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Managing NICU Patient Information with Computers Requires Re-Conceptualizing NICU Care - Part 2

By Joseph Schulman, MD, MS

This is the second in a two-part series adapted from: Schulman J. Managing Your Patients' Data in the Neonatal and Pediatric ICU: an Introduction to Databases and Statistical Analysis. Oxford, UK: Blackwell, 2006; with permission). Part 1 was published in the December 2007 issue and is available in a PDF file on the website - www.NeonatologyToday.net.

Part 1 of this article introduced the idea that using the full potential of computer technology to facilitate the work of the NICU entails thinking in fine-grained detail about how we represent our work and manipulate the associated information. Part 1 concluded with a visually complex yet relatively simple data model of the NICU. For continuity, here is a summary of last month's data modeling discussion, along with the eNICU relationship diagram.

Data Modeling: Summary from Part 1

A data model is an abstraction aimed at broadly representing the ideas and things that constitute an organization's work. It is the framework that specifies what kinds of data to keep and how to store them.

One models – maps – the important objects and events of the reality, so they may be "saved" and subsequently "manipulated." A

> ***"The goal is to develop tools that quickly help us turn data and information into knowledge articulated as final drafts; tools that provide the correct answers and only the correct answers to our important questions; tools that even point us to the questions we should be asking.[25]"***

relational data model is so named because it is based on the notion of mathematical relations, tables.*

The relational model specifies a variety of table features. Each of the relations, or tables, must have a unique name, as must each of the columns, or attributes. The values each attribute may have are specified by a domain. This notion of domain introduces meaning to the data contained in an attribute and helps to avoid incorrect relational operations. For example, a domain might dictate that telephone numbers contain only digits and may not be subjected to arithmetical operations. Each row (observation, record) in a table must be unique. Each cell, each intersection of a row and column, should contain only one value (jargon: field values should be atomic). *Thus, a single cell holds a single answer.*

Relationship Diagram**

In the eNICU relationship diagram,[1,2] a table is named using the prefix "tbl" and "camel caps" instead of a space between words that constitute a name. Relationships between tables are indicated by lines drawn from the primary key field***, in bold font, of one table to the foreign key**** field of the other table. When the relationship is one-to-one, the number 1 appears at each end of the connecting line. When the relationship is one-to-many, the many side of the relationship is represented by the symbol ∞.

The eNICU data model (See Figure 1, page 4) is the result of a reiterative process, described below. Some understanding of how to think about choosing and structuring data in a database can give users insight to database applications as cognitive tools: devices to represent and express what one knows; even to help one to discover new knowledge; to extend and facilitate what one could otherwise achieve unaided.[3]

Steps in Designing a Patient Database Application

1. Say what the database is to achieve. For example: This NICU database will maintain a core data set that attending neonatologists, neonatal nurse practitioners, and residents use in day-to-day patient record documentation and for NICU evaluation.
2. Specify exactly what you want to accomplish with the data
    a. List specific tasks the database will support, for example:
        i. Produce admission notes.
        ii. Produce daily progress notes.
        iii. Automatic attending sign-out summary.
        iv. Report service charges.
        v. Produce discharge summaries.
        vi. Satisfy organizational chart audit requirements
        vii. Populate the fields required for other database projects.
        viii. Support NICU-level evaluation.
3. Describe the current reality:
    a. At present, how do we collect data (forms, index cards, software application interfaces, etc.)?
        i. Collect samples of each way you currently record data:
            1. For each, describe how it is used and for what purpose.
    b. How do we currently present the information?
        i. Collect sample chart notes, etc.
    c. What information do users seem to need that they don't currently have?
        i. Why do we need it?
        ii. How do we know we need it?
        iii. Exactly what will be different if we had it?
        iv. What activities or documents rely on it?

*Table: A container for holding data that share common attributes. Tables have rows (horizontal divisions) and columns (vertical divisions). Each column describes one attribute of whatever the table is intended to describe. Each row contains one instance of the table's attribute set, one observation of the thing the table describes. Each row is also called a record. Each column is also called a field. If you had a table for storing several attributes of your patients, each row would contain the information for one patient (one record), with each column recording the information for each attribute (field). In database jargon, a table is also called a relation.

- Even though you think of a table as a rectangular structure that's neatly subdivided and has data in each of those subdivisions, your computer doesn't. The table appears that way on the screen only because your computer is trying to relate to people. Your computer actually stores the data as magnetic charges distributed not so uniformly on the computer disc. This gives the computer and database software lots of flexibility to manipulate and represent the data in tables.

**Relationship: The logical connection between information in one table (relation) with the information in another table (relation). When one record in Table A can relate to only one record in table B, a one-to-one relationship exists. Thus, each patient can have only one set of admission vital signs because a second set would no longer describe the condition at admission. When one record in Table A can relate to many records in Table B, a one-to-many relationship exists. One mother, for example, can have more than one infant.

***Primary key: One or more fields uniquely identifying each record in a table. That is, for each record, the value entered in the primary key field(s) is unique among all records in the table. Without a primary key, records in a database may become confused and database content degraded.

****Foreign key: A good way to link a record in one table with a record in another table is for each record to share some common attribute value. Thus, if we wish to connect a particular record in a table of infant data with a particular record in another table of maternal data, we would ensure the infant data table includes a field containing the mother's unique identifier – primary key value. Such a linking field is called a foreign key. The linked records together describe one instance of a higher entity, the mother/infant dyad in our example, constituted by the various tables in aggregate.

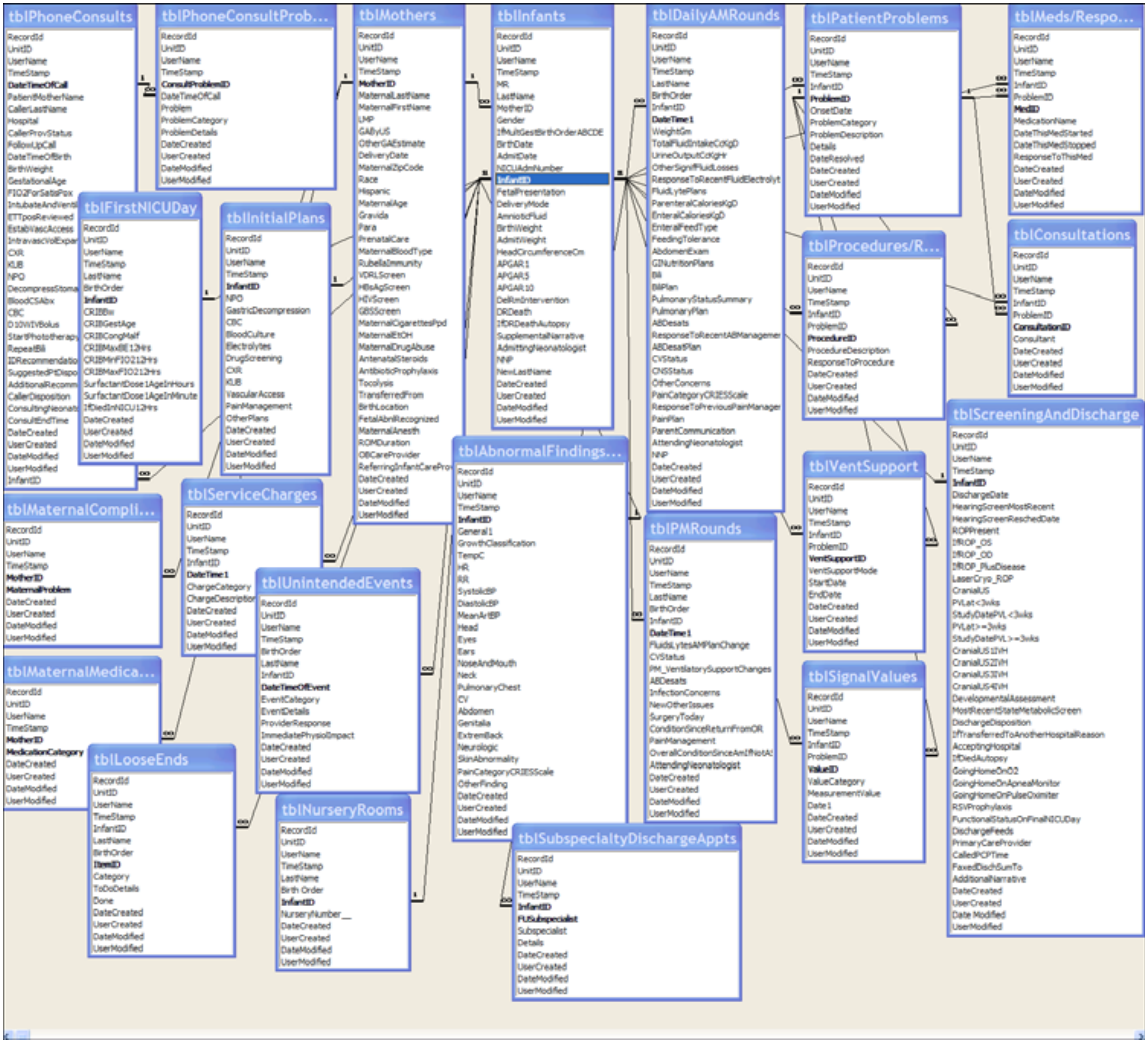

Figure 1. The eNICU data model (From Schulman J. Managing Your Patients' Data in the Neonatal and Pediatric ICU: an Introduction to Databases and Statistical Analysis. Oxford, UK: Blackwell, 2006; with permission).

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4. Make a list of all fields and calculations gathered from items 3a. and 3b.
   a. This is a preliminary field list; it contains current fundamental data requirements of the NICU and is the starting point for the design of the new database.
   b. Identify apparent duplicate fields:
      i. Do they represent the same attribute of the same entity?
         1. If so, drop all but one.
         2. If not, rename all but one so each uniquely describes a particular dimension of the entity
   c. Also look for fields with different names that actually describe the same attribute. Drop all but one.
   d. Place every calculated field (a field derived from other fields) on a separate calculated field list.
5. Ask for feedback on the list by all users. To encourage participation, schedule meetings by mutual assent and provide an appealing environment – refreshments.
6. Create the structures to contain the data:
   a. Tables
      i. Consider which fields appear to belong together
         1. Associate each field from the field list in item 4 with an appropriate table.
      ii. Review each table to ensure that it:
         1. Represents only one thing, or entity (object, event, or classification).
         2. Contains no duplicate fields.
      iii. Describe in writing what each table represents and exactly how it contributes to what the database is to achieve. Return to this description days or weeks later and assure yourself what you wrote is clear and coherent. Next, get a co-worker's opinion of it.
      iv. Edit the table names:
         1. Use unique, descriptive, and plural names: that make sense to all users.
   b. Fields (attributes). Assure yourself that each field is indeed an attribute of the object, event, or classification the table represents; relocate or delete fields as you think appropriate. Edit the fields. Use unique, descriptive, and singular names that make sense to all users. Check that each field is designed to contain only a single (atomic) value. Re-model a multi-valued field as a discrete table. Designate the primary and foreign keys to link the original table to the new table Identify each field that serves to link two tables; check that it appears in both tables, albeit under different respective field names.
7. Create a table on paper using "dummy" (fabricated) data and look for anomalies.
8. Continue to refine the table structures:
   a. Aim for redundant data only in linked fields.
   b. Aim for duplicate fields only in linked fields.
9. Designate keys for each table:
   a. Start by identifying all candidate keys.
   b. Next, select one primary key per table.
      i. Designate the remaining candidate keys as alternate keys.

Normalization: Objectives and Strategy

Several of the above database design guidelines endeavor to structure the data to conform to a branch of mathematical set theory called normalization theory. Normalization is a process applied to a set of relations so that:

1. Queries***** that logically may be asked of a set of relations indeed can be asked and will be answered correctly.
2. Relations store a minimum of redundant data.

An informally determined set of relations (tables) that is not normalized may be incapable of handling all possible queries. Further, such a set of relations may take up more storage space than necessary and therefore perform more slowly. It may even provide inaccurate query results! Thus, arbitrarily constructed databases, though they may contain the data elements individually deemed appropriate for representing the daily work, when interrogated may yield misleading or wrong answers.

Normalization assures the functionality of a database design and provides a non-arbitrary method for determining the appropriate tables. *Absent normalization, the patient information management system sooner or later will fail as a tool to facilitate the work of the NICU.* Normalization entails applying a series of tests to a group of tables. You apply the tests at successively more detailed levels of scrutiny. Each level imposes greater restrictions on the tables, ensuring greater resistance to problems with data management. Normalizing to three levels usually provides satisfactory performance results. Four more levels may be applied, but these deal with situations that most people are exceedingly unlikely to create even accidentally (refer to Connolly and Begg[4] Chapter 6; Whitehorn and Marklyn,[5] Chapter 25).

Is the Tool a Success?

Van Der Meijden et al reviewed publications between 1991 and 2001 that evaluated inpatient information systems requiring data entry and retrieval by health care professionals.[6] They found a plethora of studies extensively describing system failures, but could find no study that explicitly defined system success. Indeed, health information systems are rather prone to failing.[7] One fundamental for learning from an information system failure is to disentangle user resistance to change[8] from suboptimal technical solutions. Those who protest the changes now occurring in patient information technology must come to see that the real choice does not include the status quo.[9,10,11] Bearing in mind that user acceptance need not imply a problem successfully solved, you may want to read Lorenzi and Riley[12] for a review of individual and organizational factors that influence people to accept new information technology.

Many clinical information system failures are doomed at the outset because the system model did not map i.e. represent, the actual clinical work.[13] Further, "[software] systems cannot be adequately evaluated by their developers, a principle

*****Query: A question you ask of a database. You ask the question operationally, providing a set of instructions for finding a subset of the data in the database. To produce a report, for example a daily progress note, from the data that were entered into a variety of fields, a number of queries must be run. Query results – answers – are assembled according to specific instructions specifying exactly where and how they are to appear in the report.

commonly overlooked in healthcare."[13] Users play a central role in evaluating a system and calibrating it to meet user needs.

What does it take to hit the bull's-eye on the patient information system target? The target is large, so you might think that achieving even a near-success should not be very difficult. But the bull's eye is hard to discern. Our notions vary so much we frequently can't agree on what constitutes the bull's eye.[7,14-17] Hitting the bull's eye:

- May mean different solutions for apparently similar problems and aims that reside in different environments.
- Requires realistic expectations: early iterations of a solution may produce only tolerable or promising results:
  - It's just not possible to anticipate every issue that will arise after implementing new technology.

We have yet to understand clearly what we do and aim to achieve. Here are some abstract examples; try to think of specific instances from your own experience:

- We confuse reporting information with interpreting information.
- We inconsistently learn from aggregate experience.
- We like to think patient records tell stories, but we have many different ideas of what these stories should be – content and utility vary widely.
- Too often, information systems have a singular target audience: health professionals:
  - Although communication and interaction among providers, patients, and families is an integral part of care, operational specifications for these activities at the technological and organizational levels are underspecified.[18]

Candidate aims for our systems might include:

- Specifying what constitutes a minimum dataset (data model) for particular clinical contexts.
- Ensure clinicians *interpret* patient information by requiring that clinicians *transform* it to a useful category:
  - Consider, for example, the differences between Na=157, hypernatremia, free water deficit, sodium excess. The first two are, alone, insufficient to guide clinical action. The latter two constitute information you can use to guide clinical action.
- Facilitate both system-level and patient-level evaluation and learning.
- Protect patient confidentiality yet facilitate information sharing.
- Ensure capability to migrate to an alternate database management system.
- Ensure ability to communicate with other information systems
- Integrally involve patients and their families in decision making.
- Recognize the communication space that is a regular part of health care; facilitate both the formal and informal social interactions that are a basic part of the daily work.[18]

Broad evaluative criteria for solutions might include:

- Positive impact on duration and flow of daily work:
  - Decreases work flow interruption associated with communication yet facilitates conversation: – information sharing.[18]
- Decreased probability of error.[19]
- Identify unanticipated system problems by surveying:
  - What do you need that you're not getting?
  - What are you getting that you don't need?
  - How did you decide each was the case?
- Agreed upon attribute set is consistently populated for:
  - Admission notes.
  - Daily progress notes.
  - Discharge summary.
  - Sign-out summary.
- System consistently populates an agreed upon attribute set that informs facility performance evaluation and specific research questions.
- System includes elements aimed at patients and their families – so-called information prescriptions that facilitate shared decision-making, are based on current and high-quality evidence, reflect the patient's interests, and are easy to understand.[20]
- Improves operationally defined practitioner performance and patient outcomes.[21]

Conclusion: Tools that Make Us Smarter

"When IBM discovered that it was not in the business of making office equipment or business machines, but that it was in the business of processing information, then it began to navigate with clear vision."
~Marshall McLuhan, 1964
(von Baeyer,[22] p5)

Every day, we clinicians collect vast amounts of data to fuel our prodigious information processing industry. But processing information is only a part of our mission. Ultimately, we use information. We *implement* the results of data management and analysis.

In Part 1 of this article, I alluded to attitudes of technological laggards among us, those reluctant to give up the traditional ways by which they manage and learn from patient information. To be fair, health care workers tend to be rather intelligent and reasonable people. So why would intelligent and reasonable people obstinately prefer that new technology continue to impose the shortcomings of the old technology?

One common strain reverberates in workers' replies. They, indeed all of us, are accustomed to engaging with a patient problem on the basis of a narrative – a *story* about what happened. Similarly, we are accustomed to transferring our knowledge of a patient via a story. Telling stories can tie together into a coherent whole, items of information that individually may seem disparate. When they are about unsolved problems, stories, by creating a coherent account of events, may clarify the nature of the true problem and inspire new candidate solutions. If we did not tell the story we might not coherently organize the components. Thus, stories are a means to discover new knowledge.[23] Further, by their retelling, stories can establish a common interpretive framework.[23] If this is so, then the widespread variation in healthcare[14 24] suggests we have much yet to learn about telling good stories.

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In any event, our predisposition for story formats conflicts with computer outputs. These don't tell a story in the traditional way: typically, they simply provide information. Don't be deceived by software applications that offer narrative report formats. Such formats entail inserting field values into spaces in a fixed template. I know of no software that consistently creates accurate, apropos, clear, coherent, and complete stories from our data. Superficially, the computational product may look like a traditional story; but though it may gratify our human need for a story, rarely will it meet the real cognitive need for one.

The computational product lacks the richly nuanced functionality of the real thing. Storytellers calibrate details to the story aims. At times, stories are telling by what we leave out. Storytellers arrange story elements to reflect their importance and chronology for the thesis. Generic rank- or time-ordering may be pointless, or worse, distracting. Story tellers may select one word only subtly different from an alternate, or may use especially vivid vocabulary, because word choice may be crucial to accurately communicating a particular idea. No, computers are not real story tellers.

On the other hand, the stories we are accustomed to using in our work may seem compelling, but they are not always accurate, apropos, clear, coherent, and complete. We cannot reliably identify the details that matter, nor interpret them. If we could, I would not have written, and you would not have read, this article. Nonetheless, stories are a communication modality – and often, a cognitive tool – rooted in our cultural evolution, a deep and essential part of how we engage with others' experience; and with our own. To show we understand, we tell our story. Indeed, it is by telling the story that we may first understand (see Norman,[25] especially Chapter 5). Our challenge is to use our new technology to facilitate accurate, apropos, clear, coherent, and complete stories; stories that reflect our accrual of fresh experience and knowledge, connect it to what has gone before, and communicate what we know to others.

The problem with our stories about patients is we've tended to consider these stories within the long tradition of oral storytelling. This tradition permits enormous variation in details among iterations of the same tale (Norman,[25] p 150). From the same situation people can tell different stories. From the same story, people can draw different conclusions. The cognitive tools constituting a well conceived computer-based patient information management system should help with this problem. To the extent that the tools help us determine to what we should attend and enable us to attend to them accurately and reliably, our tools can make us smarter. But the problem is broader still. When you read a scholarly article or book, you expect not the author's first draft, but the final product of reiterative composition and revision. For at that stage of refinement are the ideas likely to be clear and coherent, the reading easy as possible. From this perspective, both traditional pen- and paper-based patient notes and related oral communication with colleagues – the stories we tell about our patients – are commonly "first-drafts." New cognitive tools for patient information may automate composition and revision, but beware: we know little about how to do this well.

The goal is to develop tools that quickly help us turn data and information into knowledge articulated as final drafts; tools that provide the correct answers and only the correct answers to our important questions; tools that even point us to the questions we should be asking.[25]

> *"Science is built of facts the way a house is built of bricks; but an accumulation of facts is no more science than a pile of bricks is a house."*
> *~ Henri Poincaré*

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> *~Henri Poincaré"*

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Appendix

Part 1 of this article showed the user interface and daily progress note enabled by the eNICU data model. On the following pages 10-13 (Figures 2-5) is a discharge summary produced automatically (from fictional data). Complete operational details are available.[2]

NT

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eNICU: Discharge Note

LastName: New Last Name Female
BirthDate 9/25/2002
AdmitDate 9/25/2002
Discharge Date 9/30/2002

MR 123123
InfantID: 1231231
AMC Adm No 1
GA *LMP* 35 *U/S* *Other est.*

AmnioticFluid clear
FetalPresentation transverse
DeliveryMode Caesarian
DelRmInterventio BMV

APGAR 1, 5, 10 6 7 8
BirthWeight 1475
AdmitWeight 1410
HC (cm) 30

Supplemental narrative at admission:
Concern for GI perforation.

Maternal Information

OBCareProvider Dexter, S.
ReferringInfantCareProvider

DeliveryDate 9/25/2002 *TransferredFrom* Bassett (Coopersto *BirthLocation* AMCH

Last Name Test3 *Age* 19 *Gravida* 2 *Para* 0010 *PrenatalCare* Y
First Name Jane *Race* White *Hispanic* N
LMP 1/23/2002 *Smokes? (ppd)* 2
GA by U/S *Alcohol use?* N
Other GA est. *Illicit drug use?* N
Fetal Abnl Recognized N *Anesthesia* spinal/epidural

Prenatal Screening

Blood type	*Rubella*	*VDRL*
AB+	immune	negative
HBsAg	***HIV***	***GBS***
negative	negative	unknown

Maternal Problem

Asthma
Depression (meds)
Poor maternal weight gain

Medication Category

antidepressant
bronchodilator

Tocolysis N
Antenatal steroids? incomplete (<1 or >7 days PTD
ROMDuration 1-12 hours
Abx prophylaxis? none

Problems/Interventions

1. *Category*	*Description*	*Details*	*Onset*	*Resolved*
CNS	neuromuscular tone: low		9/25/2002	9/27/2002

Ventilatory support associated with this problem

	Start Date	*End Date*
conventional mech ventilation	9/25/2002	9/26/2002
HFOV	9/26/2002	9/26/2002
NCPAP	9/26/2002	9/27/2002
oxyhood	9/27/2002	9/28/2002

New Last Name 123123 *Discharge Summary* *Page 1 of 5*

Figure 2. The eNICU data model (From Schulman J. Managing Your Patients' Data in the Neonatal and Pediatric ICU: an Introduction to Databases and Statistical Analysis. Oxford, UK: Blackwell, 2006; with permission).

Procedures associated with this problem

9/25/2002 10:28:21 AM LP subseq status unrelated

Consultants for this problem

neurology

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2. *Category*	*Description*	*Details*	*Onset*	*Resolved*
INFECTION	sepsis < 72 HRS: suspected		9/25/2002	9/28/2002

Medications associated with this problem

	Started	*Response*	*Stopped*
ampicillin	9/25/2002	improved	9/27/2002
gentamicin	9/25/2002	improved	

Signal values related to this problem

WBC 37 9/25/2002

Procedures associated with this problem

9/25/2002 10:40:38 AM LP no detectable effect

Consultants for this problem

ID

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3. *Category*	*Description*	*Details*	*Onset*	*Resolved*
PULMONARY	RDS		9/25/2002	9/30/2002

Medications associated with this problem

	Started	*Response*	*Stopped*
O2	9/25/2002	improved	9/28/2002

Signal values related to this problem

pCO2 96 9/25/2002

Procedures associated with this problem

9/25/2002 10:37:22 AM endotracheal intubation improved

4. *Category*	*Description*	*Details*	*Onset*	*Resolved*
PULMONARY	O2 requirement		9/25/2002	9/30/2002

Signal values related to this problem

pO2 32 9/25/2002

New Last Name 123123 *Discharge Summary* *Page 2 of 5*

Figure 3. The eNICU data model (From Schulman J. Managing Your Patients' Data in the Neonatal and Pediatric ICU: an Introduction to Databases and Statistical Analysis. Oxford, UK: Blackwell, 2006; with permission).

5. *Category*	*Description*	*Details*	*Onset*	*Resolved*
SURGICAL	jejunal atresia		9/25/2002	9/30/2002

Procedures associated with this problem

9/25/2002 11:03:11 AM jejunostomy improved

Screening and Discharge Information

DischargeDate 9/30/2002

HearingScreen (most recent) Passed *If Screen Re-scheduled, Date:*

ROP present? Yes *IfROP_OS:* Stg 2, Zn 1 *IfROP_OD:* Stg 2, Zn 2 *PlusDisease?* O.S. and O.D

LaserCryo_ROP: O.S. and O.D.

CranialUS: Y

IVH stage on cranial U/S
#1 0
#2 1
#3 1
#4 1

PVLat<3wks: N *StudyDatePVL<3wks:*

PVLat>=3wks: Y *StudyDatePVL>=3wks:* 10/30/2002

DevelopmentalAssessment Normal

Functional status normal newborn

Most recent metabolic screen normal *If died, autopsy*

DischargeDisposition home *If transferred, reason* *AcceptingHospital:*

Discharge equip/supplies: *O2* Y *PulseOximiter:* Y *Apnea monitor* Y

DischargeFeeds: Breast milk + HMF *RSVProphylaxis:* Indicated:<32 wks

Primary care provider Tomiak *Discussed:* 9/30/2002 10:00:00 AM *Faxed copy to:* (518) 262-5421

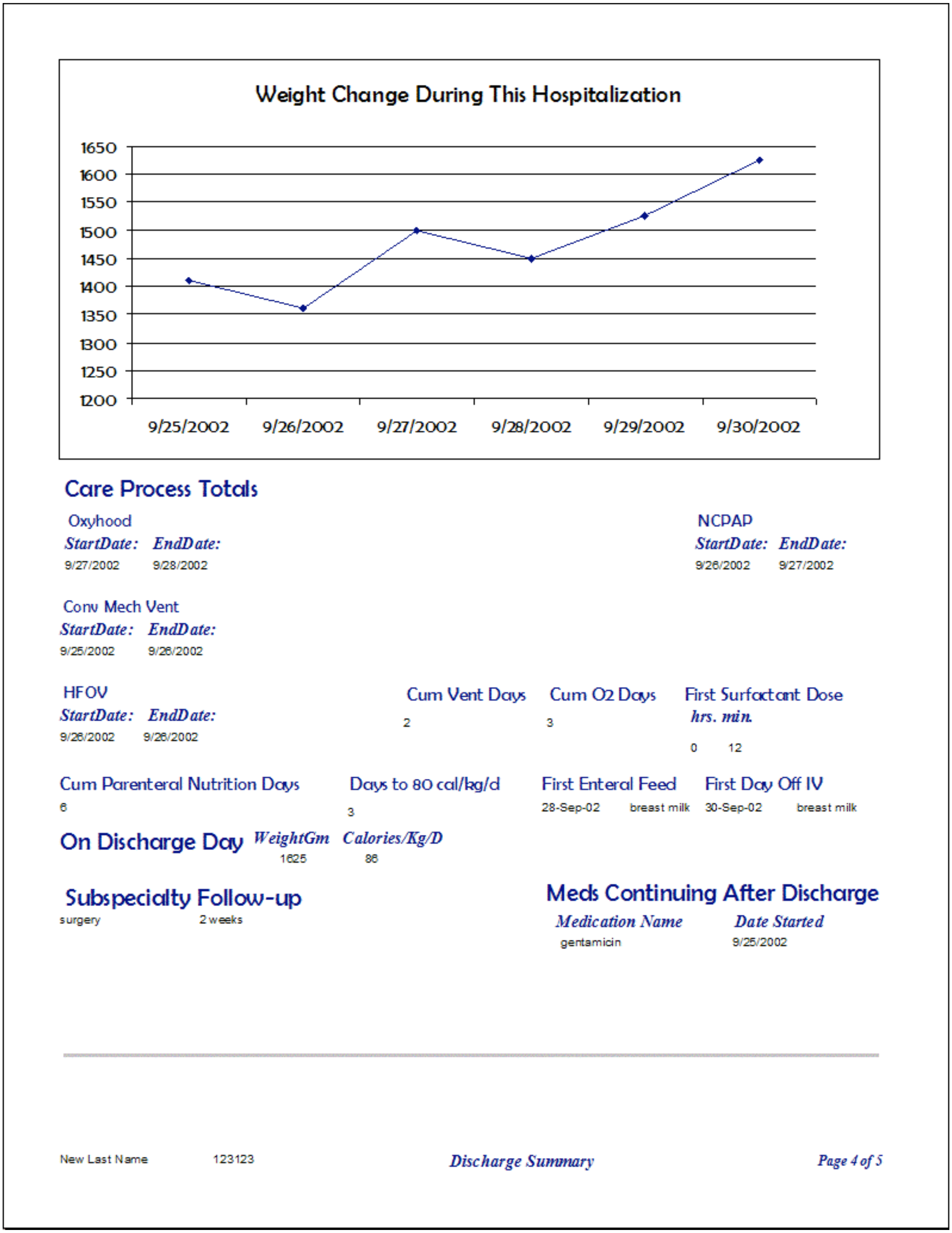
Pre-discharge exam unremarkable except as noted below:

Pertinent Findings on Discharge PE and Supplemental Narrative

Normal exam for age

NewLast Name 123123 *Discharge Summary* *Page 3 of 5*

Figure 4. The eNICU data model (From Schulman J. Managing Your Patients' Data in the Neonatal and Pediatric ICU: an Introduction to Databases and Statistical Analysis. Oxford, UK: Blackwell, 2006; with permission).



Weight Change During This Hospitalization

Care Process Totals

Oxyhood
StartDate: *EndDate:*
9/27/2002 9/28/2002

NCPAP
StartDate: *EndDate:*
9/26/2002 9/27/2002

Conv Mech Vent
StartDate: *EndDate:*
9/25/2002 9/26/2002

HFOV
StartDate: *EndDate:*
9/26/2002 9/26/2002

Cum Vent Days
2

Cum O2 Days
3

First Surfactant Dose
hrs. min.
0 12

Cum Parenteral Nutrition Days
6

Days to 80 cal/kg/d
3

First Enteral Feed
28-Sep-02 breast milk

First Day Off IV
30-Sep-02 breast milk

On Discharge Day *WeightGm* *Calories/Kg/D*
1625 86

Subspecialty Follow-up
surgery 2 weeks

Meds Continuing After Discharge

Medication Name	*Date Started*
gentamicin	9/25/2002

New Last Name 123123 *Discharge Summary* *Page 4 of 5*

Figure 5. The eNICU data model (From Schulman J. Managing Your Patients' Data in the Neonatal and Pediatric ICU: an Introduction to Databases and Statistical Analysis. Oxford, UK: Blackwell, 2006; with permission).

The Internet and the Horizontalization of Learning

By Marcelo Cardarelli, MD, MPH and Rodolfo Neirotti, MD, MPA, PhD

In 1751, France and then the rest of Europe saw the first volume of Le Encyclopedie, a visionary combination of a 300 year-old technology (the printing press) with an innovative way of collecting and distributing knowledge. That would be the first of 35 volumes containing over 70,000 articles on all aspects of life. This was an innovative, daring way to disperse information and ideas among the European elites and it would create the model to be followed by all the encyclopedias to come, among them Encyclopedia Britannica, the oldest of its kind and still in publication.

A quarter of a millennium later, the combination of yet another revolutionary technology and an evolutionary way of looking at the distribution of information made the sharing of files, news, music, videos, experiences and science an easy and satisfying experience. This novel form of knowledge broadcasting, the Internet, can be seen as a truly progressive step because this time new ideas and information are not restricted to the elites. This time, knowledge is available to the global village.

In this same vein and with the financial support of a family foundation (The Nieves Foundation based in Maryland, U.S.A.), a new website dedicated to the sharing of files, experiences, anecdotes, history and knowledge in the field of Pediatric Heart Disease was introduced last December.

PediCardioPedia (www.PediCardioPedia.org) was created with the purpose of becoming one of the world's most useful online mediums dedicated exclusively to the global audience of specialists in the areas of Pediatric and Congenital Heart Surgery, Pediatric Cardiology, and all the related specialties.

This new website merges two of the most successful models on the Internet today, Wikipedia™ and YouTube™, combining them to facilitate the teaching/learning experience of pediatric heart disease and placing it within reach of a very selective audience like yourself.

After a free and simple registration process, any specialist logging on to Pedicardiopedia has immediate access to a wide array of features: a growing "Wikipedia-like" editable collection of topics in the sciences related to pediatric cardiology and pediatric cardiac surgery, including areas on: cardiac anesthesia, pediatric cardiac pathology, pediatric intensive care, nursing and adult congenital cardiology/surgery. Submissions are simple and unrestricted. There is no need for editorial approval since peers edit the material on line and as needed. Within this section the possibilities are limitless. Topics are not restricted to clinical issues and the idea is to incorporate collaborations in the areas of humanitarian medicine leadership/management and international development.

This open-access/open content format initiative gives professionals around the world, particularly those with fewer resources, free access to educational materials that can be easily manipulated to suit individual learning styles.

Files of up to 30 MB of video in the form of angiograms, interventional catheterizations or surgical techniques can be uploaded and shared thanks to the website's video uploading capability. Experiences can now be distributed at a speed never before imagined and yet necessary in such a fast moving specialty. A master lectures and short papers section, a non-editable and by invitation only feature where PowerPoint ™ presentations, video or text can be uploaded. Lectures and essays by distinguished figures in the field will give the user an inside look at their experiences and wisdom. Lastly, there is a section dedicated to common problems that affect those in the field and their collective solutions: A place for professionals to share their experiences, their problems as well as their solutions and to get expert advice from colleagues around the world. This section contains a clinical and a non-clinical issues component, from consultations on what to do with a difficult clinical case to how to organize a humanitarian trip to a developing country, it will all be there, waiting for the collaboration of the universal audience.

PediCardioPedia takes advantage of two other innovative features of the Internet. By the use of a Creative Commons™ licensing and its "some rights reserved" approach, contributions are licensed in a way that is open and dynamic yet offering protection. Contributors are not giving up credit while opening their ideas to a larger audience.

Although English is the language of choice, an automatic computer generated multilingual translation system is available giving contributors the opportunity to read and post material in the "Topics section" in some of the most often spoken languages.

Armed with tools like the one described here, the future of congenital heart disease may still look challenging and unpredictable, but it has probably never been better equipped for it.

While a small part of our mind still lives in the France or Britain of the XVIII century and craves for the illumination from the elites, the self-motivated and imaginative part of it bathes in the interconnected world of the XXI century, where the collective intelligence may help to resolve more efficiently our daily trials.

NT

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Salary Survey - Sponsored by TIVA HealthCare, Inc.

Please complete the following survey and FAX this page to: 1-240-465-0692

Where does you salary compare with your peers? Please complete the following anonymous salary survey. We will publish the findings in a follow-up article on salary levels in Neonatology.

1. How many years has it been since your Fellowship? ________Years

2. Are you a Board Certified in Neonatology (Place an "X" in the appropriate box)?
   a❑ Yes b❑ No c❑ In the process of becoming B/C

3. In terms of your compensation, what is your Base Salary? $________________________

3A. How much is your Bonus? $_________________________

4. What type of Position do you hold (check all that apply)? a❑ Academic b❑ Clinical

5. What type of Healthcare benefits you receive (check all that apply)?
   a❑ Healthcare c❑ Dental
   b❑ Vision d❑ None

6. If you receive Healthcare, is it (check one)? a❑ Individual Only b❑ Family

7A. Is your Healthcare (check one)? a❑ Fully Paid by Employer b❑ Partially Paid by Employer

7B. How many Vacation Weeks per year do you get? __________ Weeks

8. Do you get a CME Allowance (check one)? a❑ Yes b❑ No If, yes, how much? $____________________

9. Is your Malpractice Insurance paid by your employer (check one)? a❑ Yes b❑ No c❑ Partially paid

10A. What type of Retirement Plan do you have through your place of employment (check one)?
   a❑ 401K b❑ 401B c❑ Other d❑ None

10B. What is the approximate Value of your employer's participation in your retirement? $__________________

11. How many years have you been at your current place of employment? _________ Years

12. For demographic analysis only, what is your 5-digit Residential (Home) Zip or Postal Code? _______________

13. **Optional:** Do you have any additional comments you would like to make: ______________________________

____

____

Thank you,

Research Department
Neonatology Today

Medical News, Product and Information

IKARIA'S INOMAX® (Nitric Oxide) for Inhalation Approved in Australia

Ikaria Holdings, Inc., through its subsidiary INO Therapeutics LLC, has announced that it has received approval from Australia's regulatory body, the Therapeutic Goods Administration (TGA), for INOmax (nitric oxide) for inhalation. INOmax has been designated an orphan drug by the TGA. The Australian Orphan Drug Act provides a pathway for the development of medical products to treat rare disorders. INOmax is the first pharmaceutical gas approved in Australia, a designation it also has received in the US, Europe, Canada, Singapore and several countries in Latin America. INOmax is indicated for the treatment of near- and full-term newborns who suffer from hypoxic respiratory failure (HRF), a potentially life-threatening condition that keeps babies' lungs from delivering enough oxygen to their bodies.

Ikaria expects that INOmax will be marketed and distributed in Australia beginning in January 2008 through an alliance with BOC Medical, a division of BOC Limited, a company within the Linde Group. BOC Medical is a leading supplier of medical gases and equipment to the health care sector and will supply INOmax throughout Australia.

"As we broaden the reach of INOmax to new continents, we are expanding our ability to advance critical care around the globe," said Ikaria Chairman and CEO David Shaw. "Through our partner, BOC Medical, with its 60 years of experience in Australia, we look forward to bringing this important therapy to neonatal critical care across the Australian continent."

INOmax, in conjunction with ventilatory support and other appropriate agents, is used for the treatment of term and near-term (>34 weeks) neonates with hypoxic respiratory failure associated with clinical or echocardiographic evidence of pulmonary hypertension.

INOmax is designed to help critically ill newborns breathe more effectively by dilating the blood vessels of the lungs, which improves oxygen uptake and oxygen supply to the tissues of the body. INOmax therapy has been shown to reduce the need for a highly invasive surgical procedure known as extracorporeal membrane oxygenation, or ECMO. During ECMO, an infant's blood is mechanically oxygenated by connecting the baby to a heart-lung machine.

INOmax should not be used in the treatment of neonates known to be dependent on right-to-left shunting of blood. Abrupt discontinuation of INOmax may lead to a worsening condition. Methemoglobinemia is a dose-dependent side effect of inhaled nitric oxide therapy. Nitrogen dioxide (NO_2) forms rapidly in gas mixtures containing nitric oxide and oxygen and thus may cause airway inflammation and damage. Methemoglobin, NO_2, and the fraction of inspired oxygen (FiO_2) should be monitored during nitric oxide administration.

For more information on INOmax, visit www.inomax.com/.

Ikaria Holdings, Inc. is a fully integrated biotherapeutics company focused on the development and commercialization of innovative in-hospital pharmaceutical products and drug/device combinations that improve the lives of patients. The company's product, INOmax (nitric oxide) for inhalation, is an FDA-approved drug for the treatment of hypoxic respiratory failure in term and near-term newborns and is extensively used in critical care settings in the US.

The drug also is approved by regulatory authorities and used in Canada, Europe and Latin America. In addition to marketing and selling its INOmax product, Ikaria is engaged in both Phase II trials with Covox® (carbon monoxide) for inhalation and Phase I trials with hydrogen sulfide (H_2S) for various indications. For more information on Ikaria, please visit www.ikaria.com.

Prenatal Arsenic Exposure

The children of mothers whose water supplies were contaminated with arsenic during their pregnancies harbored gene expression changes that may lead to cancer and other diseases later in life, MIT researchers and colleagues reported in a new study. In addition to establishing the potential harmful effects of these prenatal exposures, the study also provides a possible method for screening populations to detect signs of arsenic contamination. This is the first time evidence of such genome-wide changes resulting from prenatal exposure has ever been documented from any environmental contaminant. It suggests that even when water supplies are cleaned up and the children never experience any direct exposure to the pollutant, they may suffer lasting damage.

The research was published in the Nov. 23 issue of PLoS Genetics (published by the Public Library of Science). The research at MIT was led by Leona Samson, Director of MIT's Center for Environmental Health Sciences and the American Cancer Society Professor in the Departments of Biological Engineering and Biology. This research was funded by the National Institutes of Environmental Health Sciences and the Chulabhorn Research Institute. For more information: http://web.mit.edu/newsoffice/2007/arsenic-1122.html

Researchers Identify Definitive Marker to Predict Preterm Delivery

Researchers have identified a definitive marker to predict preterm delivery, according to a new study, entitled, Prediction of Preterm Delivery Based on Maternal Plasma Urocortin, accepted for publication in the Journal of Clinical Endocrinology & Metabolism (JCEM).

"Preterm birth remains a significant management problem and a large number of markers of the disease have been investigated," said Pasquale Florio, PhD, of the University of Siena in Siena, Italy and lead author of the study. "We have found that urocortin had a positive predictive value of 100% as a marker for preterm delivery."

This is the first study to report that maternal plasma urocortin levels were increased in women with threatened preterm delivery, and that those with highest concentrations delivered within seven days of hospitalization for painful regular uterine contractions.

A rapid release version of this paper has been published online and will appeared in the December issue of JCEM, a publication of The Endocrine Society.

Other researchers involved in this study include Michela Torricelli, Elisa Faldini, Fernando Reis, Alberto Imperatore, Giulia Calonaci, Enrico Picciolini, and Felice Petraglia of the University of Siena in Siena, Italy and Elizabeth Linton of the University of Oxford in Oxford, England.

Fetal Heart Rate Yields Clues to Children's Later Development

Variations in heart rate patterns provide information on how the nervous system functions in adults and children. Obstetricians have long considered heart rate patterns to be important indicators of fetal well-being during the prenatal period as well as in labor and delivery. Now a new study has found that heart rate patterns before birth also predict the rate at which children develop through their toddler years.

The research, conducted by scientists at Johns Hopkins Bloomberg School of Public Health, the National Institutes of Health, and Johns Hopkins Medical Institutions, appeared in the November/December 2007 issue of the Journal Child Development.

In the study, scientists measured fetal heart rate and variability (the degree to which heart rate gets faster and slower within a specific time period) six times from 20 through 38 weeks of gestation in 137 healthy women with normal pregnancies. They then examined the children born to those women when the children were between the ages of 24 and 36 months, looking at their mental, motor, and language abilities.

After about 28 weeks of gestation, greater variation in fetal heart rate predicted better performance on a standardized developmental exam administered when the children were 2 years old, and more proficient language ability when the children were 2-1/2 years old, the study found. Also, fetuses that showed more rapid gains in heart rate variation beginning at 20 weeks gestation progressed through mental, motor, and language milestones as children more quickly than fetuses with slower gains in heart rate variation.

The results suggest that the foundations of individual differences in children's development originate during gestation, and that the developmental momentum of the fetal period continues after birth. In short, individual differences in variations in fetal heart rate as early as midway through pregnancy appear to provide information about children's developing nervous systems after birth and through the toddler years.

"Further demonstration that these and other indicators of fetal functioning supply important information about the developing nervous system will enrich our understanding of the importance of the prenatal period for later life," according to Janet DiPietro, a professor in the Department of Population, Family, and Reproductive Health and Associate Dean for Research at Johns Hopkins

Bloomberg School of Public Health, who is the lead author of the study.

"In turn, such knowledge can contribute to the formulation of strategies focused on improving prenatal functioning in these arenas by facilitating pregnancy well-being. However, since current obstetric care already routinely evaluates heart rate patterning as an indicator of fetal distress, pregnant women do not need to seek out additional information about their baby's heart rate from their providers."

The study was funded by the National Institute of Child Health and Human Development (NICHD), the Maternal and Child Health Bureau, and the NIH/NICHD Intramural Research Program.

Adding a Rapid Response Medical Team in a Children's Hospital Helps Reduce Risk of Death, Rates of Cardiac and Respiratory Arrest

A children's hospital that added a rapid response medical team for patients not in the intensive care unit saw an 18% decrease in the death rate, and about a 70% decline in the rate of cardiac and respiratory arrests, according to a study in the November 21, 2007 issue of JAMA.

Introduction of a rapid response team (RRT; medical emergency team) has been shown to decrease death and cardiopulmonary arrests outside of the intensive care unit (ICU) in adult inpatients, according to background information in the article. An RRT is a multidisciplinary team frequently consisting of ICU-trained personnel who are available 24 hours per day, 7 days per week for evaluation of patients not in the ICU who develop signs or symptoms of clinical deterioration.

"The RRT intervention was developed in response to research that revealed adult patients on general medical and surgical hospital units often have evidence of physiological deterioration several hours before cardiopulmonary arrest, and that after a cardiac arrest occurred, survival rates were poor. Given that there appears to be a window of opportunity to identify and proactively treat 'prearrest' adult inpatients effectively, the Institute for Healthcare Improvement recommended RRTs be implemented nationwide in an effort to decrease inpatient mortality rates," the authors write. Limited data exist evaluating the effectiveness of RRT implementation in pediatric inpatients.

Paul J. Sharek, MD, MPH, of Stanford University School of Medicine, Palo Alto, CA, and colleagues evaluated whether RRT implementation was associated with decreases in hospital-wide mortality rates and code rates (respiratory and cardiopulmonary arrests) outside of the ICU in pediatric inpatients at a 264-bed academic children's hospital. Pediatric inpatients who spent at least one day on a medical or surgical ward between January 2001 and March 2007 were included. A total of 22,037 patient admissions were evaluated pre-intervention (before September 1, 2005), and 7,257 patient admissions were evaluated post-intervention (on or after September 1, 2005).

A significant decrease of 18% occurred in the hospital-wide mortality rate after implementation of the RRT. The rate of codes outside of the ICU setting per 1,000 eligible admissions declined by 71.7%, with pre-intervention and post-intervention rates of 2.45 vs. 0.69, respectively. The rate of codes outside of the ICU per 1,000 eligible patient-days decreased by 71.2% after RRT implementation.

The RRT intervention, using statistical modeling, was associated with a decrease of 0.178 deaths per 100 discharges or 1.78 deaths per 1,000 discharges. During the 19-month post-intervention period, the RRT intervention is estimated to have resulted in 33 lives saved at this hospital.

"Implementation of an RRT in our freestanding, quaternary care academic children's hospital was associated with statistically significant reductions in hospital-wide mortality rates and code rates outside of the ICU setting. These reductions cannot be explained by differences in patient characteristics or severity of illness between the control and post-intervention populations," the authors write.

"The potential implications of these findings on national mortality rates for children are dramatic. Future research should focus on replicating these findings in other pediatric inpatient settings, including settings where children are treated in predominantly adult-focused hospitals, developing efficient methods for implementing RRTs, and evaluating the cost-effectiveness of this intervention."

(JAMA. 2007;298(19):2267-2274. Available pre-embargo to the media at www.jamamedia.org).

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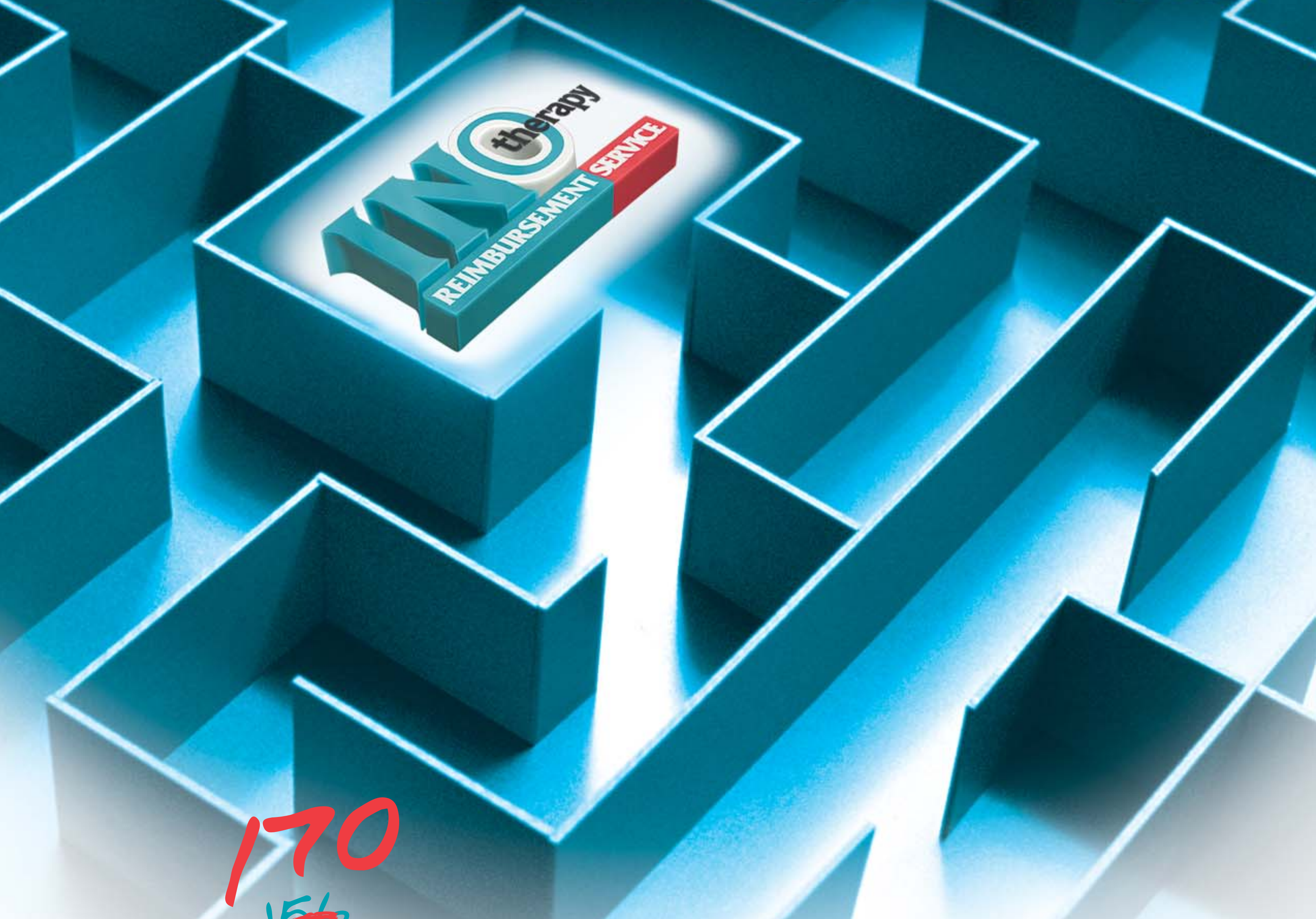
Helping hospitals through the reimbursement maze



So far, ~~115~~ 156 170 hospitals across the nation have increased reimbursement for INOmax® (nitric oxide) for inhalation. Is your hospital one of them?

Our team can help you identify the information you need to seek and obtain appropriate payment. To learn more, please contact IKARIA™ and the INOtherapy Reimbursement Service at 1-877-KNOW-INO (1-877-566-9466)
or visit our Web site at INOmax.com