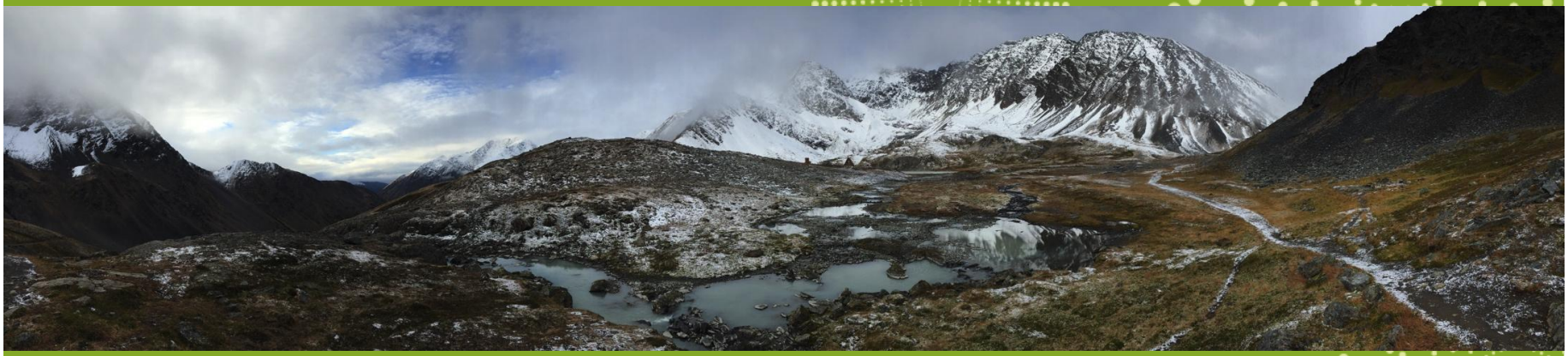


Pediatric Early Warning Scores

PEWS

Lilian Ho

10/11/2016

YKHC Grand Rounds

Alaska Track — University of Washington Pediatric Residency

YKHC

Seattle Children's HOSPITAL • RESEARCH • FOUNDATION

UW Medicine
UW SCHOOL OF MEDICINE

Outline

Challenges in clinical decision making

PEWS scoring tools & their application

QI project at YKHC

The challenge

A sick child arrives in the Bethel ED…

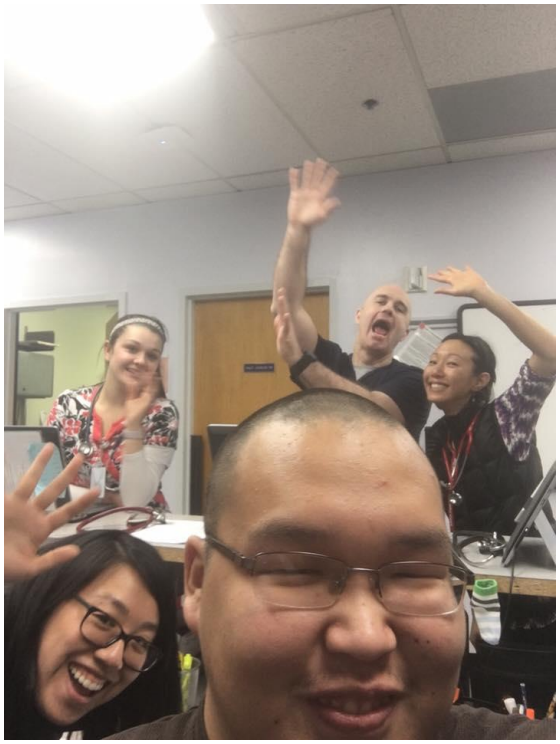
Do you admit or transfer?

The challenge

About YKHC Regional Hospital

Services include:

- **Respiratory therapy during the day**
- **Level IV ED**
- **OR with CRNAs**
  - Dental and minor procedures under sedation
  - No surgeon on staff
- **Radiology**
  - XR, CT, US (sometimes)
- **Laboratory**
- **Outpatient clinics, specialty field clinics, audiology and physical therapy**



Friendly Delta clinic staff

The challenge

About YKHC Regional Hospital

High acuity

- 4,000-5,000 admissions
- Level IV ED with 20,000 encounters
- LifeMed medevac data:

LifeMed Caravan

	2015	2016 to date
Village to Bethel	465	449
Bethel to Anchorage	451	439

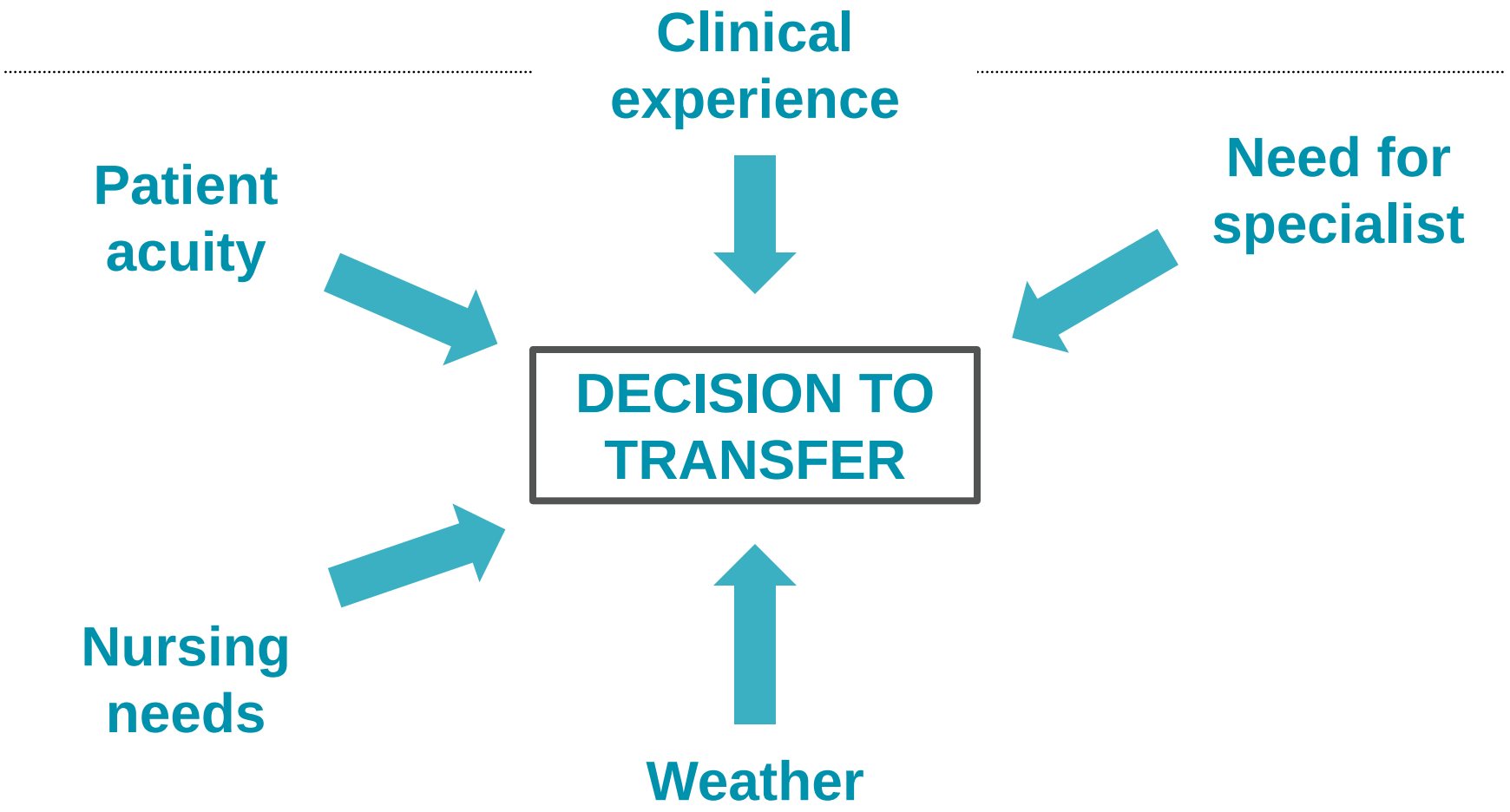
Data provided by LifeMed paramedic, Clifton Dalton

The challenge

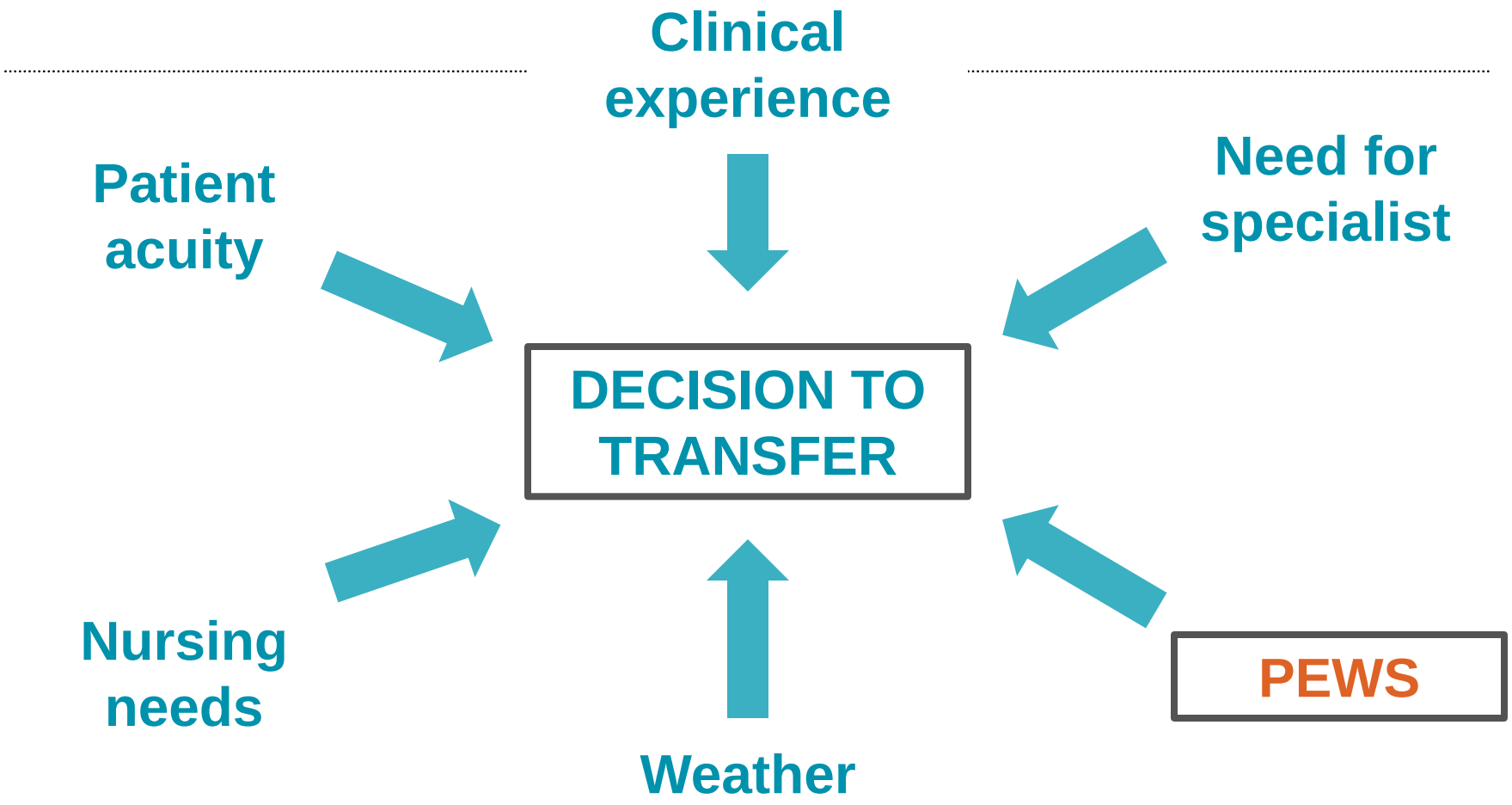
Specific challenges for our community

- Overcrowding in homes
- Lack of access to running water
- High rates of genetic disease
- High rates of infectious disease
- Weather
- Transient staff
- Limited and expensive transportation
- Distance to care

The challenge



The challenge



PEWS tools

What is the Pediatric Early Warning Score (PEWS)?

- **Scoring system developed for early recognition of deteriorating patients**
- **Based on objective data**
  - Physiologic data
    - Vital signs
    - Oxygen requirements
  - Medical history
    - ICU admission history
    - G-tube
    - Oxygen

www.nytimes.com

PEWS tools

Why were PEWS tools created?

- Greater recognition that patients are dying unnecessarily in hospitals
- UK study found 26-43% pediatric deaths potentially avoidable
- 44,000 Americans die from preventable medical errors

Robson et al 2013

PEWS tools

Why were PEWS tools created?

- **Increase in rates of cardiopulmonary arrest (CPA)**
  - Higher acuity in hospitals
  - Greater reliance on technology
- **AHRQ (Agency for Healthcare Research and Quality) & JCO (Joint Committee) push to improve patient safety**

Robson et al 2013

PEWS tools

Why were PEWS tools created?

- **CPA often result of potentially reversible cause**
  - Hypoxia
  - Shock
- **Preceded by physiologic changes up to 24 hours before event**
- **Rapid response teams created**
- **PEWS tools developed to aid early recognition**

Robson et al 2013

PEWS tools

Goals of PEWS

- Early recognition and response
- Avoid preventable deaths
- Generate clear, timely, accurate communication
- Prevent patient harm
- Standardized and objective
- Does not rely on level of provider experience

Robson et al 2013

PEWS tools

Many different scoring tools exist

As many as 12 scoring published tools

- **Variations of “points” assigned to vital signs**
- **Additional parameters**
  - Need for oxygen
  - Recent IV fluid boluses
  - Past medical history

PEWS tools

One example – PEW Score (Monaghan, 2005)

TABLE 1. Pediatric Early Warning Score

	0	1	2	3
Behavior	Playing/appropriate	Sleeping	Irritable	Lethargic/confused or reduced response to pain
Cardiovascular	Pink or capillary refill 1–2 s	Pale or capillary refill 3 s	Gray or capillary refill 4 s or tachycardia of ≥20 bpm above normal rate	Gray and mottled or capillary refill ≥5 s or tachycardia ≥30 bpm above normal rate or bradycardia
Respiratory	Within normal parameters, no retractions or tracheal tug	Respiratory rate ≥10 breaths/min above normal parameters, using accessory muscles or 30%+ F_{IO_2} or 3+ L/min	Respiratory rate ≥20 breaths/min above normal parameters, retractions, tracheal tug, or 40%+ F_{IO_2} or 6+ L/min	RR 5 breaths/min below normal rate with retractions and/or grunting, or 50%+ F_{IO_2} or 8+ L/min

	Normal Vital Sign Ranges	
	Heart Rate (beats per minute)	**Respiratory Rate (breaths per minute)**
Newborn (<31 d)	100–180	40–60
Infant (1–12 mo)	100–180	35–40
Toddler (13 mo to 3 y)	70–110	25–30
Preschool (4–6 y)	70–110	21–23
School age (7–12 y)	70–110	19–21
Adolescent (>12 y)	55–90	16–18

Score 2 extra for persistent vomiting following surgery or ¼ hourly nebulizers.

Application of PEWS

- **Inpatient**
  - Early recognition of clinical deterioration
  - Alert rapid response teams
  - Frequency nursing and physician assessments
- **Emergency Department**
  - Admit vs discharge
  - Acute care vs ICU
- **Medical transport**
  - Assess stability during transport
- **Patient safety and communication**

Application of PEWS

Journal of Pediatric Nursing (2013) **28**, e33–e41

Comparison of Three Acute Care Pediatric Early Warning Scoring Tools

Mary-Ann J. Robson BSN, RN, CCRN[a,*], Carole L. Cooper MSN, MHA, RN, CNS, CPN[b], Lori A. Medicus MN, RN, CNS, CPNP[b], Mary J. Quintero AS, AA, CCRN, CPN[c], Stephen A. Zuniga PhD[d]

[a]*Clinical Education and Informatics, Children's Hospital Central California, Madera, CA*
[b]*Patient Care Support, Children's Hospital Central California, Madera, CA*
[c]*Emergency Department, Children's Hospital Central California, Madera, CA*
[d]*Outcomes and Quality Department, Children's Hospital Central California, Madera, CA*

Table 2 Validated Pediatric Early Warning Instrument Variables.

Variables	PEW Tool	PEW System Score	Bedside PEW System Score
Heart rate	X	X	X
Blood pressure	X	X	X
Pulses	X	X	
Capillary refill	X	X	X
Acute airway obstruction	X		
Abnormal airway		X	
Respiratory rate	X	X	X
Respiratory effort			X
Apnea	X		
Oxygen saturation	X	X	X
Oxygen therapy		X	X
Home oxygen		X	
Level of Consciousness (LOC)	X	X	
Convulsions	X		
Cerebral palsy		X	
Temperature		X	
Fluid bolus		X	
Medications		X	
3 medical subspecialists		X	
Previous ICU admission		X	
Central Venous Catheter		X	
Gastrostomy tube		X	
Transplant recipient		X	
Hyperkalemia	X		
Suspected meningococcus	X		
Diabetic ketoacidosis	X		
Condition is worrying	X		
Total score range	0–1	0–32	0–26
Trigger score	1	5	8

Adapted from Duncan et al. (2006), Haines et al. (2006), and Parshuram et al. (2009).

Robson et al 2013

Application of PEWS

Table 8 Results From Comparison of the Three PEW Tools.

Threshold Score	PEW System Score		PEW Tool		Bedside PEW System Score	
	Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)	Sensitivity (%)	Specificity (%)
1	100.0	3.1	76.3	61.5	100.0	1.0
2	100.0	11.5	42.3	91.7	95.8	16.7
3	100.0	32.3	22.7	96.9	89.6	34.4
4	92.8	55.2	9.3	100	82.3	47.9
5	86.6	72.9	3.1	100	74	61.5
6	67.0	77.1			61.5	71.9
7	61.9	83.3			56.3	78.1
8	48.5	87.5			43.8	85.4

Robson et al 2013

Journal of Pediatric Nursing (2013) **28**, e33–e41

ELSEVIER

Comparison of Three Acute Care Pediatric Early Warning Scoring Tools

Mary-Ann J. Robson BSN, RN, CCRN[a,*], Carole L. Cooper MSN, MHA, RN, CNS, CPN[b], Lori A. Medicus MN, RN, CNS, CPNP[b], Mary J. Quintero AS, AA, CCRN, CPN[c], Stephen A. Zuniga PhD[d]

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[d]*Outcomes and Quality Department, Children's Hospital Central California, Madera, CA*

- **Retrospective case-control study**
- **Compared 3 PEW tools in acute care setting**
- **PEW System Score (Duncan et al) effective for identifying 86.6% of patients prior to CPA**

Robson et al 2013

Application of PEWS

- **Inpatient**
  - Early recognition of clinical deterioration
  - Alert rapid response teams
  - Frequency nursing and physician assessments
- **Emergency Department**
  - Admit vs discharge
  - Acute care vs ICU
- **Medical transport**
  - Assess stability during transport
- **Patient safety and communication**

Application of PEWS

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Validity of Different Pediatric Early Warning Scores in the Emergency Department

Nienke Seiger, Ian Maconochie, Rianne Oostenbrink and Henriëtte A. Moll

Pediatrics; originally published online September 9, 2013;
DOI: 10.1542/peds.2012-3594

TABLE 1 PEWS and Their Parameters

PEWS	Origin	Type	Normal Vital Sign Cutoff Levels							Other Parameter	Excluded Parameters
			Age Range	Heart Rate (beats/min)	Respiratory Rate (breaths/min)	Systolic Blood Pressure (mm Hg)	Oxygen Saturation	Temperature (°C)	Level of Consciousness		
Monaghan[7]	Original	Scoring (0–9)	<1 y	120–190	35–50	NA	NA	NA	Sleeping; irritable; lethargic; confused; reduced response to pain	Capillary refill; oxygen therapy; work of breathing	1/4 hourly nebulizers; persistent vomiting after surgery
			1–2 y	80–130	30–45	NA					
			3–4y	70–130	26–41	NA					
			5–11y	70–130	22–37	NA					
			12–16 y	60–110	11–26	NA					
Akre et al[8]	Derived[7]	Scoring (0–9)	<1 m	100–200	35–70	NA	NA	NA	Sleeping; irritable; lethargic; confused; reduced response to pain	Capillary refill; cyanotic; oxygen therapy; work of breathing	1/4 hourly nebulizers; persistent vomiting after surgery
			1–12 m	100–200	30–50	NA					
			13 m–3 y	70–130	20–40	NA					
			4–6 y	70–130	16–33	NA					
			7–12 y	70–130	14–31	NA					
			13–16 y	55–110	11–28	NA					
Skaletzky et al[9]	Derived[7]	Scoring (0–9)	<3 m	85–225	30–70	NA	NA	NA	Sleeping; irritable; lethargic; confused; reduced response to pain	Capillary refill; oxygen therapy; work of breathing	1/4 hourly nebulizers; persistent vomiting after surgery
			3 m–1 y	100–210	30–70	NA					
			1–2 y	100–210	24–50	NA					
			2–3 y	60–160	24–50	NA					
			4–5 y	60–160	22–44	NA					
			6–10 y	60–160	18–40	NA					
			10–12 y	60–120	18–40	NA					
			13–16 y	60–120	12–26	NA					
Duncan et al[10]	Original	Scoring (0–23)	<3 m	110–150	30–60	60–80	>95%	36–38.5	Glasgow Coma scale score ≤11	Pulses; capillary refill; oxygen therapy; bolus fluid	None (dynamic model was used)
			3–12 m	100–150	25–50	80–100					
			1–4 y	90–120	20–40	90–110					
			4–12 y	70–110	20–30	90–120					
			>12 y	60–100	12–16	100–130					
Parshuram et al[11]	Derived[10]	Scoring (0–26)	<3 m	110–150	30–60	60–80	>94%	NA	NA	Capillary refill; respiratory effort; oxygen therapy	
			3–12 m	100–150	25–50	80–100					
			1–4 y	90–120	20–40	90–110					
			4–12 y	70–110	20–30	90–120					
			>12 y	60–100	12–16	100–130					
Egdell et al[4]	Original	Scoring (0–21)	<1 y	110–160	30–40	NA					
			1–2 y	100–150	25–35	NA	≥93%	36–38	Responds to voice; responds to pain; unresponsive	Work of breathing; capillary refill	
			2–5 y	95–140	25–30	NA					
			5–12 y	80–120	20–25	NA					
			>12 y	60–100	15–20	NA					

Seiger et al 2013

Application of PEWS

TABLE 1 Continued

PEWS	Origin	Type	Normal Vital Sign Cutoff Levels							Other Parameter	Excluded Parameters
			Age Range	Heart Rate (beats/min)	Respiratory Rate (breaths/min)	Systolic Blood Pressure (mm Hg)	Oxygen Saturation	Temperature (°C)	Level of Consciousness		
Tibballs et al[12]	Original	Triggering	<3 m	100–180	>60	<50					
			4–12 m	100–180	>50	<60	≥90% or ≥60% with cyanotic heart disease	NA	Acute change in neurologic status or convulsion	Airway threat; severe respiratory distress, apnea, cyanosis; cardiac or respiratory arrest; worried about clinical state	
			1–4 y	90–180	>40	<70					
			5–12 y	80–140	>30	<80					
			>12 y	60–130	>30	<90					
Edwards et al[13]	Derived[12]	Triggering	<1 y	90–160	20–50	70–90					
			1–2 y	80–150	15–45	80–95	≥93%	NA	Responds to voice; responds to pain; unresponsive	Airway threat (eg, stridor); work of breathing; worried about clinical state	
			2–5 y	75–140	15–40	80–100					
			5–12 y	60–120	10–35	90–110					
			>12 y	55–100	10–30	100–120					
Haines et al[14]	Derived[12]	Triggering	<6 m	≥150	≥70	NA					
			6–12 m	≥150	≥60	NA	≥92% or ≥75% with cyanotic heart disease	NA	Glasgow Coma scale score ≤11; responds only to pain; convulsion	Airway threat; signs of shock (eg, prolonged capillary refill [3 s]); worried about clinical state; bolus fluid	Hyperkalemia; suspected meningococcus; suspected ketoacidosis
			1–5 y	≥150	≥40	NA					
			5–12	≥120	≥25	NA					
			>12 y	≥100	≥25	NA					
Brilli et al[15]	Original	Triggering	NA	NA	NA	NA	≥90%	NA	Agitation or decreased level of consciousness	Work of breathing; cyanosis; worried about clinical state	

NA, not available.

Seiger et al 2013

Application of PEWS

PEDIATRICS®
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Pediatrics; originally published online September 9, 2013;
DOI: 10.1542/peds.2012-3594

- Prospective study, calculated 10 different PEWS using different scores
- PEWS validated in 17,943 children
- 2% ICU and 16% acute care
- Moderate-to-good predictability of ICU admission
- None with both high sensitivity and high specificity

Seiger et al 2013

Application of PEWS

Journal of Intensive Care Medicine
1-7

DOI: 10.1177/0885066615571893
jic.sagepub.com
SAGE

Identifying High-Risk Children in the Emergency Department

Katie R. Nielsen, MD, MPH[1], Russ Migita, MD[2], Maneesh Batra, MD, MPH[3], Jane L. Di Gennaro, MD[1], Joan S. Roberts, MD[1], and Noel S. Weiss, MD, DrPH[4]

- Case-control study 597 pediatric ED admits to inpatient ward
- Followed patients that required ward-to-PICU admission in <24 hours
- MPEWS ≥ 7 associated with higher risk with specificity of 97.4%, but sensitivity 18.0%

Application of PEWS

- **Inpatient**
  - Early recognition of clinical deterioration
  - Alert rapid response teams
  - Frequency nursing and physician assessments
- **Emergency Department**
  - Admit vs discharge
  - Acute care vs ICU
- **Medical transport**
  - Assess stability during transport
- **Patient safety and communication**

Application of PEWS

ORIGINAL ARTICLE

The Use of a Modified Pediatric Early Warning Score to Assess Stability of Pediatric Patients During Transport

Toni Petrillo-Albarano, MD,† Jana Stockwell, MD,*† Traci Leong, PhD,‡ and Kiran Hebbar, MD*†*

- **Retrospective chart review on 100 transports**
- **Created a "TPEWS"**
  - Points for pressors, transfusion, paralytics (intubation), MAPs
- **Compared score at dispatch to arrival, found significant improvement in scores during transport**
- **Use of TPEWS can be helpful assessment tool with management during dispatch and transport**

Albanrano et al 2012

Application of PEWS

Track and trigger system for use in community hospitals

Wolfenden J *et al* (2010) Track and trigger system for use in community hospitals. Nursing Standard. 24, 45, 35-39. Date of acceptance: April 9 2010.

- Prospective study of adult early warning systems
- Implemented in 10 community hospitals in Wales
- Tracked inpatient scores and patients who were transported
- Scores associated with clinical deterioration and predicted need for transfer

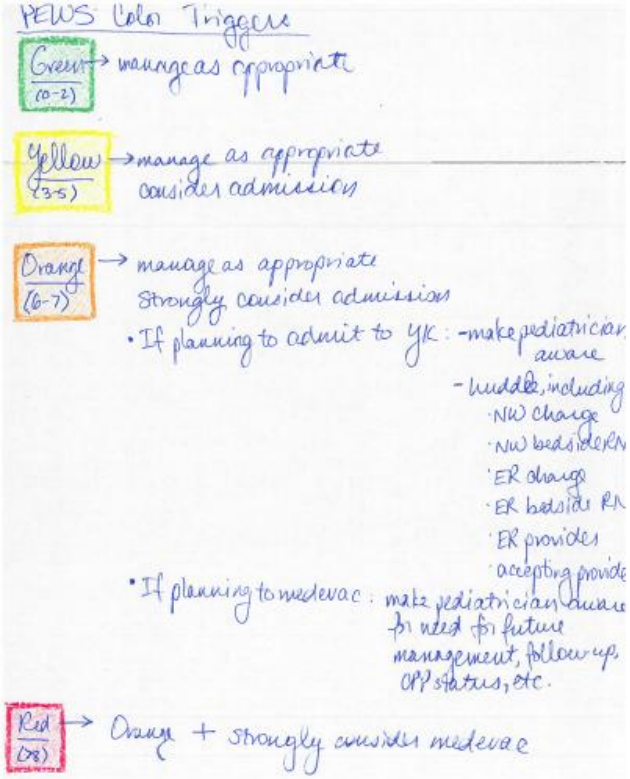
Application of PEWS

- **Inpatient**
  - Early recognition of clinical deterioration
  - Alert rapid response teams
  - Frequency nursing and physician assessments
- **Emergency Department**
  - Admit vs discharge
  - Acute care vs ICU
- **Medical transport**
  - Assess stability during transport
- **Patient safety and communication**

QI project

Implementation of PEWS at YKHC

- Used Seattle Children's modified PEWS (MPEWS)
- Based on PEW System Score (Duncan et al)
- Adjusted thresholds for YKHC



Dr. Herrmann's notes during planning

YKHC Modified Pediatric Early Warning Score (mPEWS)

Pediatric Complexity	
1 point for each	
□ [illegible]	□ [illegible] (developmental delay, etc.)
□ [illegible]	□ [illegible]
□ [illegible]	

Level of Consciousness			
	0 points		2 points
	Alert, awake, asleep, or arouses easily		Agitated, anxious, lethargic, confused, or irritable

Temperature			
	0 points	1 point	2 points
	96.8 – 101.1°F	95.2-96.7°F 101.2-104°F	<95.2°F >104°F

Heart Rate			
	0 points	1 point	2 points
<90 days	113-171	103-112 172-186	<103 >186
3-6 months	108-167	98-107 168-182	<98 >182
6-9 months	104-163	94-103 164-178	<94 >178
9-12 months	101-160	91-100 161-176	<91 >176
12-18 months	97-157	87-96 158-173	<87 >173
18-24 months	92-154	82-91 155-170	<82 >170
2-3 years	87-150	77-86 151-167	<77 >167
3-4 years	82-146	71-81 147-164	<71 >164
4-6 years	77-142	68-76 143-161	<68 >161
6-8 years	71-137	61-70 138-155	<61 >155
8-12 years	66-129	56-65 130-147	<56 >147
12-15 years	61-121	51-60 122-138	<51 >138
>15 years	57-115	48-56 116-132	<48 >132

Respiratory Rate			
	0 points	1 point	2 points
<90 days	27-62	22-26 63-76	<22 >76
3-6 months	25-58	21-24 59-71	<21 >71
6-9 months	23-54	20-22 55-67	<20 >67

QI project

Implementation of PEWS at YKHC

Started on 9/22/15

- **All patients admitted to inpatient service scored in ED and inpatient**
- **Assigned an acuity color based on score to help guide communication**

YUKON-KUSKOKWIM HEALTH CORPORATION

Modified Pediatric Early Warning Score (mPEWS) Scoring Guide and Checklist for ER

Patient Sticker

Date & Time

Patient Disposition

- □ Discharged home
- □ Admitted to NW
- □ Transferred

Scorecard

PMH (1 point for each)

- □ Home oxygen
- □ Previous ICU admission
- □ Heart disease or surgery
- □ Severe neurologic abnormality
- □ Gastrostomy tube

Level of Consciousness

- □ 0 points
- □ 2 points

Temperature

- □ 0 points
- □ 1 point
- □ 2 points

Heart Rate (see age-specific scoring cards)

- □ 0 points
- □ 1 point
- □ 2 points

Respiratory Rate (see age-specific scoring cards)

- □ 0 points
- □ 1 point
- □ 2 points

Systolic BP (see age-specific scoring cards)

- □ 0 points
- □ 1 point
- □ 2 points

Oxygen

- □ 0 points
- □ 1 point
- □ 2 points

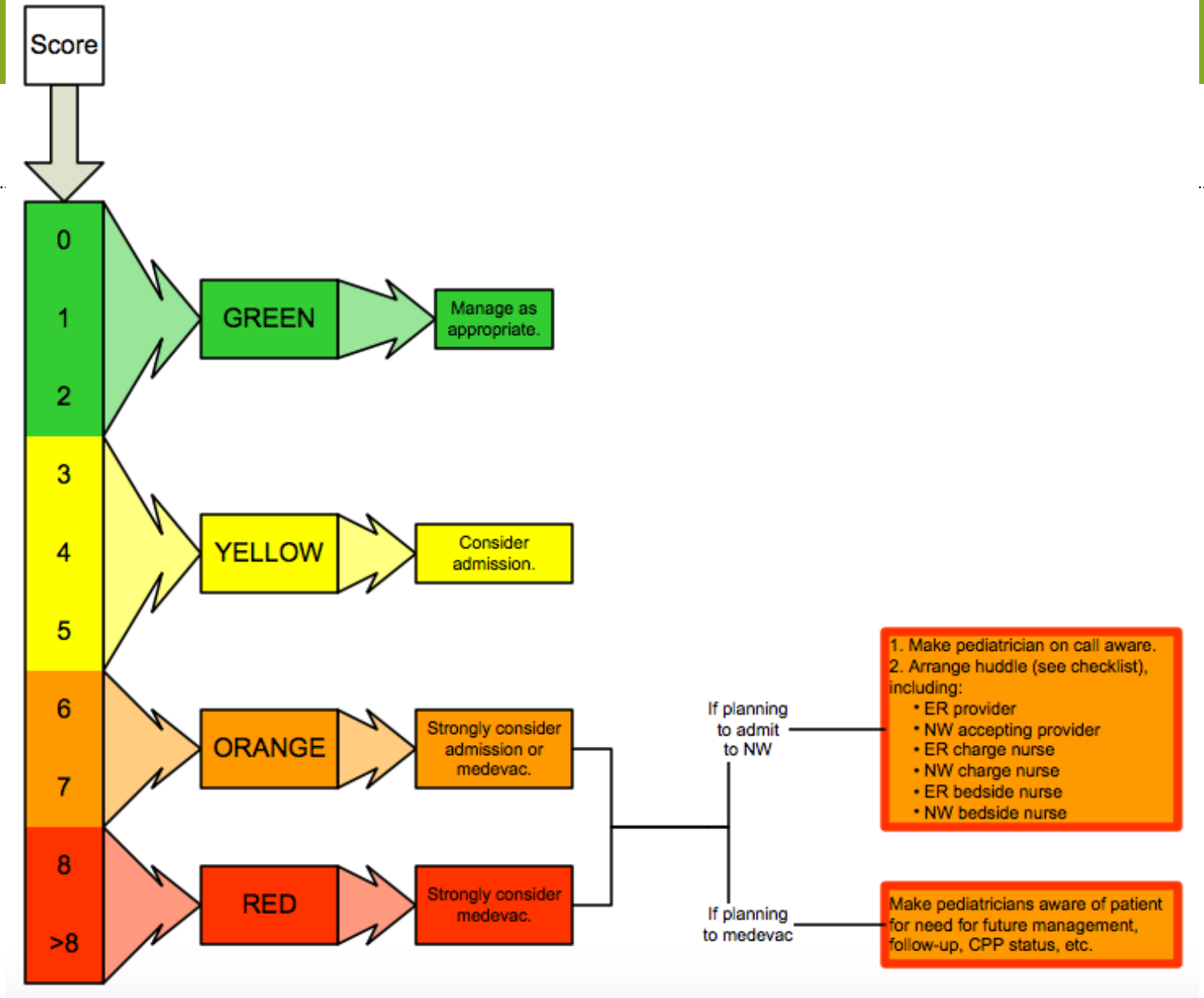
Bolus Fluids (within the last 8 hours)

- □ 0 points
- □ 1 point
- □ 2 points

Score

Color

- Green (0-2)
- Yellow (3-5)
- Orange (6-7)
- Red (>8)


Score
0
1
2
GREEN
Manage as appropriate.
3
4
5
YELLOW
Consider admission.
6
7
ORANGE
Strongly consider admission or medevac.
8
>8
RED
Strongly consider medevac.
If planning to admit to NW
1. Make pediatrician on call aware.
2. Arrange huddle (see checklist), including:
• ER provider
• NW accepting provider
• ER charge nurse
• NW charge nurse
• ER bedside nurse
• NW bedside nurse
If planning to medevac
Make pediatricians aware of patient for need for future management, follow-up, CPP status, etc.

Checklist for Admitting Patients with Score of Orange or Red

- □ ER provider has discussed patient with NW provider.
- □ NW provider has accepted patient.
- □ On-call pediatrician is aware of patient.
- □ ER charge nurse has discussed patient with NW charge nurse.
- □ NW bedside nurse has come to ER for bedside report, OR there has been a huddle by phone that includes the ER provider, the NW provider, the ER bedside nurse, and the NW bedside nurse.
- □ NW bedside nurse has discussed patient with NW provider.
- □ All are in agreement with plan.
- □ Patient clear to go to floor.

QI project

Characteristics of admitted patients (9/22/15-4/30/16)

Characteristics			
Total admissions	276		
Total with at least one PEWS	202	73%	
Age	2 weeks-18 years		
Mean	3 years		
Median	10 months		
Gender	Males n=66 Females n=64		
		Total	**%**
Admission Diagnosis	respiratory	123	61%
	skin infection	20	10%
	other infection	21	10%
	other	15	7%
	dehydration	10	5%
	FTT	8	4%
	seizure	5	2%

QI project

Percent transferred after admission based on color

	All Patients		
Score	Total	Transferred	Percent Transferred
Green	115	8	7%
Yellow	69	13	19%
Orange	16	3	19%
Red	2	1	50%
Total	202	25	12%

QI project

Characteristics of transferred patients

	All Patients		
Score	Total	Transferred	Percent Transferred
Green	115	8	7%
Yellow	69	13	19%
Orange	16	3	19%
Red	2	1	50%
Total	202	25	12%

- **25 patients transferred**
- **5 transferred for subspecialty care**
  - All green scores
  - 2 via commercial flights
- **Average time 37hrs**

Diagnosis	
respiratory	60%
other infection	24%
FTT	12%
skin infection	4%

QI project

Characteristics of high scoring patients

18 patients scoring orange or red

Diagnosis	
respiratory	89%
other infection	6%
FTT	6%

- **4 transferred (22%)**
  - All respiratory cases
  - Average transfer time 15 hours

QI project

Respiratory patients only

Respiratory Only			
Score	Total	Transferred	Percent Transferred
Green	53	2	4%
Yellow	54	9	17%
Orange	14	3	21%
Red	2	1	50%
Total	123	15	12%

All Patients			
Score	Total	Transferred	Percent Transferred
Green	115	8	7%
Yellow	69	13	19%
Orange	16	3	19%
Red	2	1	50%
Total	202	25	12%

QI project

PEWS thresholds

Our data based on number transferred

Score	Sensitivity	Specificity
≥1	0.880	0.209
≥2	0.800	0.407
≥3	0.680	0.605
≥4	0.480	0.746
≥5	0.280	0.842
≥6	0.160	0.921
≥7	0.160	0.960
≥8	0.040	0.994

QI project

Results and reflection

Accomplished

- **Implementation of scoring tool**
- **Nursing staff trained and has incorporated into routine tasks**
- **Improved communication**
  - Empowered nursing staff
  - Provided additional objective measure to consider

QI project

Results and reflection

Challenges

- **Training of nursing staff**
  - Accuracy of scoring
  - Buy-in from nursing and ED providers
- **Implementation into routine**
  - Not always completed
- **Paper scoring**
- **Small number of transferred patients**

QI project

Results and reflection

Future directions

- Electronic entry into Cerner (in progress)
- Evaluation of patients admitted vs transferred directly from ED
- Use in village clinics
- Adjust thresholds to improve sensitivity and specificity for our population
- Adult warning score system

Summary

PEWS are a scoring tool to help with early recognition and ensure the appropriate level of care.

Designed to improve patient safety and communication.

Many different tools have been created and validated for different purposes.

Initial data suggests that PEWS may be a helpful tool, but more data is needed to improve sensitivity and specificity.

Acknowledgements

Thank you!

PEWS Mentors

- Leslie Herrmann, MD
- Katie Nielsen, MD, MPH
- Joan Roberts, MD

YKHC staff

- ED nurses and providers
- Inpatient nurses and providers

Alaska Track Residency

Hanger lake with Northern Lights

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