Unique Usability Challenges in Designing EHRs Used for the Care of Children

David Brick, MD, FAAP, FACC
One size fits all?
Unique Usability Challenges Goals

1) Understand why pediatric patients have special requirements
2) Understand critical special functions used in pediatric charts
3) Understand how the absence, difficult to use, or malfunctioning of those functions can cause errors
4) Understand human factor solutions
A Human Factors Guide to Enhance EHR Usability of Critical User Interactions when Supporting Pediatric Patient Care
Pediatric Patients - Time continuum

- MFM-fetus
  - Fetal diagnosis, fetal therapy, fetal surgery
- Neonatology-1-6 weeks
  - Unique immune, respiratory, cardiovascular,...
- Pediatrics (newborns, infants, toddlers, children, adolescents)
  - 1 second old to 24 years, on a continuum
- Adolescent medicine 12-24 years
  - Brain scans show unique features.
- Adult congenital
  - Brand new natural histories to learn
Dimensions of Care

Outpatient
Urgent Care
ER
Ward
ICU
OR
Variables that affect patient care

- Weight
- Height
- BSA (body surface area)
- BMI (body mass index)
- Age
- Gestational age
- Etc....
Pediatric EMR

- Children’s EMR charts need to have those special functions
- EMRS tend to be designed for the largest audience of patients (Adult Medicine)
- Key functionality in pediatric electronic charts can be missing, limited, un-customizable, malfunctioning, "hard to use"
What do we need?

- Growth Charts
- Mg/kg dosing
- Vaccines
- Age related normal values
- Privacy
- Newborn issues
- Radiology issues
- Patient ID
What do we need?

- Growth Charts
- Mg/kg dosing
- Vaccines
- Age related normal values
- Privacy
- Newborn issues
- Radiology issues
- Patient ID
Growth Chart

- Critical component of any pediatric chart
- Allows doctor to check for proper growth at a glance.
- Standard of care part of each child's chart
CDC
(Center for Disease Control)
Growth Chart
What does Normal CDC Growth Chart Look Like
What does a Normal Growth Chart Look Like?
Growth Chart with (CHF) Congestive Heart Failure
Growth Chart constitutional growth issue (growth issues caused by genetic mutation or syndromes)
EMR growth chart

Weight-Age Chart: Girls (Birth to 36 months)

- **Weight (lb)**
  - 40
  - 35
  - 30
  - 25
  - 20
  - 15
  - 10
  - 5

- **Age (months)**
  - 40
  - 35
  - 30
  - 25
  - 20
  - 15
  - 10
  - 5

- **Chart Type**
  - in/lb
  - cm/kg

- **Display Options**
  - Display Data point value
  - Don't Display Data point Value
  - Display Legend
  - Full Screen

- **Visit Date**
- **Wt (lb)**
- **Age (m)**
- **%tile**
When is a pound a pound?

- 10 lbs = 10 lbs
- 10 lbs = 10 kg
This is critical,
Patient weighs 5.4 kg

Let's say we start the patient on digoxin

Dose is 10 mcg/kg/day

50 mcg per day

Patient dies, and the cause is......OVERDOSE!
Error not caught by the doctor
IVA. Do not permit changes to measurement systems (e.g., lbs vs kg) unless initiated by the user.
IVB. Support accurate conversion from pounds to kilograms
IVC. Visibility of chart data and axes
IVD. Display units accurately in standard notation
IVE. Support selection of particular weight data value to display
IVF. Display age-based percentiles for weight and height data
IVG. Single-click navigation to access growth chart display
IVH. Single-click interaction to view complete growth chart (e.g., no scrolling)
IVI. Display height and weight on same chart
IVJ. Support custom views with custom time ranges (i.e., 3 months to 6 months)
IVK. Support corrections to plotted data
What do we need?

- Growth Charts
- Mg/kg dosing
- Vaccines
- Age related normal values
- Privacy
- Newborn issues
- Radiology issues
- Patient ID
Mg/kg dosing

- Amoxicillin-Clavulanate (Augmentin)
- Typical adult medicines have a standard dose
  750 Mg Twice a day
- In pediatrics dose can be based on wt.
  - 20-100 mg/kg/day divided twice a day
Dose can depend on

- Wt
- Age
- Gestational Age (how many weeks pregnant)
- Plus all of the adult variables
  - Renal function
  - Diagnosis
  - Etc....
Many more formulations

- Typical adult doctor can use 1 or 2 forms
  - Amoxicillin-Clavulanate (Augmentin) 875 or 1000

- Typical pediatrician can choose from
  - 13 formulations
    - Liquids 200, 400, 600, 125, 250
    - Tabs-250, 500, 875, 1000
    - Chewables -200, 400, 125, 250
  - Plus two in Europe 375, 676 Europe
Vancomycin

- **PNA <7 days:**
  - <1200 g: 15 mg/kg/dose every 24 hours
  - 1200-2000 g: 10-15 mg/kg/dose every 12-18 hours
  - >2000 g: 10-15 mg/kg/dose every 8-12 hours

- **PNA ≥7 days:**
  - <1200 g: 15 mg/kg/dose every 24 hours
  - 1200-2000 g: 10-15 mg/kg/dose every 8-12 hours
  - >2000 g: 10-15 mg/kg/dose every 6-8 hours
Vancomycin

- 0.5 kg  15 mg/kg/dose every 24 hours
  - 7.5 mg every 24 hours

- 100 kg  15 mg/kg/dose every 6 hours
  - 1500 mg every 6 hours

- 200 times the dose for teenager.
Liquid Formulations

- Amlodipine
- Amiodarone

- Look-alikes that get confused
- Both are used in adult medicine
- Tablets however do not look alike
More prone to error

- Amlodipine
- Amiodarone
Amiodarone and Amlodipine are used in adults

Amiodarone is used in kids, pretty safe

Amlodipine is lethal in infants
# Amlodipine Amiodarone

<table>
<thead>
<tr>
<th>Comme</th>
<th>Name</th>
<th>Strength</th>
<th>Formula</th>
<th>Take</th>
<th>Route</th>
<th>Frequency</th>
<th>Duration</th>
<th>Disp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Amlodipine 10 mg Tablet 1 tablet Orally Once a day 30 days 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Start</td>
<td>Amiodarone 100 MG Tablet 1 tablet Orally Once a day 30 days 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Amiodarone Amlodipine Amiodarone Amlodipine Amiodarone Amlodipine
Which is which?- You cannot catch the mistake

- Amiodarone Amiodarone Amlodipine Amlodipine
Primary prevention of rheumatic fever (treatment of streptococcal tonsillopharyngitis)

- Children 3-18 years: 50 mg/kg once daily (maximum dose: 1000 mg) for 10 days
- Adult: Extended release tablets: 775 mg once daily for 10 days
Not what the doctor ordered

<table>
<thead>
<tr>
<th>Commer</th>
<th>Name</th>
<th>Strength</th>
<th>Formul:</th>
<th>Take</th>
<th>Route</th>
<th>Frequency</th>
<th>Duration</th>
<th>Disp</th>
<th>Refills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Penicillin 250 MG/5ML Solution</td>
<td>5 ml</td>
<td>Orally</td>
<td>twice a day</td>
<td>30 days</td>
<td>300 r</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rx

Penicillin V Potassium Solution Reconstituted 250 MG/5ML Orally
Disp: ***200*** (TWO HUNDRED)
Sig: 5 ml every 6 hrs 10 day(s)

Refills: ***** (ZERO)
Auth No:
Usability Guidelines - Dosing

- IIA. Protect against mode errors for mg/kg dosing and ml dosing
- IIB. Flag that an intended dose is unusual
- IIC. Support high-precision dosing for low-weight patients
- IID. Do not permit automated defaults to adult doses
- IIE. Support custom formulations for liquid medications
- IIF. Support documentation of incomplete medication information
- IIG. Reduce displayed options for medication orders
- IIH. Display the recommended dose range for the selected mg/kg dose
- III. Display “input masks” for data entry to clarify type of data
- IIJ. Avoid truncation of medication names and dosages in menus
- IIIE. Display normal ranges for medication doses and lab values based upon weight, height, Body Surface Area, Body Mass Index, and age information
- Growth Charts
- Mg/kg dosing
- **Vaccines**
- Age related normal values
- Privacy
- Newborn issues
- Radiology issues
- Patient ID
vaccines

- Types of Administration Errors
  - Wrong vaccine or wrong diluent
  - Wrong dosage
  - Expired vaccine
  - Wrong route / site / needle size
  - Wrong time
  - Wrong patient
Vaccines

- Most common error – wrong vaccine
- Such errors usually involved vaccines whose generic or trade names looked or sounded alike (Tdap and DTaP; Adacel and Daptacel) or those with similar packaging.
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTaP</td>
<td>Diphtheria, Tetanus &amp; Acellular Pertussis</td>
<td>DAPTACEL®, Infanrix®, Tripedia®</td>
</tr>
<tr>
<td>DTaP-HepB-IPV</td>
<td>Diphtheria, Tetanus &amp; Acellular Pertussis, Hepatitis B, Polio</td>
<td>Pediarix®</td>
</tr>
<tr>
<td>DTaP-IPV</td>
<td>Diphtheria, Tetanus &amp; Acellular Pertussis, Inactivated Polio</td>
<td>Kinrix®</td>
</tr>
<tr>
<td>HepA</td>
<td>Hepatitis A Virus</td>
<td>Havrix®, VAQTA®</td>
</tr>
<tr>
<td>HepB</td>
<td>Hepatitis B Virus</td>
<td>ENGERIX B®, RECOMBIVAX®</td>
</tr>
<tr>
<td>HepA-HepB</td>
<td>Hepatitis A and Hepatitis B</td>
<td>Twinrix®, Twinrix Junior®</td>
</tr>
<tr>
<td>Hib-HepB</td>
<td>Hepatitis B and Haemophilus influenzae type b</td>
<td>COMVAX®</td>
</tr>
<tr>
<td>Hib</td>
<td>Haemophilus influenzae type b</td>
<td>ACTHIB®, Hiberix®</td>
</tr>
<tr>
<td>Hib</td>
<td>Haemophilus influenzae type b</td>
<td>PedvaxHIB®</td>
</tr>
<tr>
<td>DTaP-IPV/Hib</td>
<td>Diphtheria, Tetanus &amp; Acellular Pertussis, Haemophilus influenzae type b, Polio</td>
<td>Pentacel®</td>
</tr>
<tr>
<td>HPV2</td>
<td>Human papillomavirus (bivalent)</td>
<td>Cervarix®</td>
</tr>
<tr>
<td>HPV4</td>
<td>Human papillomavirus (quadvalent)</td>
<td>Gardasil®</td>
</tr>
<tr>
<td>IPV</td>
<td>Inactivated Polio</td>
<td>IPOL®</td>
</tr>
<tr>
<td>LAIV</td>
<td>Live, Attenuated Influenza (nasal spray)</td>
<td>FluMist®</td>
</tr>
<tr>
<td>MMR</td>
<td>Measles, Mumps &amp; Rubella</td>
<td>MMR-II®</td>
</tr>
<tr>
<td>MMRV</td>
<td>Measles, Mumps, Rubella &amp; Varicella</td>
<td>ProQuad®</td>
</tr>
<tr>
<td>MCV</td>
<td>Measles &amp; Cytomegalovirus Vaccine</td>
<td>MCV®</td>
</tr>
<tr>
<td>TIV</td>
<td>Trivalent (inactivated) Influenza</td>
<td>AFluria®, Fluarix®, FluLava®, Fluirix®, Fluzone®, Agriflu®, Fluzone High-Dose®, Fluzone Intradermal®</td>
</tr>
<tr>
<td>TT</td>
<td>Tetanus Toxoid</td>
<td>VAR/IVAX®</td>
</tr>
<tr>
<td>VZV</td>
<td>Varicella</td>
<td>Zostavax®</td>
</tr>
<tr>
<td>ZOS</td>
<td>Varicella Zoster-Virus (Shingles)</td>
<td>Zostavax®</td>
</tr>
</tbody>
</table>

**Note:** You can find the most recent version of CDC's list at [www.cdc.gov/vaccines/about/summary/vaccine-abbreviations.htm](http://www.cdc.gov/vaccines/about/summary/vaccine-abbreviations.htm)
FIGURE 3. Catch-up immunization schedule for persons aged 4 months through 18 years who start late or who are more than 1 month behind — United States 2012

The figure below provides catch-up schedules and minimum intervals between doses for children whose vaccinations have been delayed. A vaccine series does not need to be restarted, regardless of the time that has elapsed between doses. Use the section appropriate for the child’s age. Always use this table in conjunction with the accompanying childhood and adolescent immunization schedules (Figures 1 and 2) and their respective footnotes.

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Minimum Age for Dose 1</th>
<th>Minimum Interval Between Doses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dose 1 to dose 2</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>Birth</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Rotavirus*</td>
<td>6 weeks</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Diphtheria, tetanus, pertussis*</td>
<td>6 weeks</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Haemophilus influenza type b</td>
<td>6 weeks</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Pneumococcal*</td>
<td>6 weeks</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Inactivated poliovirus*</td>
<td>6 weeks</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Meningooccal*</td>
<td>9 months</td>
<td>8 weeks</td>
</tr>
<tr>
<td>Measles, mumps, rubella*</td>
<td>12 months</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Varicella*</td>
<td>12 months</td>
<td>3 months</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>12 months</td>
<td>6 months</td>
</tr>
<tr>
<td>Tetanus, diphtheria/tetanus, diphthera, pertussis*</td>
<td>7 years</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Human papillomavirus*</td>
<td>9 years</td>
<td>Routine dosing intervals are recommended*</td>
</tr>
</tbody>
</table>

Persons aged 7 through 18 years

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Minimum Age for Dose 1</th>
<th>Minimum Interval Between Doses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Dose 1 to dose 2</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>Birth</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Inactivated poliovirus*</td>
<td>6 weeks</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Meningooccal*</td>
<td>9 months</td>
<td>8 weeks</td>
</tr>
<tr>
<td>Measles, mumps, rubella*</td>
<td>12 months</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Varicella*</td>
<td>12 months</td>
<td>3 months</td>
</tr>
<tr>
<td>Rotavirus*</td>
<td>12 months</td>
<td>4 weeks</td>
</tr>
</tbody>
</table>

Note: For hepatitis B, the second dose should be administered at 12 months, but if not administered at 12 months, it should be administered as soon as possible. If the child has not received the third dose by 15 years of age, a booster dose is recommended.

Inactivated poliovirus vaccine (IPV): The recommended minimum interval between doses is 4 weeks. The second dose was administered if not administered by 15 years of age.
Guidance for vaccine shortage

The following are sample schedules for completing a series using Pediarix (DTaP-IPV-HepB) and Hib vaccines for children previously vaccinated with Pentacel (DTaP/IPV-Hib).

- When using combination vaccines, ensure that minimum intervals between doses and the minimum age have been met for each of the component vaccines.

1 prior dose of Pentacel

<table>
<thead>
<tr>
<th></th>
<th>Birth</th>
<th>1 month</th>
<th>2 months</th>
<th>4 months</th>
<th>6 months</th>
<th>12-15 months</th>
<th>15-18 months</th>
<th>4-6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>HepB</td>
<td>HepB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentacel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hib</td>
<td>Hib</td>
<td>Hib</td>
<td>Hib</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2 prior doses of Pentacel

<table>
<thead>
<tr>
<th></th>
<th>Birth</th>
<th>1 month</th>
<th>2 months</th>
<th>4 months</th>
<th>6 months</th>
<th>12-15 months</th>
<th>15-18 months</th>
<th>4-6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>HepB</td>
<td>HepB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentacel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hib</td>
<td>Hib</td>
<td>Hib</td>
<td>Hib</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3 prior doses of Pentacel

<table>
<thead>
<tr>
<th></th>
<th>Birth</th>
<th>1 month</th>
<th>2 months</th>
<th>4 months</th>
<th>6 months</th>
<th>12-15 months</th>
<th>15-18 months</th>
<th>4-6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>HepB</td>
<td>HepB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentacel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hib</td>
<td>Hib</td>
<td>Hib</td>
<td>Hib</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Administration of a 4th dose of HepB vaccine is permissible when a combination vaccine containing HepB is given after the birth dose.

** The 4th dose of DTaP can be given as early as 12 months of age, provided at least 6 months have elapsed since the 3rd dose. Off label Advisory Committee on Immunization Practices recommendation.

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Use for</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTaP</td>
<td>Any dose in the 5-dose series for children 6 weeks through 6 years of age</td>
</tr>
<tr>
<td>DTaP/IPV/HepB (Pediarix)</td>
<td>Doses 1, 2, and 3 of DTaP and IPV; any dose of HepB for children 6 weeks through 6 years of age</td>
</tr>
<tr>
<td>HepB</td>
<td>Any dose in the HepB series for children at birth and older</td>
</tr>
<tr>
<td>Hib (ActHIB, PedvaxHIB)</td>
<td>Any dose in the Hib series for children 6 weeks through 4 years of age</td>
</tr>
<tr>
<td>Hib (Hiberix)</td>
<td>The last (booster) dose in the Hib series for children 12 months* through 4 years of age</td>
</tr>
<tr>
<td>IPV</td>
<td>Any dose in the polio series for persons 6 weeks of age and older</td>
</tr>
<tr>
<td>DTaP/IPV (Kinrix)</td>
<td>Dose 5 of DTaP and dose 4 of IPV for children 4 through 6 years of age</td>
</tr>
</tbody>
</table>

*Off label Advisory Committee on Immunization Practices recommendation

Do not use for doses 1 through 3 of DTaP and IPV or dose 4 of DTaP.
## Vaccine errors

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Time</th>
<th>Given By</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTaP-HepB</td>
<td></td>
<td>13:51:16</td>
<td></td>
</tr>
<tr>
<td>Polio (IPV)</td>
<td></td>
<td>13:51:28</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTaP-HepE-IPV</td>
<td></td>
<td>13:51:16</td>
</tr>
<tr>
<td>Polio (IPV)</td>
<td></td>
<td>13:51:28</td>
</tr>
</tbody>
</table>
Long list of combo vaccines with various sorting options.
Usability Guidelines - Vaccines

- VA. Allow ordering vaccination via reminder
- VB. Allow data entry for vaccinations given at other institutions
- VC. Support display and tracking of components of combination vaccines
- VD. Display the days prior vaccinations were given and support alerts for recommended minimum/ideal/maximum intervals between vaccinations
- VE. Allow sorting of vaccination data by multiple fields
What do we need?

- Growth Charts
- Mg/kg dosing
- Vaccines
- Age related normal values
- Privacy
- Newborn issues
- Radiology issues
- Patient ID
Pediatric Normal Values

- Wt
- Ht
- BSA
- BMI
- Age
- Gestational age
One of the most important measurements cardiologists make is the **Left Ventricular End Diastolic Dimension**.

- **Adult** 4.5 cm
- **Pediatric patient age, wt, ht, into formula of BSA**
  - If the patient is neonate 2000-4000 gm

---

**Table 2 Normal M mode echocardiographic values from infancy to 18 years with a mean body surface area (BSA) from 0.25 m² to 2.0 m²**

<table>
<thead>
<tr>
<th>BSA (m²)</th>
<th>RVAd (mm)</th>
<th>RVDD (mm)</th>
<th>IVs (mm)</th>
<th>IVs (mm)</th>
<th>LVEDD (mm)</th>
<th>LVESD (mm)</th>
<th>LVPWd (mm)</th>
<th>LVPWs (mm)</th>
<th>IMD (mm)</th>
<th>AoD (mm)</th>
<th>LAD (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.275</td>
<td>1</td>
<td>1.2</td>
<td>1.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td>1</td>
<td>1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
<td>2.2</td>
</tr>
<tr>
<td>0.35</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.40</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.45</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.50</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.55</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.60</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.65</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.70</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.75</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.80</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.85</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.90</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
<tr>
<td>0.95</td>
<td>1</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
</tr>
</tbody>
</table>

---

**NOMOGRAM**

- **Height**
  - For children of normal height for weight
    - Height in cm
    - BSA in m²

- **Weight**
  - For children of normal height for weight
    - Weight in lb
    - Weight in kg

---

**Surface area (square meters)**

- Surface area in m²
- Weight in lb
- Height in cm

---

**LAD (mm)**

- Normal range: 8.3 mm
- Increased range: 11.5 mm
- Extreme range: 14.7 mm
Birth to 36 months: Girls
Length-for-age and Weight-for-age percentiles

NAME ___________________________ RECORD # ____________

AGE (MONTHS)

Birth 3 6 9 12 15 18 21 24 27 30 33 36

cm

in

41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1

kg

lb

Use this chart (NIH)
Usability Guidelines- Normal

- VIA. Support communications to change inaccurate normal ranges
- VIB. Enable seeing where normal ranges originated from (adult normal, pediatric normal, weight-based normal, age-based normal, body surface area normal)
- VIC. Enable integrated view of lab results from different sources
- IIIE. Display normal ranges for medication doses and lab values based upon weight, height, Body Surface Area, Body Mass Index, and age information
What do we need?

- Growth Charts
- Mg/kg dosing
- Vaccines
- Age related normal values
- **Privacy**
- Newborn issues
- Radiology issues
- Other....
Privacy

- Certain parts of your chart are handled differently
- Teenagers have special rights to protect their privacy.
What is the difference between......

- Private Note
- Confidential Note
- Secure Note
- Internal Note
- Sticky Note
- What happens when you export the chart.
Guidelines - Privacy

- VIII A. Support documenting consent agreements for non-traditional parents (children in foster or custodial care, adults who are not parents, adoptive parents, and guardians)
- VIII B. Support “break the glass” privacy law violations for urgent care situations
- VIII C. Make easily visible the rules that describe what information can be viewed, printed, and transferred with different levels/types of security on notes and all text in the chart
What do we need?

- Growth Charts
- Mg/kg dosing
- Vaccines
- Age related normal values
- Privacy
- **Newborn issues**
- Radiology issues
- Patient ID
In 2000, we had 25 cases where the babies of positive moms did not receive HBIG at birth. Three of these babies are now infected. In one of the cases, the mother’s status was erroneously marked as unknown, another was marked as negative, and in one the status was correctly marked, but the HBIG was still not given.”
1 minute old baby

- Before born can have
  - Surgery
  - Cath
  - Blood transfusion

- Needs work arounds to get post natal blood transfusion because does not have MRN
Usability Guidelines - Newborns

- VIIA. Enable efficient creation of newborn records
- VIIB. Support updating information that is initially inaccurate or unknown (e.g., last names, sex, weight)
- VIIC. Support the use of gestational age and corrected age for patient care (in addition to chronologic age)
- VIID. Support efficient processes for administration of breast milk, including labeling and matching mother to baby to milk
- VIIE. Support connecting prenatal data (e.g., fetal imaging procedure) with post-birth data
- VIIF. Support efficient documentation of blood type
- VIIG. Support the use of alternative weights for dosing
- VIIH. Support conversion from Days of Life (DOL) to Days Old (DO) during care transitions
- VIII. Display weights in grams and ages in days, weeks, or months under thresholds
What do we need?

- Growth Charts
- Mg/kg dosing
- Vaccines
- Age related normal values
- Privacy
- Newborn issues
- Radiology issues
- Patient ID
Radiology

- Kids often are sedated/intubated for radiology procedures
- Ionizing radiation can be more important issue due to rapid cell growth
- Entire lifetime to have affect.
- Dose of contrast agents based on mg/kg
- More variation in what is typically ordered
- Need to keep track of radiation exposure
Usability - Radiology

- IXA. Support physician-radiologist communications to clarify which scan variation to order for high-stakes sedation and intubation procedures.
- IXB. Support alerts for contraindicated procedures
- IXC. Monitor cumulative radiation exposure over time
What do we need?

- Growth Charts
- Mg/kg dosing
- Vaccines
- Age related normal values
- Privacy
- Newborn issues
- Radiology issues
- Patient ID
Patient ID

- All Babies born the same Day
- BG SMITH----> Sara Jones
- BG SMITH----> Rebecca Smith-→ Rebecca Porter
- BB Chen-------→ John Chan
- BB Chen-------→ John Chen
- BG Martinez→ Sarah Rabinowitz
- BG Martinez→ Sheila Rivera
- BG DOE→ BG Harrison → Amanda Kuo
Usability-Patient ID

- IA. Use unique patient identification numbers that are not based upon social security numbers
- IB. Include photographs of newborns with primary caregivers for patient identification
- IC. Include age, gestation, gender, and weight on constant-identification banner headers on all screens
- ID. Distinguish between newly generated and copied information
In Summary

- Pediatric patients have special requirements
- Pediatric patients have critical special functions required in EHR
- Absense, difficult to use or malfunctioning of those functions can cause errors
- There are human factor solutions to these important issues
Thank you

♦ NIST

♦ ONC

♦ Authors
  • Svetlana Z. Lowry, Mala Ramaiah, Emily S. Patterson, Jiajie Zhang, Patricia Abbott, Michael C. Gibbons

♦ Peer Review/Contributors
  • Ben-Tzion Karsh, PhD, University of Wisconsin, Ayse Gurses, PhD, Johns Hopkins University, Daniel Essin, MA, MD, USC Keck School of Medicine, Susan Torrey, MD, NYU Langone Medical Center, Roberts Wears, MD, PhD, University of Florida Health Center Jacksonville, Debora Simmons, PhD, RN, CCNS, St. Luke’s Episcopal Health System, Mary Patterson, MD, Med, Akron Children's Hospital, Deepa Menon, MD, Johns Hopkins University, Dean Sittig, PhD, University of Texas Houston, Marta Hernanz-Schulman MD, Vanderbilt Children's Hospital, Kevin Jones, MS, Ohio State University, Colleen McLaughlin, MPH PhD, Patient Safety Center, New York State Dept. of Health, Sean Petty, RN, Jacobi Medical Center, Anne B. Francis, MD, Elmwood Pediatric Group, Rochester, NY, George Kim, MD, Johns Hopkins University Children's Center, Rainu Kaushal, MD, MPH, Weill Cornell Medical College, Marta Hernanz-Schulman MD, Vanderbilt Children’s Hospital, David Kreda, Social Research Corporation, Willa Drummond, MD, University of Florida College of Medicine, Andrew Kroger, M.D., M.P.H., National Center for Immunization and Respiratory Diseases, Arthur Smerling, MD, Columbia University College of Physicians and Surgeons, Herschel R. Lessin MD, The Children's Medical Group, S. Andrew Spooner, MD, MS, Cincinnati Children's Hospital Medical Center, Eugenia Marcus, MD, Pediatric Health Care at Newton Wellesley, Scott Finley, MD, MPH, Westat and VHA, Office of Health Information, Yiannis L. Katsogridakis, MD, MPH, Children's Memorial Hospital, Michael S. Victoroff, MD, University of Colorado School of Medicine, Nancy F. Krebs, MD, MS, University of Colorado School of Medicine, Anne Bobb, R.Ph, Children's Memorial Hospital.
The End