A sequential approach of classical screening enriched with machine learning, improves neonatal wellness screening in low resource settings

Babar Sultan Hasan[1], Zahra Hoodbhoy[1], Amna Khan[1], Mariana Nogueira[2], Bart Bijnens [2,3], Devyani Chowdhury[4,5]

[1]Department of Pediatrics and Child Health, Stadium Road, The Aga Khan University, Karachi, Pakistan relocated to Sindh Institute of Urology and Transplantation (SIUT), Karachi, Pakistan.
[2]IDIBAPS (August Pi i Sunyer Biomedical Research Institute), Barcelona, Spain [3]ICREA, Barcelona, Spain [4]Cardiology Care for Children, Pennsylvania, USA,[4,5] Nemours Cardiac Center, Wilmington, DE

Objectives

- Despite a high neonatal mortality, existing tools such as pulse oximetry (POx) and WHO signs have moderate sensitivity to identify at-risk neonates
- The aim of this study was to assess the value of Pox and WHO signs used on their own, in combination, and enriched with machine learning (ML) from clinical features, to develop a neonatal wellness screening tool for community health workers to identify at-risk neonates

Methods

- This prospective cohort study was conducted in a peri-urban community in Pakistan
- Maternal and neonatal clinical features along with screening using the WHO Young Infants Clinical Signs and the American Academy of Pediatrics pulse oximetry screening algorithm was performed for all eligible live births
- These neonates were followed till 4 weeks of life for adverse outcomes i.e., neonatal sepsis, critical congenital heart disease (CCHD), hospitalization or death.
- The predictive value for adverse outcome of WHO signs, Pox and an ML model based on the clinical characteristics as well as their sequential use was assessed to identify at-risk neonates
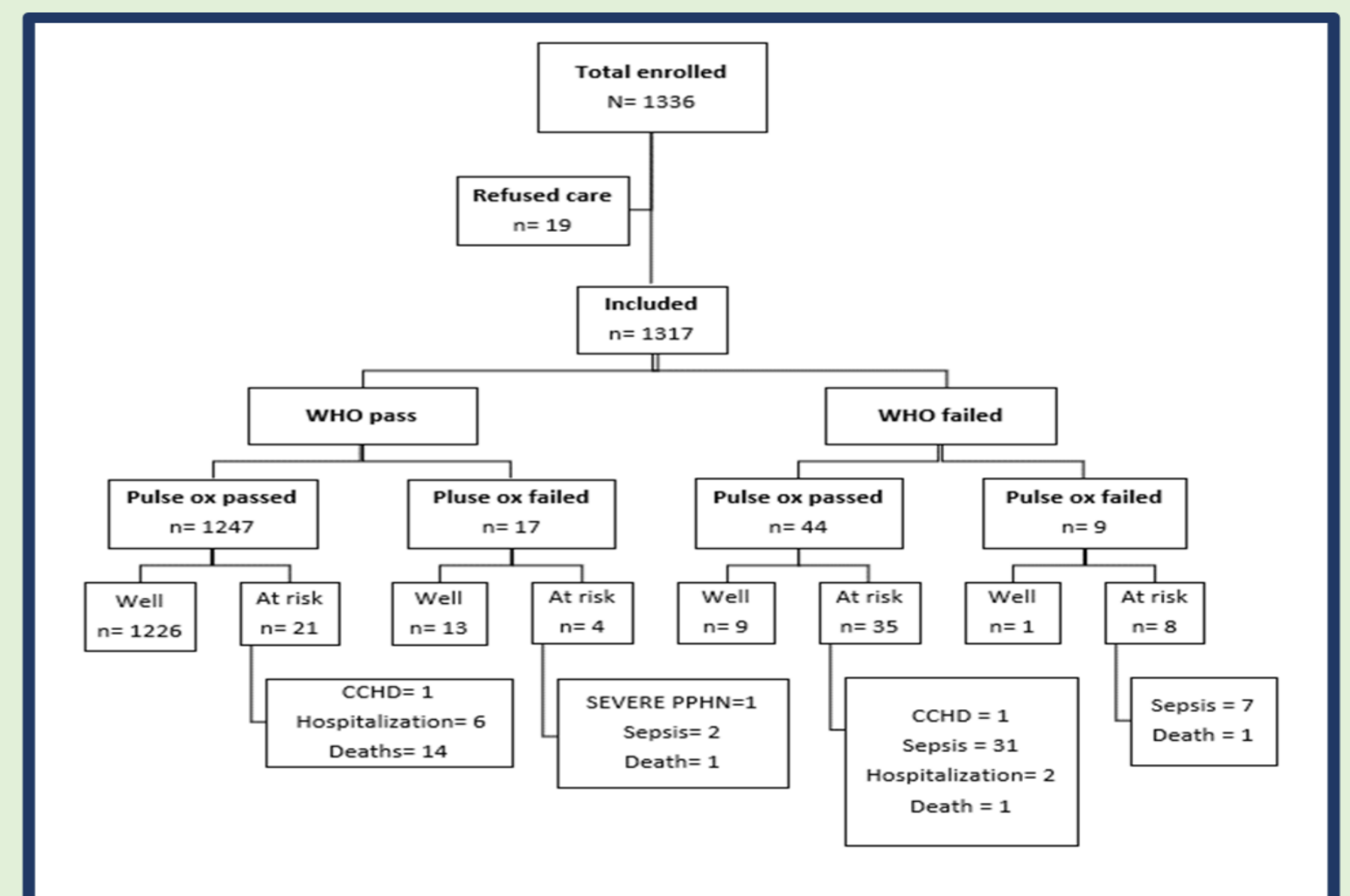
Fig 1: Screening algorithm and data collection process
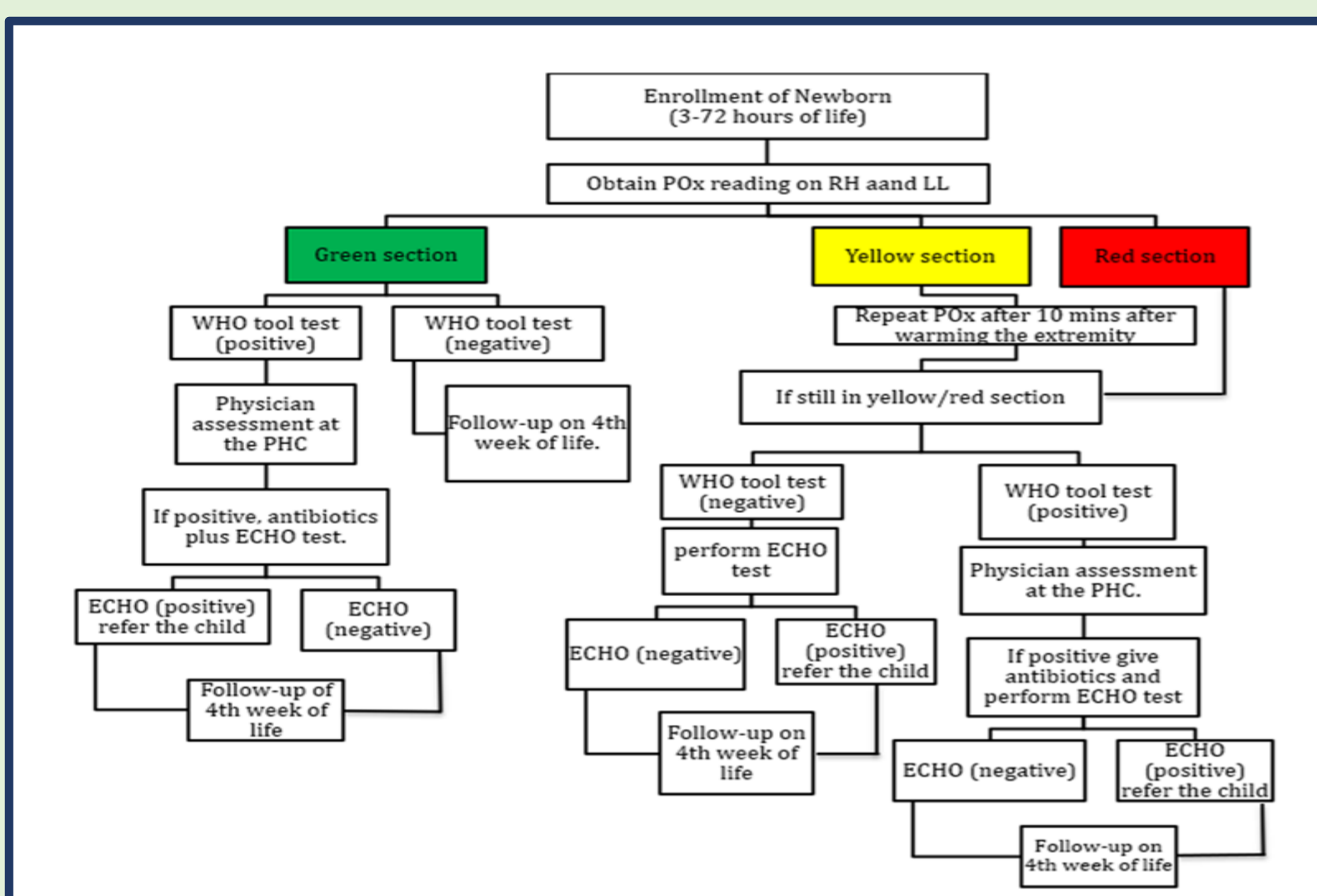
Findings

- 68 out of the 1336 neonates enrolled were at risk
- These included neonatal sepsis (n=40, 59%), critical CHD (n=2, 3%), severe persistent pulmonary hypertension (n=1), hospitalized (n=8, 12%) and death (n=17, 25%) in the first 4 weeks of life

Fig 2: Distribution of neonates who failed the WHO and/or POx screening


- When POx and WHO were used to screen at-risk neonates, the sensitivity was moderate while specificity was high

Table 1 Sensitivity and specificity of the combination of POx and WHO signs in identifying at-risk neonates

	WHO signs and pulse oximetry (n=1317)
True positives (n)	48
True negatives (n)	1229
False positives (n)	20
False negatives (n)	20
Sensitivity (95% CI) (%)	70.5 (59.4-81.6)
Specificity (95% CI) (%)	98.3 (97.4-99)

- Performing a staged assessment, where WHO signs, POx and ML are sequentially used to triage neonates, sensitivity increased to 85%, with a specificity of 75%

Fig 3 Potential integration of the machine learning model in community-based workflows
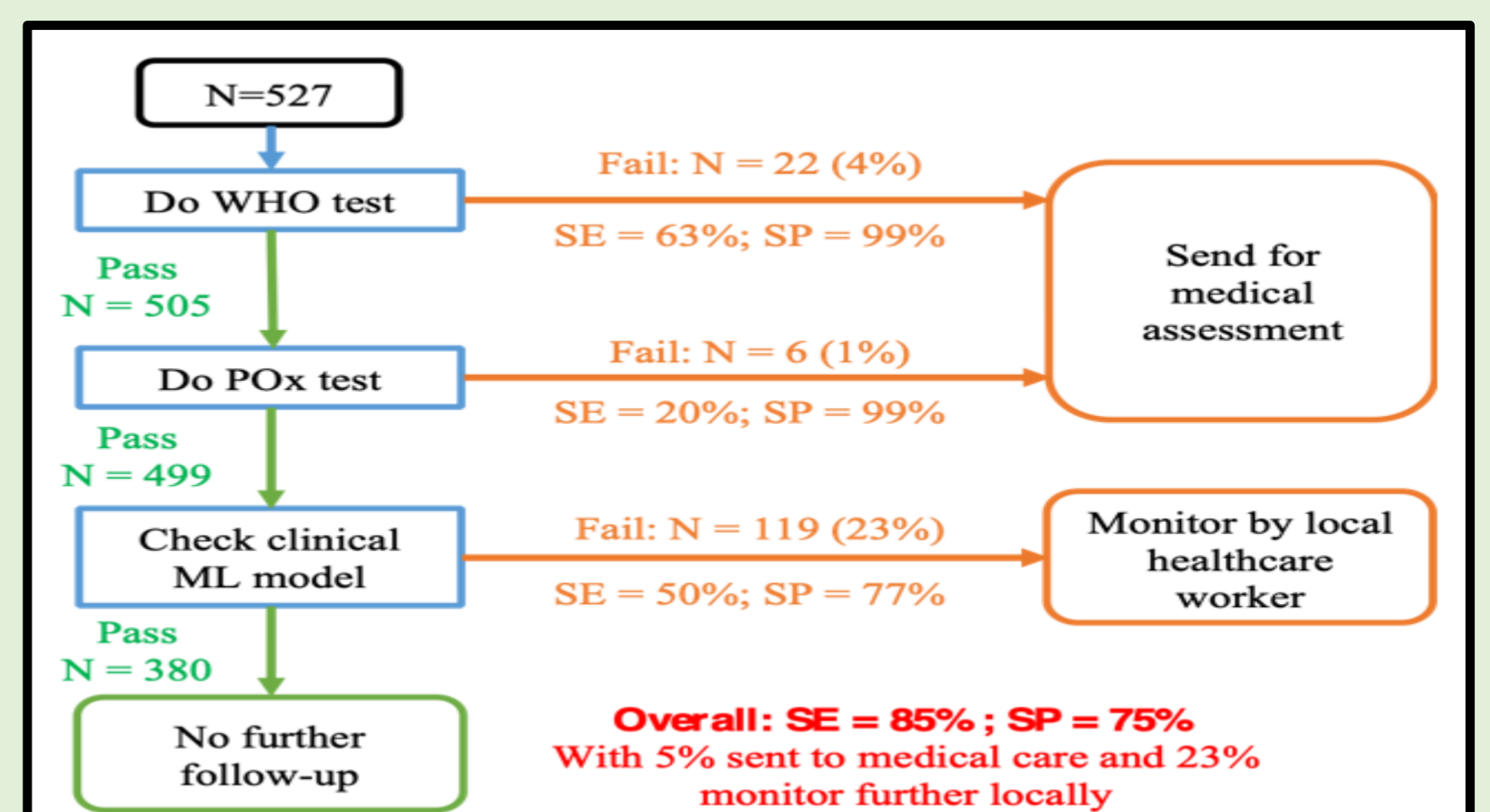
Conclusion

- A sequential approach, combing classical assessment with ML can be utilized to help identifying the maximal number of at-risk neonates in the community and optimizing further care