placed in incubator or heated crib	17	NA	5
Arterial gasometry done	13	NA	9
Chest x-ray taken	22	NA	2
Alveolar surfactant applied	9	NA	13
<b>Conditions of the neonate during transport</b>			
In ambulance	20	0	2
Transported in incubator	10	8	4
Accompanied by physician	10	NA	12
Duration of transport (h)	2	11	9
Seriousness of RDS during transport	4	9	9
Silverman evaluation	3	7	12
Delivery of oxygen	5	7	10
Glucose upon arrival at NICU (mg/dL)	8	12	2
Body temperature upon arrival at NICU (°C)	10	2	10
<b>Assisted ventilation and comorbidity</b>			
Protocol for endotracheal intubation	19	NA	3
Protocol for assisted ventilation	20	NA	2
Ventilatory management	17	NA	5
Course(s) for pediatric or neonatal CPR	21	NA	1
Frequency of BPD >20%	16	NA	6
Frequency of pneumothorax in >20%	19	NA	3
<b>Healthcare activities of NICU physicians</b>			
Visits patients (h/week)	5	17	0
Participates in certification classes (h/week)	20	2	0
Accompanied by residents during the visit (h/week)	0	0	22
Library sessions (h/week)	9	0	13
General hospital sessions (h/months)	9	1	12
Administrative activities (h/week)	18	2	2
<b>NICU physician response in regard to alveolar surfactant</b>			
Surfactant can be substituted in RDS	12	4	6
Evaluate use of surfactant in RDS	20	2	0
Protocol for its administration	15	3	4
Frequency with following protocol	10	7	5
<b>Findings of surfactant in the clinical file</b>			
Gestational age at administration (weeks)	5	12	5
Age of newborn at time of administration of surfactant (h)	4	8	10
Applied dose of alveolar surfactant (mL/kg)	5	12	5
Number of doses applied	6	10	6

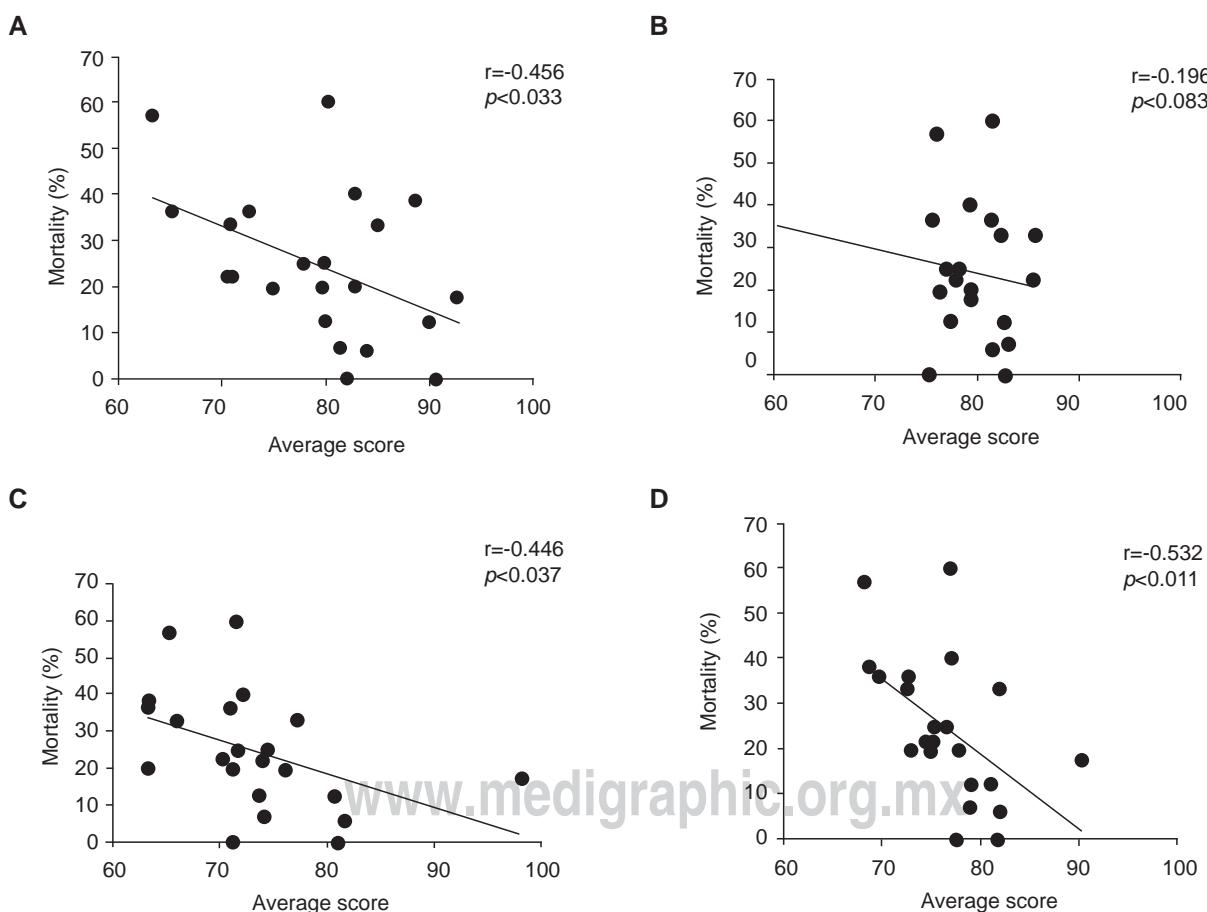
NICU, neonatal intensive care unit; NA, not applicable; BPD, bronchopulmonary dysplasia. Good: 85-100 points. Average: 84-60 points. Poor ≤59 points.  
 \* Survanta. \*\* Corosurf.

1. Implement greater academic activities
2. Dedicate more time to training of residents
3. Provide, as resources allow, a higher salary so that the majority of physicians work only for the assigned NICU, which would probably increase the important role that training of human resources should have, as is the case of nurses and neonatology and pediatric residents.

In terms of “processes”, the recommendations were as follows:

1. Correct the different causes that had an influence in the deficiencies found in the management done in the first 12 h of life in level I and II NICUs such as not admin-

- istering alveolar surfactant in 13 NICUs, not performing arterial blood gases in nine NICUs, or not utilizing incubators or radiant warmers in children with RDS.
2. The principal deficiencies found during the process of transfer in terms of severity indicated that neonates of level I and II NICUs should have been transferred sooner due to their serious condition, hypothermia or hypoglycemia experienced at their arrived at the level III NICU, which increases by not being monitored, in various cases, during the transfer by a physician.
  3. With regard to alveolar surfactant, administration criteria should be specified with respect to the gestational age of the neonate, age during administration of the alveolar surfactant, dose administered and number of applications.



**Figure 1.** Diagram of dispersion and coefficient of linear correlation of average scores on the indices of quality of neonatal intensive care in different evaluations. (A) “Structure”. (B) “Medical personnel”. (C) Health care “processes”. (D) Average total scores (A+B+C).

A finding that supported the method of evaluation of the quality applied in the present study was that it was shown that with the “results”, a lower score of the total average points of the ‘structure’ and of “processes” indicated a higher mortality. This was not the case with respect to the evaluation of the physicians when the three components were taken together (“structure”, “personal physician” and “processes”), although the association was also demonstrated. This correlation should not be necessarily considered to be categorical because although statistical significance has been demonstrated, it cannot be said that there is a cause-effect relationship. For this, new studies with better statistical methodology are required.

Among the limitations of the present study, it should be highlighted that although the information with respect to the “structure” was obtained directly from the chief of the NICU, which may generate a bias, it was controlled by the visual inspection of an external observer, which guaranteed the integrity of the data. This was not the case in some of the components evaluated with respect to the “processes”, which were obtained using a questionnaire given to the physicians assigned to the NICU. Here there may have been serious biases such as those related with ventilatory assistance and comorbidity, assistance activities of the NICU physicians, their response with respect to alveolar surfactant and the degree of availability of 15 indispensable medications for the management of RDS in the NICU. Despite this, the integrity of the physician responses could be inferred by what is reported in the *poor* category, noted by them in the questions graded with a Likert-type scale, which included aspects related with their assistance or educational activities. Another weakness of the study could be attributed to the dichotomic scores which, on occasion, were 100 and 75 points and in others 100 and 50 points. Also, according to the Likert scale only three variables out of the five it contains were utilized, and this is why it is called Likert *type*. Although the foregoing could affect the total scores of the indices, these were applied evenly to all the NICUs, decreasing the bias.

With respect to the remaining components of the “processes” the possibility of bias was eliminated as these were obtained directly from a review of the clinical records in which the physicians who worked in the NICU evaluated did not participate. Although obtaining the information was done through the medical record, some

limitations also were presented.<sup>11</sup> Largely, it is considered a direct source of information less able to be manipulated when compared with permanent records in databases in which, for example, the notes by the nursing staff are usually not incorporated. Another limitation of the present study that should be considered is not having evaluated the opinion of the parents with respect to their satisfaction of the medical care provided to their child.<sup>33</sup> In this regard it should be mentioned that there are doubts with respect to its usefulness when applied to the parents during the child’s stay in the NICU instead of carrying this out 2 to 3 months postdischarge.<sup>34</sup>

Other limitations include that there may have been a selection bias because patients who did not survive in levels I or II NICU were excluded from the study because the requirement was that they would arrive alive at the level III NICU. Although it may influence the mortality analysis, this would have prevented follow-up of RDS as a tracer condition evaluated from the time of birth. With regard to sample size (15 records were selected for each NICU), it should be mentioned that it was not statistically calculated because for the study of a tracer disease it is sufficient that for evaluation of the degree of compliance of the processes, a review of a maximum of five records can be evaluated.<sup>35</sup>

To place in context the results and limitations of this work and not to justify some methodological flaws, it is necessary to describe that among the few quality studies conducted in the world—focused in the areas of neonatal intensive care—is, among them, the system of accreditation of hospitals for adults and children carried out by the Joint Commission.<sup>35</sup> Mexico is familiar with this methodology. Although it is not specifically directed at the NICU, a tracer disease follow-up is used with a large group of standards. Unfortunately, these evaluations carried out in the areas of neonatal intensive care that we were able to investigate are not published, probably because of the confidentiality of the information that exists in this regard. In addition, this methodology also evaluates aspects of “structure” and “processes”, but these elements are not associated with the “results”, as is the case of the mortality in our study. In studies carried out in the U.S., well-defined standards are used to which the NICU should adhere to, related with physical “structure”, “material” and “personnel” because, in general, they are supported according to good practices that govern the diagnosis and treatment of diseases within the NICU itself.<sup>21-25,27</sup>

With respect to the “processes”, it should be mentioned that in a study of 3633 neonates with RDS in aspects related with the administration of the surfactant, there was failure found with regard to the adherence to the existing normativity in 46% of the NICUs evaluated.<sup>17</sup>

The publication of Blackmon et al. had another methodology focused on the ‘structure’ and the problem-solving capacity of the NICU by means of a questionnaire used in 35 U.S. states. The degree of compliance was evaluated of the national regulatory guidelines that apply for the NICU from level II to level IV.<sup>36</sup> In the study, it was identified that of a total of 35 states evaluated, only 24 met with one of the pre-established “regulatory criteria” and 25 covered the requisites of the “functional criteria” that included characteristics of the population, ability to provide respiratory support and cardiac surgery. With these results, they authors arrived at the conclusion that in the U.S. there are wide variations in care provided in the NICU.

Other variations of evaluations in the U.S. focused on the results of the incidence of certain diagnostic or therapeutic maneuvers to decrease comorbidities or mortality of neonates in the NICU as well as the impact of better practices.<sup>30,31</sup> In a study in which a group of experts in neonatology originally constructed a total of 28 measures of quality which, after a process of analysis, included only nine: antenatal steroid administration, time in which exam was done for retinopathy of prematurity, late start of sepsis, hypothermia on admission, presence of pneumothorax, rate of body growth, oxygen administration at 36 weeks of age postmenstruation, breastfeeding upon discharge of the neonate, and mortality. It was found that the effectiveness of the NICU evaluated was only 40% and safety 30%.<sup>37</sup> Another study exists in which quality was evaluated by means of the percent mortality based on different definitions for it, which are in agreement at the time of death and showed a great variability in the results depending on the classification used.<sup>38</sup>

In comparison with the U.S., in England there is a greater normality identified with respect to the standards covered in the different types of NICU. These are very detailed and precise and allow that those who are responsible for each NICU could perform a self-assessment with respect to the resources of “physical structure, materials and personnel”, including characteristics of the different levels of care. For example, in the year 2011, a Central Evaluation Committee performed an audit on 171 NICUs operat-

ing in England. This was supported by a questionnaire that each chief of service answered electronically.<sup>18</sup> The results were also electronically sent to each chief of the NICU personally, which allowed them to identify the deficiencies found with respect to meeting the existing standards. However, as was reported for the U.S., a model does not exist that includes the methodology of “structure”, “personal physician”, “processes” and “results” coupled with the tracer method. Another example is a quality study that included numerous NICUs of the U.S., England, Canada, Switzerland, and Australia in which great variability was demonstrated among countries regarding trends of percentage of neonates born at high risk, as well as variations of mortality and morbidity, organization and levels of care of the NICU, conditions during transfer of the neonate and better practices for the neonate and the families.<sup>39</sup>

Other factors that may also affect the limitations of the studies of the quality of the NICUs are questions that are recently posed to distinguish, with greater precision, the neonate with a diagnosis of RDS from other ailments that do not strictly correspond to that entity and whose ICD-10 codes for the same patient can be changed. This situation, despite being a suggestion, also may explain the variations found in quality studies performed.<sup>40</sup> Based on different quality studies of the NICU that have been described, it can be concluded that approaches have been varied and also have their limitations. However, they allow coming closer to the reality with respect to quality at the same time that they function as background for those who have developed each methodology to achieve an improvement in the quality of the NICU in subsequent evaluations.

Finally, in this study no further elaborate statistical analyses were performed and, perhaps, more accurately, a central finding was that, with this methodology, a comprehensive assessment was made of the quality of the NICU funded by the SMNG to provide care for infants and may serve as benchmarks for future assessments. It is then possible that the continual application of these indices could form the basis for a monitoring system and that tracking quality could of course be improved with new versions.

## ACKNOWLEDGMENTS

The authors acknowledge Drs. Raúl Villegas Silva, Rodolfo Rivas and Dina Villanueva García, neonatol-

ogists, for their important work in the validation of the quality indices.

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