# Validity and reliability of measurement of capillary refill time in children: a systematic review

**Web Appendices**

#### WebAppendix 1: Search Strategy

|  |  |
| --- | --- |
| **Medline/Embase (via Ovid SP interface)** | **Cinahl** |
| 1. (capillary adj3 refill\*).mp. [mp=ti, ab, sh, hw, tn, ot, dm, mf, dv, kw, ps, rs, nm, an, ui]  2. limit 1 to english language | capillary n3 refill\*  Limiters - English Language |

#### WebAppendix 2: Quality assessment criteria

|  |  |
| --- | --- |
| **Patient selection** | Bias: suitable sampling method used |
| Bias: appropriate exclusion criteria |
| Applicability: appropriate inclusion criteria |
| **Index test (CRT)** | Bias: blinded to result of comparator \* |
| Bias: time measured OR pre-specified threshold used |
| Applicability: site and time measurement method defined |
| **Comparator \*** | Bias: blinded to index test result \* |
| Bias: independent of result of index test \* |
| Applicability: objective measurement \* |
| **Timing and flow** | Bias: contemporaneous measurement of index test and comparator \* |
| Bias: all children had index test performed |
| Bias: all children had comparator assessed \* |

\*indicates criteria not used in the assessment of studies of normal ranges of CRT

#### WebAppendix 3: Quality assessment of included studies

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Patient selection** | | | **Index test (CRT)** | | | **Comparator** | | | **Timing and flow** | | |
|  | sampling method | exclusion criteria | inclusion criteria | CRT blinding | time measured | defined site and time | comparator blinding | comparator objective | comparator independent | contemporaneous | all children had CRT | all children had comparator |
| Beskardes, 20131 | ✓ | ✓ | ✓ | - | ✓ | ? | - | - | - | - | ✓ | - |
| Chen, 20052 | ✓ | ✓ | ✓ | X | ✓ | ✓ | X | ✓ | ? | ✓ | ✓ | ✓ |
| Crook, 20133 | ✓ | ✓ | ✓ | X | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ |
| Duggan, 19974 | ✓ | ✓ | ✓ | ✓ | X | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Gorelick, 19935 | ? | ✓ | ✓ | ? | ✓ | ✓ | ? | ✓ | ✓ | ✓ | ✓ | X |
| Gorelick, 1997a6 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ? | ✓ | ✓ | X | ✓ | X |
| Gorelick, 1997b7 | ✓ | ✓ | ✓ | ? | ✓ | ✓ | ? | ✓ | ✓ | ✓ | ✓ | X |
| Karpitskaya, 20088 | ? | ✓ | ? | X | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ |
| Leflore, 20059 | ✓ | ✓ | ✓ | X | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ |
| Otieno, 200410 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | X | ? | ✓ | ✓ |
| Purcell, 200911 | ✓ | ✓ | ✓ | ? | ✓ | ✓ | ? | ✓ | ✓ | ✓ | ✓ | ✓ |
| Raichur, 200112 | ✓ | ? | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ? | ✓ | ✓ |
| Raimer, 201113 | ? | ✓ | ✓ | ? | ✓ | ✓ | ? | ✓ | ✓ | ✓ | ✓ | ✓ |
| Raju, 199914 | ✓ | ✓ | ✓ | ? | ✓ | ✓ | ? | ✓ | ✓ | ? | ✓ | X |
| Roland, 201015 | ✓ | ✓ | ✓ | ✓ | ✓ | ? | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Saavedra, 199116 | ? | ✓ | ✓ | - | ✓ | ✓ | - | - | - | - | ✓ | - |
| Schriger, 198817 | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | - | - | - | ✓ | - |
| Stinson, 201118 | ? | ✓ | ✓ | ? | ? | ? | ? | ✓ | ✓ | ? | ✓ | ✓ |
| Strozik, 199719 | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | - | - | - | ✓ | - |
| Strozik, 199820 | ? | ✓ | ✓ | X | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ |
| Tibby, 199921 | ? | ✓ | ✓ | ? | ✓ | ✓ | ? | ✓ | ✓ | ✓ | ✓ | ✓ |

? used for “unclear”

#### **WebAppendix 4: Effect of pressing time on CRT in infants**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Paper** | **Population** | **N** | **Shorter time** | **Longer time** | **Head** | **Chest** | **Finger** | **Heel** |
| Leflore, 20059 | healthy term neonates | 42 | 1-2 seconds | 3-4 seconds |  | 1.4 seconds  (P<0.0001) | 1.2 seconds  (P<0.0001) | 1.4 seconds  (P<0.0001) |
| Strozik, 1998^20 | healthy term neonates | 40 per site per time | 1 second | 7 seconds | 0.42 seconds  (0.27, 0.57, P<0.0001) | 0.23 seconds  (0.09, 0.37, P=0.0008) |  | 0.1 seconds  (-0.07, 0.27, P=0.25) |
| healthy term neonates | 40 per site per time | 1 second | 3 seconds | 0.3 seconds  (0.16, 0.44, P<0.0001) | 0.17 seconds  (0.04, 0.30, P=0.009) |  | 0.16 seconds  (-0.01, 0.33, P=0.07) |
| healthy term neonates | 40 per site per time | 2 seconds | 4 seconds | 0.15 seconds  (0.01, 0.29,  P=0.03) | 0.19 seconds  (0.05,0.33, P=0.006) |  | 0.16 seconds  (0.001, 0.32, P=0.048) |
| healthy term neonates | 40 per site per time | 2 seconds | 5 seconds | 0.2 seconds  (0.06, 0.34,  P=0.006) | 0.29 seconds  (0.15, 0.43, P=0.0001) |  | 0.23 seconds  (0.03, 0.43, P=0.02) |
| healthy term neonates | 40 per site per time | 3 seconds | 5 seconds | 0.04 seconds  (-0.10, 0.18, P=0.58) | 0.11 seconds  (-0.03, 0.25, P=0.14) |  | 0.14 seconds  (-0.08, 0.36, P=0.22) |
| healthy term neonates | 40 per site per time | 1 second | 3-7 seconds | 0.36 seconds  (0.25, 0.47, P<0.0001) | 0.24 seconds  (0.15, 0.33, P<0.0001) |  |  |

Mean difference (95% CI and p value). Shaded are significant

^ Strozik20 compared seven pressing times (1, 2, 3, 4, 5, 6, and 7s), at each of 3 sites (head, chest, and heel), as well as composite data for pressing times of 3-7s for the head and chest. Comparisons were not pairwise, as each pressing time was tested on 40 independent infants, therefore we selected the following clinically relevant pairs for comparison: 7s vs 1s, 3s vs 1s, 4s vs 2s, 5s vs 2s, 5s vs 3s, and, where possible, 3-7s vs 1s.

#### **WebAppendix 5: Effect of ambient temperature, skin temperature and core temperature on CRT**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | **Ambient temperature** | | **Skin temperature** | | **Core Temperature / fever** | |
| **Paper** | **Population** | **N** | **Site** | **Results** | **P value** | **Results** | **p value** | **Results** | **p value** |
| Gorelick, 19935 | children (0-12years) attending ED with minor complaints | 32 | finger | 1.53 seconds (95% CI 1.31, 1.75 seconds) mean difference in CRT between rooms at 25.7 and 19.4oC; 100% of children had CRT <2 seconds at 25.7oC, but only 31% had CRT <2 seconds at 19.4oC | <0.001 | Pearson correlation coefficient =-0.81 (95% CI -0.64, -0.9) |  |  |  |
| children (0-12years) attending ED with minor complaints | 32 | foot | 2.14 seconds (95% CI 1.76, 2.53 seconds) mean difference in CRT between rooms at 25.7 and 19.4oC | <0.001 |  |  |  |  |
| Gorelick, 1997b7 | children (1month-5years) attending ED with vomiting, diarrhoea or poor oral intake who were >=5% dehydrated | 80 | finger |  |  |  |  | febrile children (>38.3oC) had mean (SD) CRT 2.2 seconds (1.3), afebrile 1.9 seconds (0.9) | >0.4 |
| children (1month-5years) attending ED with vomiting, diarrhoea or poor oral intake who were <5% dehydrated | 154 | finger |  |  |  |  | febrile children (>38.3oC) had mean (SD) CRT 1.3 seconds (0.5), afebrile 1.3 seconds (0.5) | >0.8 |
| Raichur, 200112 | healthy term infants | 155 | chest | r=0.27, mean temp 28.4oC (range 26-30oC) | <0.01 |  |  |  |  |
| Raju, 199914 | healthy term infants | 137 | hand | r=-0.24 (95% CI -0.39, -0.07) | 0.0042 | r=-0.59 (95% CI -0.69, -0.57) | <0.00001 | r=-0.33 (95%CI -0.42, -0.12) | 0.0008 |
| healthy term infants | 137 | foot | r=-0.21 (95% CI -0.37, -0.04) | 0.016 | r=-0.33 (95%CI -0.46, -0.16) | <0.0001 | r=-0.17 (95%CI -0.33, 0) | 0.05 |

#### WebAppendix 6: Reliability of CRT

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Paper** | **Measurement method** | **Observer pair** | **N** | **Cutoff** | **Kappa (95% CI)** | **ICC (95% CI)** | **Pairwise comparison** |
| Duggan19974 | not stated | A v B | 100 | not stated | 0.072 (0.229--0.085) |  |  |
| B v C | 100 | not stated | 0.008 (0.073--0.057) |  |  |
| Gorelick19935 | 5 seconds moderate pressure on finger and heel, measured with stopwatch | 3 observers | 16 | >2 seconds | 0.54 (0.33-0.73) | 0.7 (0.56-0.85) |  |
| Gorelick1997a6 | fingertip, measured with stopwatch, mean of three measurements | 2 per patient (nurses and investigators) | 84 | >2 seconds | 0.65 (weighted kappa) | 0.71 |  |
| Otiento200410 | 3 seconds pressure on finger, measured by counting whole seconds | 4 observers (data combined) | 100 | ≤1second | 0.48 (0.34-0.62) |  |  |
| 100 | 2 seconds | 0.37 (0.25-0.49) |  |  |
| 100 | 3 seconds | 0.35 (0.23-0.47) |  |  |
| 100 | ≥4 seconds | 0.49 (0.35-0.63) |  |  |
| 100 | combined | 0.42 (0.29-0.55) |  |  |
| Raichur200112 | 5 seconds pressure, measured with stopwatch | 2 observers, forehead | 155 | measured |  |  | p<0.001 |
| 2 observers, chest | 155 | measured |  |  | not significant |
| 2 observers, palm | 155 | measured |  |  | p<0.05 |
| 2 observers, heel | 155 | measured |  |  | p<0.001 |
| Raju199914 | 5 seconds moderate pressure, measured with stopwatch, 1st measurement used | 3 observers, hand | 20 |  |  | 0.55-0.71 |  |
| 3 observers, foot | 20 |  |  | 0.47-0.68 |  |
| Roland201015 | 5 seconds pressure on sternum, 2 second and 4 seconds cutoffs | resident and registrar | 100 | <2 seconds, 2-4 seconds, >4 seconds | 0.08 |  |  |
| resident and consultant | 100 | <2 seconds, 2-4 seconds, >4 seconds | 0.14 |  |  |
| registrar and consultant | 100 | <2 seconds, 2-4 seconds, >4 seconds | -0.15 |  |  |
| overall (3 observers) | 100 | <2 seconds, 2-4 seconds, >4 seconds | 0.02 |  |  |

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