# Project 7

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**Question 1)**

Given: No. of patients = 15,932; Patients with septic shock = 3507; Sensitivity (S) = 88% (0.88), Specificity (Sp) =84% (0.84); Average Positive Predictive Value (PPV) = 58% (0.58);

Prevalence in Pediatric Patients (pP) = (1/3) \* Prevalence in adults (P)

1. **Calculating Prevalence in pediatric patients**

We know that PPV is given as:

……………………………………Eq. 1

Solving for P, we get:

P = 0.20069

P= 20.07%

Since

To calculate PPV for pediatric patients (pPPV) we use pP in Eq. 1

Therefore:

1. **Calculating NPV**

TP = True Positive; TN = True Negative; FP: False Positive; FN: False Negative; NPV = Average Negative Predictive Value

We know that.

Substituting the values for pediatric patients

1. **Changing algorithm parameters for pediatric patients**

“Children are not small adults” – The following belief of pediatricians is valid. Children differ from adults in a wide array of physiological parameters and system development. This diversity is important when considering the clinical implications of management of critical illness. The baseline conditions for pediatric patients and adult patients are significantly different. Listed below are a few of the many examples:

1. Total Body Water

Children are more susceptible to rapid fluid losses thus making them more vulnerable to hypovolemic shock. The reason being the fluid loss as a percentage of body weight is easier to occur for children. For example, if there is a child who is 10kgs in weight and an adult who is 80kgs in weight. For both of them to be dehydrated by 10% of their weight means two very separate things in terms of volume of fluid loss. The child will have to lose 1000mL of fluid (approximately) whereas the adult will have to lose 8000mL of fluid (approximately).

Total Body Water comprises of two components Intracellular Fluid (ICF) and Extracellular Fluid (ECF). Children have higher ECF to ICF ratio this bolstering easier fluid loss

1. Cardiac physiology

There are physiological differences in the cardiovascular system of the neonate when compared to the adult. Cardiac Output is a function of stroke volume and heart rate. Unlike adults, neonates have a limited capacity of increasing stroke volume to increase cardiac output, making the cardiac output in neonates heart rate dependent.

Following is a table which represents heart rates for patients of different age groups:

|  |  |
| --- | --- |
| Age | Heart Beats Per Minute |
| 0-1month | 70 to 90 |
| 1-11 month | 80 to 160 |
| 1-2 years | 80 to 130 |
| 3-4 years | 80 to 120 |
| 5-6 years | 75 to 115 |
| 7-9 years | 70 to 110 |
| 10+ years (including adults and seniors) | 60 to 100 |
| Athletes | 40 to 60 |

Similarly, there is a significant difference in adult patient physiology and pediatric patient physiology in renal, respiratory and coagulatory systems.

When we look at these systems, they act as the basis for calculating various patient assessment scores which are used in modelling.

When we talk about the work of Liu et al, the algorithm uses elevated lactate, cardiovascular sequential organ failure assessment (SOFA) score, heart rate, partial pressure of oxygen, fraction of inspired oxygen, and decreased Glasgow Coma Score (GCS) as the parameters to determine and predict the pre shock state. However, the model is build using adult patient data.

Since there is a significant difference in the adult and pediatric patient physiology, the features need to be modified in a way where they are applicable for pediatric patients. The SOFA Score and the GCS Score can be modified or replaced by the following to be treated as features for the model.

1. SOFA Score

One of the major limitations of the SOFA score is that it was developed for adult patients and contains measures that vary significantly with age, which makes it unsuitable for children. There are alternative scoring methods which can be used:

1. Pediatric Logistic Organ Dysfunction (PELOD) Score
2. Updated PELOD-2 Score
3. Pediatric Multiple Organ Dysfunction Score
4. pSOFA Score (Pediatric SOFA Score)

Amongst the scores mentioned above the pSOFA score should be preferred because the range, scale, and coverage of the other scores are significantly different from those of the SOFA score, which makes their concurrent use problematic.

pSOFA:

It is a SOFA Score for critically ill pediatric patients using age adjusted criteria. The original SOFA Score is modified to generate the pSOFA score in two ways – the renal and cardiovascular sub scores which are age dependent are modified using validated cut-offs from the PELOD-2 Score and the respiratory sub score is expanded to include SpO2:FiO2 as a surrogate for lung injury.

1. GCS Score

This score is used as a representative for consciousness after a traumatic brain injury. It is the sum of the Eye-Opening Score, Verbal Score and Motor Response Score. While applying the model for pediatric patients the following table should be used to calculate the GCS Score.

1. Eye Opening Score

|  |  |  |
| --- | --- | --- |
| Adults, Children (greater than 2 years old) | Children (Less than 2 years) | Score |
| Spontaneous — opens with blinking at baseline | Eye opening spontaneously | 4 |
| Opens to verbal command, speech or shout | Eye opening to speech | 3 |
| Opens to pain | Eye opening to pain | 2 |
| None | No eye opening | 1 |

1. Verbal Score

|  |  |  |
| --- | --- | --- |
| Adults, Children (greater than 2 years old) | Children (Less than 2 years) | Score |
| Oriented and converses | Infant coos or babbles (normal activity) | 5 |
| Confused, but able to answer questions | Infant is irritable and continually cries | 4 |
| Inappropriate responses, words are discernible | Infant cries to pain | 3 |
| Incomprehensible speech / sounds | Infant moans to pain | 2 |
| None | No verbal response | 1 |

1. Motor Response Score

|  |  |  |
| --- | --- | --- |
| Adults, Children (greater than 2 years old) | Children (Less than 2 years) | Score |
| Obeys commands for movement | Infant moves spontaneously or purposefully | 6 |
| Purposeful movement to painful stimulus | Infant withdraws from touch | 5 |
| Withdraws from pain | Infant withdraws from pain | 4 |
| Abnormal (spastic) flexion, decorticate posture | Abnormal flexion to pain for an infant (decorticate response) | 3 |
| Extensor (rigid) response, decerebrate posture | Extension to pain (decerebrate response) | 2 |
| None | No motor response | 1 |

If the above-mentioned features are modified to apply to the model it will help the algorithm to be applied to pediatric patients as well.

**Question 2)**

We take =1 and considering for a minute we consider 60 samples.

The Likelihood function is represented as:

Taking log of the likelihood and differentiating we get,

Now we set it to 0,

Where, is the maximum likelihood estimate.

**References:**

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