Sepsis Risk Assessment Algorithm

Complete Calculation Guide

Purpose

This algorithm categorizes post-discharge patients into four risk tiers based on self-reported symptoms and home vital signs:

Tier	Label	Action
GREEN	Safe	Continue home monitoring
YELLOW	Concerning	Contact provider today
RED	Urgent	Seek immediate medical attention
RED_EMERGENCY	Emergency	Call 911

Algorithm Flow (7 Steps)

```
INPUT: Patient survey responses
    ↓
STEP 1: Emergency Conditions → If triggered → RED_EMERGENCY (exit)
    ↓
STEP 2: Hard RED Overrides → If triggered → RED_EMERGENCY (exit)
    ↓
STEP 3: Detect Clinical Patterns → Determines pattern escalation level
    ↓
STEP 4: Calculate Base Score → Sum of individual symptom points
    ↓
STEP 5: Apply Context Bonuses → Additive adjustments from patient history
    ↓
STEP 6: Apply High-Risk Modifier → Score × 1.25 if applicable
    ↓
STEP 7: Determine Final Risk Level → MAX(score-based level, pattern-based level)
    ↓
OUTPUT: Risk tier + reasoning
```

STEP 1: Emergency Conditions

Logic: If ANY of these are true, immediately return RED_EMERGENCY. No further calculation.

Field	Condition	Result
`fainted_or_very_dizzy`	`= true`	RED_EMERGENCY

Field	Condition	Result
breathing_level	= 3 (extremely difficult)	RED_EMERGENCY
thinking_level	= 3 (not making sense)	RED_EMERGENCY
extreme_heat_or_chills	= true	RED_EMERGENCY
discolored_skin	= true (mottling/cyanosis/jaundice)	RED_EMERGENCY

STEP 2: Hard RED Overrides

Logic: Critical vital sign thresholds that require immediate escalation. Evaluated after Step 1. No further calculation if triggered.

Field	Condition	Result
temperature_value	≥ 103.5°F	RED_EMERGENCY
oxygen_level_value	< 90%	RED_EMERGENCY
heart_rate_value	> 140 bpm	RED_EMERGENCY
breathing_level	= 3	RED_EMERGENCY
thinking_level	= 3	RED_EMERGENCY
blood_pressure_zone	= 3 (severe hypotension/crisis)	RED_EMERGENCY

Note: breathing_level = 3 and thinking_level = 3 appear in both Step 1 and Step 2 as redundant safety nets.

STEP 3: Detect Clinical Patterns

Logic: Check for dangerous symptom combinations. Each pattern maps to an escalation level. Patterns can only **increase** risk, never decrease it. Priority order: RED_EMERGENCY > RED > YELLOW.

Infection Context Definition

Several patterns reference hasClearInfectionContext, which is true if ANY of:

- fever_chills = true
- temperature_zone ≥ 2
- urine_appearance_level ≥ 2
- wound_state_level = 3
- has_cough = true AND mucus_color_level ≥ 2

Pattern Definitions

Pattern 1: Septic Shock — only applies when blood_pressure_zone = 2; zone 3 is caught by the hard override in Step 2

```
IF blood_pressure_zone = 2 AND thinking_level ≥ 2 THEN:
    IF hasClearInfectionContext = true → RED_EMERGENCY (exit immediately, skip
remaining patterns)
    ELSE                               → RED
```

Pattern 2: Respiratory Failure

```
IF oxygen_level_zone ≥ 2 AND breathing_level ≥ 2 → RED
```

Pattern 3: Silent Hypoxia

```
IF oxygen_level_zone ≥ 2 AND energy_level = 3 → RED
```

Pattern 4: Septic Encephalopathy

```
IF fever_chills = true AND thinking_level ≥ 2 → RED
```

Pattern 5: Compensated Shock

```
IF blood_pressure_zone ≥ 2
    AND blood_pressure_systolic ≤ (baseline_bp_systolic OR 120)
    AND heart_rate_zone ≥ 2
→ RED
```

This pattern only triggers for LOW blood pressure. A hypertensive crisis (>180) produces BP zone 3, which is caught by the hard override before this pattern is evaluated.

Pattern 6: Septic Hypothermia

```
IF temperature_value < 96.8°F → RED
```

Pattern 7: SIRS Criteria

```
IF temperature_zone ≥ 2 AND heart_rate_zone ≥ 2 → YELLOW
```

Pattern 8: Urosepsis

```
IF fever_chills = true AND urine_appearance_level ≥ 2 → YELLOW
```

Pattern 9: Cardiovascular Stress

```
IF energy_level = 3 AND heart_rate_zone ≥ 2 → YELLOW
```

Output: `patternEscalation` = highest level triggered (or null if none match)

STEP 4: Calculate Base Score

Logic: Sum points for each symptom present. Several fields have amplified scores when certain patient history flags are set.

Energy Level

Condition	Points
`energy_level = 2` (fatigued)	+5
`energy_level = 2` AND `has_heart_failure = true`	+10
`energy_level = 3` (extremely fatigued)	+15
`energy_level = 3` AND `has_heart_failure = true`	+25

Rationale: Fatigue in CHF patients signals cardiac decompensation earlier than in the general population.

Subjective Fever

Condition	Points
`fever_chills = true AND has_thermometer = false`	+10

Only scored when no thermometer is available. When a thermometer is present, `temperature_zone` scoring applies instead.

Temperature

Condition	Points
`temperature_zone = 2` (100–101.4°F)	+15
`temperature_zone = 3` (<96.8°F or ≥101.5°F)	+40

Oxygen Level

Condition	Points
`oxygen_level_zone = 2` (92–94%)	+15

Condition	Points
`oxygen_level_zone = 3` (<92%)	+40

Subjective Heart Racing

Condition	Points
`heart_racing = true AND has_hr_monitor = false`	+5

Only scored when no heart rate monitor is available.

Heart Rate (measured)

Condition	Points
`heart_rate_zone = 2` (101–120 bpm)	+8
`heart_rate_zone = 2 AND has_heart_failure = true`	+15
`heart_rate_zone = 3` (<60 or >120 bpm)	+30
`heart_rate_zone = 3 AND has_heart_failure = true`	+40

Rationale: Tachycardia in CHF is a compensatory mechanism that signals decompensation earlier than in other patients.

Blood Pressure

Condition	Points
`blood_pressure_zone = 2` (20–39 mmHg below baseline)	+8
`blood_pressure_zone = 3` (<90, >180, or 40+ below baseline)	+20

Mental Status

Condition	Points
`thinking_level = 2` (slow or foggy)	+8

`thinking_level = 3` triggers RED_EMERGENCY in Steps 1 and 2 before scoring is reached.

Breathing

Condition	Points
`breathing_level = 2`	+8
`breathing_level = 2 AND (has_lung_condition = true OR has_heart_failure = true)`	+16

Rationale: For COPD/asthma/lung fibrosis patients, mildly difficult breathing indicates exacerbation. For CHF patients, it may signal pulmonary oedema.

Urine Appearance

Condition	Points
`urine_appearance_level = 2` (cloudy/dark/smelly)	+15
`urine_appearance_level = 3` (very dark/bloody)	+60

UTI Symptoms

Only scored when `has_recent_uti = true`.

Condition	Points
`uti_symptoms_worsening = 'same'`	+10
`uti_symptoms_worsening = 'same'` AND `has_urinary_catheter = true`	+18
`uti_symptoms_worsening = 'worsened'`	+30
`uti_symptoms_worsening = 'worsened'` AND `has_urinary_catheter = true`	+40

Rationale: Catheter-associated UTIs (CAUTI) carry higher sepsis risk than uncatheterized UTIs.

Mucus / Cough

Condition	Points
`has_cough = true` (mucus level 1 or null)	+3
`mucus_color_level = 2` (yellow/green)	+10
`mucus_color_level = 2` AND `has_lung_condition = true`	+18
`mucus_color_level = 2` AND `has_recent_pneumonia = true`	+10 additional
`mucus_color_level = 3` (brown/pink/red)	+30
`mucus_color_level = 3` AND `has_lung_condition = true`	+35
`mucus_color_level = 3` AND `has_recent_pneumonia = true`	+10 additional

Rationale: Colored or bloody mucus in patients with COPD, asthma, or lung fibrosis more reliably indicates exacerbation or superimposed infection. The pneumonia bonus stacks on top of the base or lung-condition score.

Wound Status

Condition	Points
`wound_state_level = 2` (looks different)	+10
`wound_state_level = 3` (infected: red/pus/swollen)	+60

GI Symptoms

Condition	Points
`nausea_vomiting_diarrhea = true`	+5

STEP 5: Apply Context Bonuses

Logic: Additive flat bonuses applied to the base score from Step 4. These reflect patient history risk factors independent of today's symptoms.

Recent Discharge

Condition	Bonus
`days_since_last_discharge ≤ 7`	+15
`days_since_last_discharge` 8–30	+8
`days_since_last_discharge` 31–90	+3
`days_since_last_discharge > 90`	+0

Rationale: Sepsis recurrence risk is highest immediately post-discharge and decays over 90 days.

Prior Septic Shock

Condition	Bonus
`has_had_septic_shock = true`	+10

Rationale: Prior septic shock is the strongest independent predictor of future severe sepsis. Even mild presentations warrant higher concern in this population.

STEP 6: Apply High-Risk Modifier

Logic: Certain patient groups receive a 25% score increase to compensate for atypical or attenuated symptom presentation.

High-Risk Criteria

Patient is high-risk if ANY of these are true:

Field	Condition
`age`	`≥ 65`
`has_weakened_immune`	`= true`
`admitted_count`	`> 1`
`on_immunosuppressants`	`= true`

Rationale: Immunosuppressed patients may not mount a classic fever response; the score amplification compensates for attenuated symptoms. Patients admitted more than once have demonstrated recurrence risk.

Calculation

```
IF isHighRiskPatient = true:
    totalScore = ROUND(baseScore × 1.25)
ELSE:
    totalScore = baseScore
```

STEP 7: Determine Final Risk Level

Logic: Combine score-based thresholds with pattern-based escalation. Patterns can only increase the final level, never decrease it.

Part A: Score-Based Level

```
IF totalScore ≥ 60:
    scoreBasedLevel = RED

ELSE IF totalScore ≥ 30:
    scoreBasedLevel = YELLOW

ELSE:
    scoreBasedLevel = GREEN
```

Part B: Pattern Escalation

```
IF patternEscalation = RED_EMERGENCY:
    finalLevel = RED_EMERGENCY

ELSE IF patternEscalation = RED AND scoreBasedLevel ∈ {YELLOW, GREEN}:
    finalLevel = RED

ELSE IF patternEscalation = YELLOW AND scoreBasedLevel = GREEN:
    finalLevel = YELLOW

ELSE:
    finalLevel = scoreBasedLevel
```

Final Formula

```
finalLevel = MAX(scoreBasedLevel, patternEscalation)
```

Where priority order is: `GREEN < YELLOW < RED < RED_EMERGENCY`

Zone Calculation Reference

Temperature Zones

Zone	Range	Interpretation
1 (Green)	96.8°F – 99.9°F	Normal
2 (Yellow)	100°F – 101.4°F	Low-grade fever
3 (Red)	<96.8°F or ≥101.5°F	Hypothermia or high fever

Hard override: temperature ≥ 103.5°F → RED_EMERGENCY (Steps 1–2, before scoring)

Oxygen Zones

Zone	Range	Interpretation
1 (Green)	95% – 100%	Normal
2 (Yellow)	92% – 94%	Mild hypoxia
3 (Red)	<92%	Significant hypoxia

Hard override: oxygen < 90% → RED_EMERGENCY (Steps 1–2, before scoring)

Heart Rate Zones

Zone	Range	Interpretation
1 (Green)	60–100 bpm	Normal
2 (Yellow)	101–120 bpm	Tachycardia
3 (Red)	<60 or >120 bpm	Bradycardia or severe tachycardia

Hard override: heart rate > 140 bpm → RED_EMERGENCY (Steps 1–2, before scoring)

Blood Pressure Zones

Zone	Condition	Interpretation
1 (Green)	Within 20 mmHg of baseline	Normal
2 (Yellow)	20–39 mmHg below baseline	Moderate drop
3 (Red)	<90 mmHg, >180 mmHg, or ≥40 mmHg below baseline	Severe hypotension or crisis

Default baseline: 120 mmHg if `baseline_bp_systolic` not provided. Hard override: zone 3 → RED_EMERGENCY.

Complete Worked Examples

Example A: Healthy Check-in

Input:

- All emergency questions: false/normal
- Age: 45, no immune issues, admitted once
- Temperature: 98.6°F → zone 1
- Oxygen: 98% → zone 1
- Heart rate: 75 bpm → zone 1
- Blood pressure: 118 mmHg (baseline 120) → zone 1
- Energy: level 1, Thinking: level 1, Breathing: level 1
- All other symptoms: negative/normal

Calculation:

1. Emergency conditions: none triggered
2. Hard RED overrides: none triggered
3. Patterns: none match
4. Base score: 0 (all vitals normal, no symptoms)
5. Context bonuses: none
6. High-risk modifier: no → totalScore = 0
7. Score-based level: GREEN (0 < 30)
8. Pattern escalation: none

Final: GREEN

Example B: SIRS Pattern (Fever + Tachycardia)

Input:

- Temperature: 100.8°F → zone 2
- Heart rate: 112 bpm → zone 2
- All other vitals normal, no additional symptoms
- Age: 55, no high-risk flags

Calculation:

1. Emergency conditions: none triggered
2. Hard RED overrides: none triggered
3. Patterns:
    - Pattern 7 (SIRS): `temperature_zone ≥ 2` AND `heart_rate_zone ≥ 2` → YELLOW
4. Base score:
    - Temperature zone 2: +15
    - Heart rate zone 2: +8
    - **Base score = 23**
5. Context bonuses: none → adjusted score = 23
6. High-risk modifier: no → totalScore = 23

7. Score-based level: GREEN (23 < 30)
8. Pattern escalation: YELLOW → upgrades GREEN to YELLOW

Final: YELLOW — pattern escalated from GREEN

Example C: Severe Hypotension (Hard Override)

Input:

- Blood pressure: 80 mmHg (baseline 120) → zone 3 (<90 threshold)
- All other vitals normal
- Thinking: level 1 (clear)

Calculation:

1. Emergency conditions: none triggered
2. Hard RED overrides: `blood_pressure_zone = 3` → **RED_EMERGENCY** (exit)

Final: RED_EMERGENCY — hard override triggered, no further steps

---

Example D: Septic Shock Pattern

Input:

- Blood pressure: 95 mmHg (baseline 120) → zone 2 (25 mmHg below baseline)
- Thinking: level 2 (foggy)
- Temperature: 101.0°F → zone 2
- Heart rate: 105 bpm → zone 2
- No high-risk flags

Calculation:

1. Emergency conditions: none triggered
2. Hard RED overrides: none (BP zone = 2, not 3)
3. Patterns:
    - Pattern 1 (Septic Shock): `blood_pressure_zone = 2` AND `thinking_level ≥ 2`
        - Check `hasClearInfectionContext`: `temperature_zone ≥ 2` → **true**
        - → RED_EMERGENCY, exit immediately

Final: RED_EMERGENCY — septic shock pattern with confirmed infection context

---

Example E: Multiple Symptoms, High-Risk Patient

Input:

- Age: 78 (high-risk: age ≥ 65)
- Temperature: 100.5°F → zone 2
- Heart rate: 108 bpm → zone 2
- Thinking: level 2 (foggy)

- Energy: level 2 (fatigued)
- Urine: level 2 (cloudy)
- Cough present, clear mucus (mucus level 1)
- GI symptoms present
- No `has_heart_failure`, no `has_lung_condition`

Calculation:

1. Emergency conditions: none triggered
2. Hard RED overrides: none triggered
3. Patterns:
   - Pattern 7 (SIRS): `temperature_zone ≥ 2` AND `heart_rate_zone ≥ 2` → YELLOW
4. Base score:
   - Temperature zone 2: +15
   - Heart rate zone 2: +8
   - Thinking level 2: +8
   - Energy level 2 (no CHF): +5
   - Urine level 2: +15
   - Cough, clear mucus: +3
   - GI symptoms: +5
   - **Base score = 59**
5. Context bonuses: none → adjusted score = 59
6. High-risk modifier: yes (age 78) → totalScore = ROUND(59 × 1.25) = ROUND(73.75) = **74**
7. Score-based level: RED (74 ≥ 60)
8. Pattern escalation: YELLOW (RED > YELLOW, no upgrade)

Final: RED — score-based level wins over pattern

Example F: Compensated Shock (Tachycardia + Hypotension)

Input:

- Blood pressure: 98 mmHg (baseline 125) → zone 2 (27 mmHg below baseline)
- Heart rate: 118 bpm → zone 2
- Thinking: level 1 (clear)
- No fever, no infection signs, no high-risk flags

Calculation:

1. Emergency conditions: none triggered
2. Hard RED overrides: none triggered
3. Patterns:
   - Pattern 5 (Compensated Shock): `blood_pressure_zone ≥ 2` AND `bp_systolic (98) ≤ baseline (125)` AND `heart_rate_zone ≥ 2` → RED
4. Base score:
   - BP zone 2: +8
   - Heart rate zone 2: +8
   - **Base score = 16**

5. Context bonuses: none → adjusted score = 16

6. High-risk modifier: no → totalScore = 16

7. Score-based level: GREEN (16 < 30)

8. Pattern escalation: RED → upgrades GREEN to RED

Final: RED — pattern escalated from GREEN

Clinical rationale: The heart is racing to compensate for falling blood pressure — a pre-shock state requiring urgent evaluation even though individual scores are low.

Summary Table: All Point Values

Category	Condition	Points
Energy	Level 2 (fatigued)	+5
Energy	Level 2 + `has_heart_failure`	+10
Energy	Level 3 (extremely fatigued)	+15
Energy	Level 3 + `has_heart_failure`	+25
Subjective fever	`fever_chills` + no thermometer	+10
Temperature	Zone 2	+15
Temperature	Zone 3	+40
Oxygen	Zone 2	+15
Oxygen	Zone 3	+40
Subjective HR	`heart_racing` + no monitor	+5
Heart rate	Zone 2	+8
Heart rate	Zone 2 + `has_heart_failure`	+15
Heart rate	Zone 3	+30
Heart rate	Zone 3 + `has_heart_failure`	+40
Blood pressure	Zone 2	+8
Blood pressure	Zone 3	+20
Thinking	Level 2	+8
Breathing	Level 2	+8
Breathing	Level 2 + `has_lung_condition` or `has_heart_failure`	+16
Urine appearance	Level 2	+15
Urine appearance	Level 3	+60
UTI symptoms	Unchanged (`has_recent_uti`)	+10

Category	Condition	Points
UTI symptoms	Unchanged + `has_urinary_catheter`	+18
UTI symptoms	Worsened (`has_recent_uti`)	+30
UTI symptoms	Worsened + `has_urinary_catheter`	+40
Cough	Present, clear/no mucus	+3
Mucus	Level 2 (yellow/green)	+10
Mucus	Level 2 + `has_lung_condition`	+18
Mucus	Level 2 + `has_recent_pneumonia`	+10 additional
Mucus	Level 3 (brown/pink/red)	+30
Mucus	Level 3 + `has_lung_condition`	+35
Mucus	Level 3 + `has_recent_pneumonia`	+10 additional
Wound	Level 2 (different)	+10
Wound	Level 3 (infected)	+60
GI symptoms	Present	+5
Context bonus	Discharged ≤7 days ago	+15
Context bonus	Discharged 8–30 days ago	+8
Context bonus	Discharged 31–90 days ago	+3
Context bonus	Prior septic shock history	+10

Summary Table: Risk Thresholds

Condition	Result
Emergency question triggered (Step 1)	RED_EMERGENCY
Hard vital sign override triggered (Step 2)	RED_EMERGENCY
Pattern = RED_EMERGENCY	RED_EMERGENCY
`totalScore ≥ 60`	RED
Pattern = RED	RED
`totalScore ≥ 30`	YELLOW
Pattern = YELLOW	YELLOW
Otherwise	GREEN