Measurement devices for heart rate, respiratory rate and oxygen saturation in children: A scoping review of ambulatory care applications

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Abstract (English)

Background: Young children presenting with acute illness in primary care often have self-limiting conditions, yet general practitioners (GPs) must assess the risk of serious infections requiring urgent intervention. Measuring vital signs—heart rate, respiratory rate, and oxygen saturation—is essential in evaluating illness severity. Despite primary care guidelines emphasizing their importance, these measurements are infrequently performed in young children due to challenges in prehospital settings and a lack of suitable measurement devices.

Objective: This scoping review aims to identify and evaluate ambulatory measurement instruments for heart rate, respiratory rate and oxygen saturation in children aged three months to six years. Specifically, we assessed the diagnostic accuracy and feasibility for use in primary care.

Methods: A systematic search was conducted in Medline via PubMed, Embase, Web of Science, Cochrane Library, CINAHL, and SCOPUS, along with gray literature databases. We included studies evaluating portable, easy-to-use measurement instruments applicable in ambulatory care. Two independent reviewers screened and extracted data, including device characteristics, diagnostic performance and usability. Risk of bias for studies reporting diagnostic accuracy was assessed using the QUADAS-2 tool.

Results: A total of 11,541 articles were screened for title and abstract, from which 35 studies met the inclusion criteria. We identified a range of portable devices employing various measurement techniques, including handheld monitors with probe sensors, smartwatches, and smartphone-based applications. Four devices—Xpod OEM, Masimo Radical-7, Masimo Rad-G, and Masimo iSpO2Rx—measured all three vital signs. The Masimo Rad-G was the most studied device, demonstrating 97% agreement with manual respiratory rate counting. However, only nine studies formally assessed diagnostic accuracy, and none were conducted in primary care settings. Usability varied, with some devices showing limitations in younger children due to movement artifacts and probe size constraints.

Conclusion: While several promising devices exist, validation of their accuracy and feasibility in general practice is currently lacking. The absence of primary care-based studies highlights a crucial gap in the literature. Further research is needed to determine the applicability of these devices in routine paediatric assessments and improve early detection of serious illness in ambulatory care settings.

Abstract (Dutch)

Achtergrond: Jonge kinderen die zich presenteren met acute ziekte in de eerstelijnszorg hebben vaak zelflimiterende aandoeningen. Toch moeten huisartsen het risico op ernstige infecties, die dringende interventie vereisen, beoordelen. Het meten van vitale functies — hartslag, ademhalingsfrequentie en zuurstofsaturatie — is essentieel voor het inschatten van de ernst van de ziekte. Hoewel richtlijnen voor de eerstelijnszorg het belang ervan benadrukken, tonen studies aan dat deze metingen bij jonge kinderen zelden worden uitgevoerd vanwege uitdagingen in de ambulante setting en het gebrek aan geschikte meetapparatuur.

Doel: Deze scoping review heeft als doel ambulante meetinstrumenten te identificeren en te evalueren voor hartslag, ademhalingsfrequentie en zuurstofsaturatie bij kinderen van drie maanden tot zes jaar. Specifiek wordt gekeken naar de diagnostische nauwkeurigheid en de haalbaarheid van gebruik in de eerstelijnszorg.

Methode: Een systematische zoekopdracht werd uitgevoerd in PubMed, Embase, Web of Science, Cochrane Library, CINAHL en SCOPUS, samen met grijze literatuurdatabases. In aanmerking kwamen volledige tekst studies die draagbare en gebruiksvriendelijke meetinstrumenten voor ambulante zorg evalueerden. Twee onafhankelijke beoordelaars screenden en extraheerden gegevens, waaronder apparaat kenmerken, diagnostische prestaties en bruikbaarheid. Het risico op bias werd beoordeeld met behulp van het QUADAS-2-instrument.

Resultaten: In totaal werden 11.541 artikelen gescreend op titel en abstract, waarvan 35 studies aan de inclusiecriteria voldeden. Deze review identificeerde verschillende draagbare apparaten met diverse meettechnieken, waaronder handheld monitors met probe-sensoren, smartwatches en smartphone-gebaseerde applicaties. Vier apparaten — Xpod OEM, Masimo Radical-7, Masimo Rad-G en Masimo iSpO2Rx — maten alle drie de vitale functies. De Masimo Rad-G kwam in meerdere studies naar voren en toonde 97% overeenstemming met de ademhalingsfrequentie die handmatig geteld werd. Echter, slechts negen studies beoordeelden formeel de diagnostische nauwkeurigheid, en geen enkele studie werd uitgevoerd in de eerstelijnszorg. De bruikbaarheid varieerde, waarbij sommige apparaten beperkingen vertoonden bij jongere kinderen vanwege bewegingsartefacten en beperkingen in de grootte van de probe.

Conclusie: Hoewel er veelbelovende apparaten bestaan, is er beperkt onderzoek dat de nauwkeurigheid en haalbaarheid in de huisartsenpraktijk valideert. Het ontbreken van studies in de eerstelijnszorg benadrukt een cruciale kennisklоof. Verder onderzoek is nodig om de toepasbaarheid van deze apparaten in routinematige pediatrische beoordelingen te bepalen en de vroege detectie van ernstige ziekten in de ambulante zorg te verbeteren.

Introduction

Background and Rationale

Young children with an acute illness presenting in a general practitioner's office, often have a self-limiting disease. Yet, a GP must always be aware of the possibility of a serious infection requiring immediate treatment or hospital referral. To assess the urgency, there are numerous primary care guidelines that emphasize the importance of a reliable clinical history and examination. Key components of the physical examination are the measurement of vital signs, such as body temperature, heart rate, respiratory rate, and oxygen saturation.[1-4]

In ambulatory care, clinical history is often well documented, for example behavioural assessment, temperature measurement, capillary refill time, skin examination, and auscultation are typically well-executed. However studies indicate that general practitioners hardly measure other vital signs, such as heart rate, respiratory rate, and oxygen saturation in young children[2]. Given the importance of objective parameters in paediatric patient assessment to evaluate the severity of acute illness, incorporating these measurements into routine practice can support clinical decision-making and help determine the need for urgent referral to secondary care.[3–5]

Measuring vital signs, here focused on heart rate, respiratory rate and oxygen saturation, is more challenging in prehospital settings compared to emergency departments. This can be attributed to various factors such as a stressful environment, the child's pain or distress, the presence of unfamiliar people, noise and fever. Another important reason is the lack of known and applicable first line, easy-to-use measurement devices for young children.[6–8]

This scoping review aims to provide a comprehensive overview of the available devices for measuring heart rate, respiratory rate, and oxygen saturation in primary care settings. It will assess their diagnostic performance and serve as a horizon-scanning report of the current evidence supporting their use.

Objective

Specifically, in this scoping review we aim to provide an answer to the following research questions: What quantitative ambulatory measurement tools are available to assess heart rate, respiratory rate, and oxygen saturation in children aged three months to six years, beyond manual methods such as counting? What is the diagnostic accuracy of these instruments?

Method

We performed a scoping review according to the methods of the OSF 'Scoping Review Protocol Guidance'[9] and reported it according to the PRISMA extension for Scoping Reviews (PRISMA-ScR)[10].

Search Strategy

A systematic search was conducted in the following databases and/or interfaces: Medline via PubMed, Embase, Web of science, Cochrane Library, CINAHL and SCOPUS. A gray literature search was conducted in the following databases: ClinicalTrials.gov and International Clinical Trials Registry Platform (ICTRP). The search strategy for all databases was developed by two authors L.S.J. and J.Z. and evaluated by a third author, D.B. and the Désiré Collen learning center and biomedical library at KU Leuven. Search terms from the three concept groups and their synonyms were used to search these databases. For the PubMed and Embase searches, MeSH and Emtree terms respectively, along with title and abstract search terms were used (Supplementary table 1). Full search strings for all databases are listed in Supplementary materials. Reference screening and forward snowballing has been performed on the eligible articles.

Inclusion and exclusion criteria

The objectives of this scoping review were to describe and summarize literature findings for vital signs in children aged three months to six years in ambulatory practice. Studies were eligible if they described, evaluated and/or compared measurement instrument(s) for measuring heart rate, respiration rate and/or oxygen saturation in ill and/or healthy children aged three months to six years. The measurement instrument(s) had to be evaluated in ambulatory practice and/or could be used in ambulatory practice in terms of portability, size and/or ease of use. We excluded studies reporting measurement instruments which cannot be implemented in ambulatory practice such as nonportable measurement instruments, instruments that must be operated by more than one person and measurement instruments that do not display results within a reasonable timeframe (at least within the timeframe of one consultation with the healthcare professional). The used device had to be mentioned in the title or abstract of the included study. We included full text RCT, cohort studies, case-control studies, cross-sectional (comparative) studies, manuscripts or descriptive studies. No limitations in terms of publication year or language were considered. Exclusion criteria were defined as studies without full text, review articles, protocol studies, protocol preprints, conference abstracts, posters and guidelines.

Selection and data extraction

Search results were imported into a reference management program Rayyan software [Rayyan Systems, Inc., Cambridge, USA] and duplicate citations were removed. Two independent reviewers selected studies for inclusion in the scoping review according to the eligibility criteria. The reviewer's decisions were blinded to each other. First, a title and abstract screening

for relevance was performed by the two authors. Second, full texts of the selected studies were screened for definite eligibility. Records that did not contain an abstract were automatically passed on to full-text screening. Any disagreements were resolved through discussion or, if necessary, by a third author, D.B. For friend studies, data was extracted from the study with the largest number of participants and/or the most recent version of the used device. The following data items were extracted: First author, title, journal, year, country/city/district and centre of executed study, study design, used device, measured parameter(s) with device, device characteristics (size, portability, method of use, …), participant characteristics (total number, mean age, pathology if available), outcome, specificity, sensitivity, area under the curve, accuracy, predictive value and 2 by 2 tables of true positives, false positives, false negatives, true negatives. Corresponding authors were contacted for additional study information, if needed. The Excel software was used for data extraction. Missing or unclear/incomplete data was respectively coded as "Not reported" and "Unclear".

Risk-of-bias assessment

The methodological quality of the selected studies reporting on diagnostic accuracy was evaluated independently by two authors using the Quadas-2 risk of bias tool[11].

Protocol registration

We published and prospectively registered the protocol for this scoping review on Open Science Framework (OSF).

Results

Bibliographic overview

On May 14, 2024 a systematic search was conducted according to the search strategy described in the method section. The search yielded a total number of 29060 studies. The PRISMA flow chart (Figure 1) shows the corresponding number of studies at each step of the identification, screening and inclusion process. After deduplication and title and abstract screening, 40 studies were assessed for eligibility by the two authors. 21 studies were eventually found to be eligible according to our exclusion criteria. Main reasons for exclusion were wrong outcome, age and language. Citation search and forward snowballing on those 21 studies yielded 13 extra eligible articles. One study has been included by expert opinion. In total, we included extracted data from 35 studies in our scoping review.[12–46]

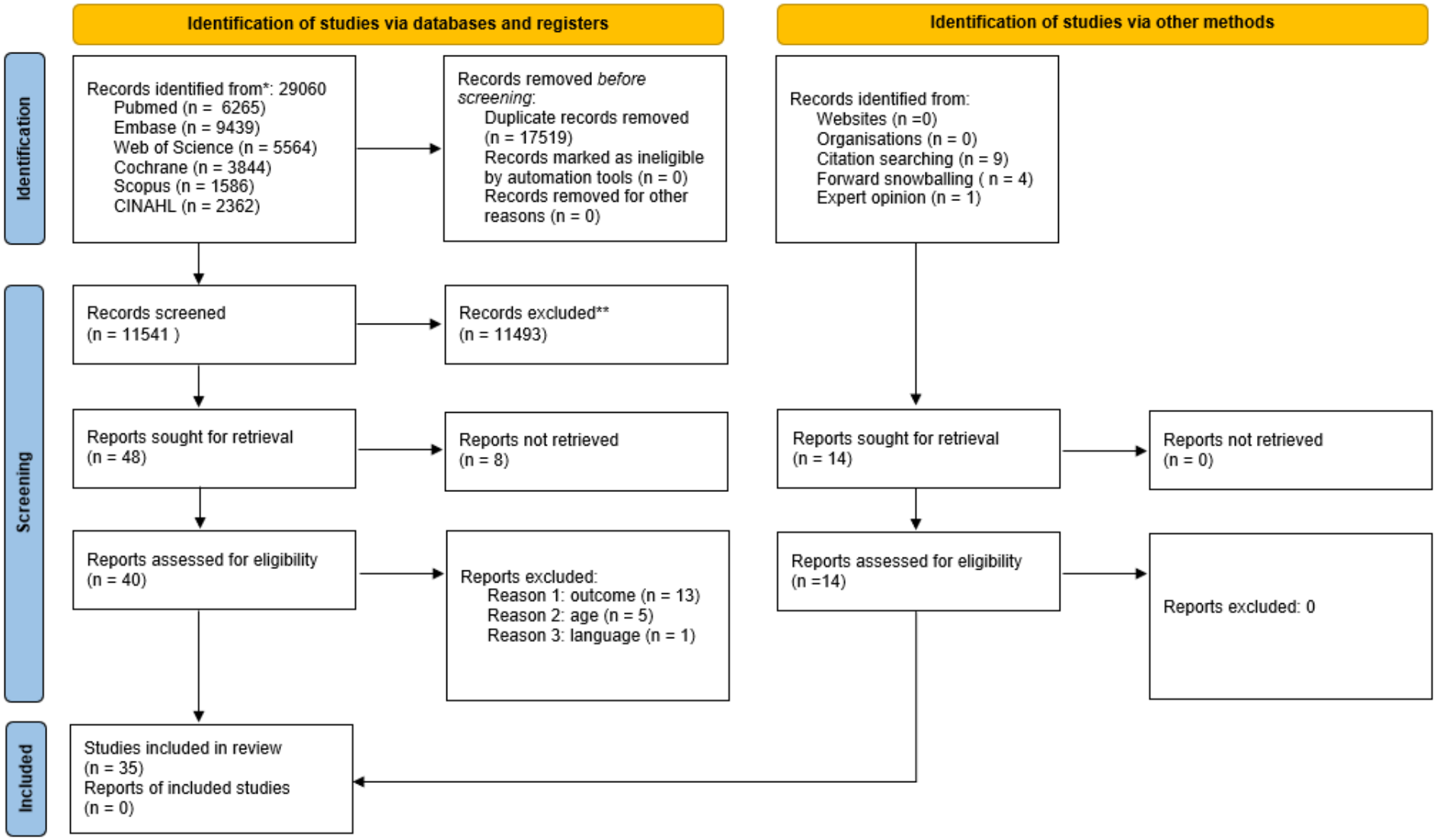

***Figure 1*:** PRISMA 2020 flow chart for study selection.

Study Characteristics

Table 1 gives an overview of the studied devices ordered according to their characteristics. The table describes the parameters being measured by the device, device characteristics and the use of supplementary material. Fourteen of the thirty-five studies were conducted in low- and middle-income countries, with all but one taking place in the emergency department; the one remaining study was conducted in the operating room.

Heart rate

Eight out of twenty-two studied devices for measuring HR make use of a (clip) sensor which can be placed on the patients finger and/or toe.[19,21,22,23,32,33,36,49] Wristbands[21] and smartwatches[12,14,28,35,45] were described in six studies for measuring heart rate. Less studied methods include skin patches[31,41,43,44] or electrodes[38] connected to a device and smartphone camera with flash[46]. All studied devices have a size comparable to a smartphone or watch, except for the U-AMS5fs ambulatory recording device which also requires a PC[38]. In ten studies, authors were able to specify or give an estimation of the time required to obtain a reliable HR measurement.[18–20,29,31,33,36–38,41] None of these studies included smartwatches. The time for obtaining a reliable measurement varied from less than 60 seconds to approximately 6 minutes. The described advantages and disadvantages of the studied devices are found in supplementary table 2. The main disadvantages are the limited suitability for younger children mostly due to measurement failure in a restless child[18,36] or the probe not being suitable for body weight and/or age[18,19,28,36]. For HR measuring devices, statistical analysis has been performed in three studies[14,31,46] (Supplementary table 3). Tomlinson et al.[46] examined the inter-rate reliability for HR measurements for two tested methods (smartphone using probe and smartphone using phone camera). The mean difference in heart rate was respectively 3 and 12 beats per minute lower in the tested methods compared to the reference test (triage measures). A strong correlation (Pearson's $r = 0.93$) was observed between HR measurements from the VitalPatch and manual counting over 60 seconds.[31] In contrast, a low correlation was found between ECG and the ActiGraph GT9X Link for heart rate (HR), while a moderate correlation was observed with the Apple Watch Series 7.[14]

Respiratory rate

Devices with a (clip) sensor for measuring the respiratory rate, which can be placed on the patients finger and/or toe, are described in ten studies.[13,17,19,20,23,29,30,33,36,37] Manual counting[26] and screentapping[15,26,34] have also been studied four times. Other studied methods include chest and/or abdomen bands[40] and patch systems[44]. Several apps were developed for collecting and processing the measured data.[15,26,34] All devices are considered portable. Their dimensions and characteristics are given in supplementary table 2. The time needed for obtaining a reliable measurement varied from 8 seconds to approximately 6 minutes. The described advantages and disadvantages of the studied devices are described in supplementary table 2. For RR measuring devices, statistical analysis has been performed in five studies[16,23,30,31,34] (Supplementary table 3). Four respiratory rate counting methods (manual counting with MK2 ARI, counting beads with MK2 ARI, phone with RRate app and phone with Respirometer feature) were compared to a reference test. The NPA and PPA have been reported for all four measurement methods,

with respective ranges of 83% to 93% and 41% to 73%. The mean difference between the tested method and reference standard in breaths per minute ranged from -0,6 to 5,5.[16] The correlation between RR measurements obtained with the Masimo Rad-G device and manual counting was examined using various correlation coefficients. A moderate to good reliability has been found.[23] Garbern et al.[31] describe an excellent reliability for RR measurements between the VitalPatch and manual counting during 60s. Karlen et al.[34] stated that the accuracy of their screen tapping method increases with the number of included breaths. The Masimo Rad-G device demonstrated high specificity, sensitivity, accuracy and agreement compared to clinical RR measurements performed by paediatricians.[30]

Oxygen saturation

Twelve out of fourteen studied SpO2 measurement devices make use of a finger, toe, neck and/or adhesive sensor.[13,18–20,22,25,29,30,33,36,37,46] Cunningham et al.[24] didn't mention a clear method of use, but described a continuous measure of oxygen saturation with Masimo Rad-8, a book-sized device. One wristband device (WristOx2)[21] and one pulse-oximeter app (digiDoc)[46] which uses a phone camera have been studied for measuring SpO2. Two probe-based devices use an app for collecting and processing the measured data.[29,33,37,46] The duration time for becoming a reliable measurement went from 7 seconds to approximately 6 minutes. In nine studies, the result was readable within 1 minute. The described advantages and disadvantages are described in the supplementary table 2. For SpO2 measuring devices, statistical analysis has been performed in six studies[18,22,25,29,33,46] (Supplementary table 3). Baker et al. [29] compared five oxygen saturation measurement devices to a reference standard, the mean difference ranged from kappa value -0.6 to -7.9. The Masimo handheld/mobile phone pulse oximeter (Model: iSpO2 Rx) was the only oximeter in this study that had an higher agreement in younger children (<2months).[29] Pfurtscheller et al.[33] compared the usability of the same devices used in Baker et al.[29]. The main conclusion was that usability is best in a single probe handheld device. The inter-rater reliability for two test methods, smartphone using a probe and smartphone using the phone camera, for SpO2 was examined. The measured SpO2 values were 2 and 4 points lower, respectively, compared to the reference test, triage measures.[46] In children under five years of age, 90% of SpO_2 measurements were successfully obtained in less than five minutes using the LifeBox oximeter with the LB-01 probe.[18] The Masimo Rad-87 with the Lifebox LB-01 probe, the Lifebox V1.5 with the Lifebox LB-01 probe, and the Masimo Rad-87 with the Masimo probe achieved successful SpO_2 measurements within five minutes in 96%, 95%, and 96% of cases, respectively.[22] Within 60 seconds, the Masimo Rad-5V and Lifebox AH-M1 devices achieved successful SpO_2 measurements in nearly 98% and 87% of cases, respectively.[25]

Table 1: Device and characteristics

	Device	Parameter			Device characteristics				Supplementary material		
		HR	RR	SpO2	Meth. of use	Time	Acc.	Age	Ph./Tabl.	App	Oth.
Device or probe	Masimo Rad-G[23,26,33,39]	■	■	■	Toe	1-2min	Yes	2m-5y			
	Masimo Radical-7[19]	■	■	■	Finger	~ 6min		2-18y			
	Masimo Rad-5V[25]	□	□	■	Finger	< 60s		2-59m			
	Masimo Rad-87 (different probes)[13,22]	□	□	■	Toe/foot/ finger	< 60s		0-35m			
		□	■	■	Patch on neck and finger	Instant	Yes	12m-18y			
	Masimo Rad-8 with LNC[24]	□	□	■	N.r.	N.r.		6w-12m			
	Lifebox 1.5 with LB-01 probe[18,22]	■	□	■	Toe/foot/ finger	~ 1min		0-59m			
	Lifebox AH-M1[28,32,36]	■	□	□	Finger/toe	< 60s	Yes	0-59m			
	Xpod OEM[37]	■	■	■	Finger	1min		<5y		Yes	
	GIMA OXY10[17]	□	■	□	Finger	N.r.		1d-7y			
	Contec CMS50QB[33]	□	□	■	Finger/toe	< 60s		0-59m			
	Devon PC600[33]	■	□	■	Finger/toe	< 60s		0-59m			
	Utech UT100[33]	■	□	■	Finger/toe	< 60s		0-59m			
	Masimo iSpO2 Rx plug-in probe[29,33,46]	■	■	■	Finger	< 60s	Yes	0-59m	Yes	Yes	
Wristband/watch	WristOx2 [21]	■	□	■	Wrist and finger	N.r.		0-17y			
	Withings Steel HR Smartwatch [28]	■	□	□	Wrist	N.r.		2-12y	Yes	Yes	
	ActiGraph GT9X Link[14]	■	□	□	Wrist	N.r.	Yes	5-12y			
	Apple Watch Series 7[14]	■	□	□	Wrist	N.r.	Yes	5-12y			
	Polar V800 Sport Watch with Polar H10 chest strap and Polar Flow app[45]	■	□	□	Wrist and chest band	N.r.		5-9y	Yes	Yes	
	Fitbit Inspire 2[35]	■	□	□	Wrist	N.r.		3-17y	Yes	Yes	
	Fitbit Inspire HR[35]	■	□	□	Wrist	N.r.		3-17y	Yes	Yes	
	Fitbit Charge HR[12]	■	□	□	Wrist	Instant	Yes	6w-12m			
Others	VitalPatch[31,41]	■	■	□	Torso	1min	Yes	2m-17y	Yes		
	LifeTouch (Isansys, Oxford, UK)[21]	■	■	□	N.r.	N.r.		0-17y			ECG
	U-AMS5fs ambulatory recording device[38]	■	□	□	Electrodes on chest	4min		5y-7y			PC
	ICON device and portable battery derived device[43]	■	□	□	Four adhesive skin sensors	N.r.		0-20y			
	Biosensor (Northwestern University) and smartphone[44]	■	■	□	Band-aid like, on variety of places	N.r.		Paediatric, not specified	Yes		
	Pulse-Oximeter (digiDoc) app that uses phone camera and flash[46]	■	□	■	Finger	N.r.	Yes	2y-13y	Yes	Yes	
	Smartphone with Rrate app[26,34]	□	■	□	Screen tapping on smartphone	3 to 6 breaths	Yes	2m-59m	Yes	Yes	
	Java Mobile Edition (J2ME) on Nokia mobile phone C1-01[15]	□	■	□	Screen tapping on smartphone	After 60 seconds, 10 breaths or 20 breaths	Yes	<5y	Yes	Yes	
	Smartphone with the Respirometer feature phone app[26]	□	■	□	Screen tapping on smartphone	N.r.	Yes	2m-59m	Yes	Yes	

	Manual counting with Mark Two ARI timer (MK2 ARI) [26]	□	■	□	Screen tapping on smartphone	60 seconds	Yes	2m-59m	Yes	Yes	
	PneuRIP[40]	□	■	□	Two bands (one on chest, one on abdomen)	Instant		6m-19y	Yes		
	Multi-modal portable RR monitoring device (no name) and smartphone[39]	□	■	□	Hand on the chest	N.r.		3y-33y	Yes		
	Children's Automated Respiration Monitor (ChARM) by Phillips[16,32]	□	■	□	N.r.	N.r.		N.r.			

Overview of the studied devices. Abbreviations: heart rate (HR), respiratory rate (RR), oxygen saturation (SpO_2), method of use (Meth. of use), measurement time (Time), age category (Age cat.), diagnostic accuracy testing (Acc.), mobile phone (Ph.), tablet (Tabl.), Other (Oth.), 'not reported' (N.r.), ■ (Yes), □ (No)

Overall, four studied devices (Xpod OEM [37], Masimo radical-7[19], Masimo Rad-G[30] and Masimo handheld mobile phone pulse oximeter model iSpoO2RX[33]) measure all three vital parameters. The Masimo Rad-G was mentioned in five different studies.[20,23,30,32,33]

Quality assessment

Risk of bias

The risk of bias was determined on the diagnostic test accuracy studies with the QUADAS-2 tool[11]. Of the 35 studies, twelve tested accuracy and where therefor eligible for bias analyses.[12–14,23,25,26,29–31,34,41,46] On each item a score of yes, unclear or no was given. For this scoping review the quality assessment was divided into 4 domains. These were overall scored with either high or low risk of bias. The full risk of bias table can be found in the supplementary table 4. In summary, most studies had low risk of bias, but patient selection and index test were often at higher risk of bias. The study by Tomlinson et. al[46] stood out because of an overall high risk of bias.

Discussion

Summary Findings

Following a systematic search of 11,541 articles, 35 studies met the inclusion criteria. A wide range of devices were identified, employing various measurement techniques. The most used devices were handheld devices equipped with age-adjusted probes or clip sensors, followed by smartwatches. All identified devices were portable and provided rapid results, making them suitable for use in ambulatory care settings. However, the time required to obtain a reliable measurement varied significantly across devices, ranging from a few seconds to up to eight minutes.

Notably, few studies assessed the usability of these devices. Pfurtscheller et al.[33] concluded that handheld devices, particularly those with age-adjusted probes, were more effective compared to reference standard, especially in younger children. Boyd et al.[18] found that the Lifebox oximeter with LB-01 probe gave 90% successful SpO2 measurements within five minutes in

children under five years of age, confirming its applicability in a primary care setting. However, only 38% of respondent health care workers found it easy to get a reading in a moving child. Additionally, the study by Baker et al.[29] highlighted that handheld devices demonstrated lower failure rates when used by newly trained healthcare workers, suggesting that these devices may be more user-friendly in primary care settings.

Among the identified devices, four—Xpod OEM, Masimo Radical-7, Masimo Rad-G, and the Masimo handheld mobile phone pulse oximeter model iSpO2Rx—were capable of measuring all three vital parameters.[19,20,29,30,33,36,37] Three of these four devices were produced by Masimo Corporation, reflecting the company's dominance in this field. Notably, only the Masimo handheld mobile phone pulse oximeter model iSpO2Rx was suitable for use in infants younger than two months due to its age-adjusted probes. However, they did not report on its accuracy. The Masimo Rad-G was the most studied device, appearing in four studies[20,23,30,36], with two studies performing statistical analyses on its respiratory rate measurements[23,30]. These analyses, with overall low risk of bias, demonstrated a 97% agreement with manual counting, suggesting promising accuracy.

Strengths and limitations

Despite these findings, significant limitations were identified. Of the 35 included studies, only nine formally evaluated the accuracy of the devices, representing a major constraint of the available evidence. Additionally, substantial bias was noted in patient selection across studies, raising concerns about the generalizability of the findings. Another critical limitation was the lack of research conducted in actual primary care settings. Instead, all studies assessed devices in emergency care or hospital environments, where conditions and patient presentations may differ from those encountered in general practice. Further limitations included small sample sizes, an absence of studies evaluating device performance in children under two years of age, and a lack of research in high-income settings.

However, this scoping review is an initial step toward establishing a comprehensive and applicable overview of measurement devices in ambulatory care. It is based on an extensive search strategy, a large number of screened articles, and an independent screening process of titles and abstracts by two authors. The methodology was thoroughly developed and pre-registered in a published protocol. It synthesizes the existing literature and includes statistical analyses where available. Four devices where found who measured all the vital signs, that with further research, could be applicable in a general practitioner’s office.

Implication for clinical practice and future research

Given the limitations demonstrated by our review, further research is required to validate the accuracy and clinical applicability of these devices in general practice. Future studies should focus on testing these measurement tools in primary care environments to ensure their feasibility and effectiveness in routine clinical use. This scoping review may serve as a valuable foundation for future research efforts, ultimately contributing to improved paediatric healthcare and more efficient referral pathways to secondary care.

Conclusion

In summary, four devices have been evaluated for quantitatively measuring all three vital signs (heart rate, respiratory rate and oxygen saturation) in children aged three months to six years. The majority of the studied devices are handheld monitors equipped with probe and/or clip sensors. However, limited statistical analyses and accuracy assessments have been conducted, making it challenging to determine their applicability in primary healthcare settings. Furthermore, none of these devices have been assessed in ambulatory care, highlighting a significant gap in the existing literature. Further research is essential to establish reliable methods for measuring vital signs in children and to assess their feasibility for use in primary care by general practitioners.

Conflict of Interest

None

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Ethical Approval

Ethical approval was obtained in November 2023 (Appendix I)

During the development of the search strategy the university library of KULeuven Désiré Collen provided their expertise.

Supplementary Materials

Full search

Clinicaltrials.gov

"infant" OR "child*" OR "preschool" OR "pre school" OR "toddler*" OR "paediatric" OR "paediatrics") AND ("vital sign*" OR "oximetr*" OR "heart rate*" OR "respiratory rate*" OR "oxygen saturation") AND ("point of care*" OR "bedside" OR "on site*" OR "ambulatory"

ICTRP (WHO)

TS=("Infant*" OR "child*" OR "preschool*" OR "pre-school*" OR "toddler*" OR "paediatric*" OR "paediatric*") AND TS=("vital sign*" OR "oximet*" OR "heart rate*" OR "respiratory rate*" OR "oxygen saturation*") AND TS=("point of care" OR "bedside*" OR "bed side*" OR "onsite" OR "on site" OR

“ambulatory” OR “outpatient” OR “general practi*” OR “family medicin*” OR “primary care” OR “general medicine” OR “emergency department*” OR “emergency care*” OR “emergency service*” OR “emergency unit*” OR “urgent care”)

PUBMED

"Infant"[Mesh:NoExp] OR "Infant*"[tiab] OR "Child"[Mesh] OR "Child*"[tiab] OR "Preschool*"[tiab] OR "Pre-school*"[tiab] OR “Girl*”[tiab] OR “Boy”[tiab] OR “Boys”[tiab] OR “toddler*”[tiab] OR "3 months old"[tiab] OR "4 months old"[tiab] OR "5 months old"[tiab] OR "6 months old"[tiab] OR "7 months old"[tiab] OR "8 months old"[tiab] OR "9 months old"[tiab] OR "10 months old"[tiab] OR "11 months old"[tiab] OR "three months old"[tiab] OR "four months old"[tiab] OR "five months old"[tiab] OR "six months old"[tiab] OR "seven months old"[tiab] OR "eight months old"[tiab] OR "nine months old"[tiab] OR "ten months old"[tiab] OR "eleven months old"[tiab] OR "3 month old"[tiab] OR "4 month old"[tiab] OR "5 month old"[tiab] OR "6 month old"[tiab] OR "7 month old"[tiab] OR "8 month old"[tiab] OR "9 month old"[tiab] OR "10 months old"[tiab] OR "11 month old"[tiab] OR "three month old"[tiab] OR "four month old"[tiab] OR "five month old"[tiab] OR "six month old"[tiab] OR "seven month old"[tiab] OR "eight month old"[tiab] OR "nine month old"[tiab] OR "ten month old"[tiab] OR "eleven month old"[tiab] OR "1 year old"[tiab] OR "2 years old"[tiab] OR “3 years old"[tiab] OR "4 years old"[tiab] OR "5 years old"[tiab] OR "6 years old"[tiab] OR "one year old"[tiab] OR "two years old"[tiab] OR "three years old"[tiab] OR "four years old"[tiab] OR "five years old"[tiab] OR "six years old"[tiab] OR "2 year old"[tiab] OR “3 year old"[tiab] OR "4 year old"[tiab] OR "5 year old"[tiab] OR "6 year old"[tiab] OR "one year old"[tiab:~0] OR "two year old"[tiab] OR "three year old"[tiab] OR "four year old"[tiab] OR "five year old"[tiab] OR "six year old"[tiab] OR "aged 1"[tiab] OR "aged 2"[tiab] OR "aged 3"[tiab] OR "aged 4"[tiab] OR "aged 5"[tiab] OR "aged 6"[tiab] OR "aged one"[tiab] OR "aged two"[tiab] OR "aged three"[tiab] OR "aged four"[tiab] OR "aged five"[tiab] OR "aged six"[tiab] OR "1 year of age"[tiab] OR "2 years of age"[tiab] OR "3 years of age"[tiab] OR "4 years of age"[tiab] OR "5 years of age"[tiab] OR "6 years of age"[tiab] OR "age 1"[tiab:~2] OR "age 2"[tiab:~2] OR "age 3"[tiab:~2] OR "age 4"[tiab:~2] OR "age 5"[tiab:~2] OR "age 6"[tiab:~2] OR "age one"[tiab:~2] OR "age two"[tiab:~2] OR "age three"[tiab:~2] OR "age four"[tiab:~2] OR "age five"[tiab:~2] OR "age six"[tiab:~2]

AND

(("Hypoxia"[Mesh:NoExp] OR "Hypoxia"[tiab] OR "Hypoxemia"[tiab] OR "anoxia"[tiab] OR "anoxemia"[tiab] OR "Tachypnea"[Mesh:NoExp] OR "Tachypnea*"[tiab] OR "Tachypnoea*"[tiab] OR "Hypercapnia"[Mesh] OR "Hypercapnia*"[tiab] OR "Bradycardia"[Mesh] OR "Bradycard*"[tiab] OR "Tachycardia"[Mesh:NoExp] OR "Tachycard*"[tiab]) AND ("Equipment and Supplies"[Mesh:NoExp] OR "Device*"[tiab] OR "suppl*"[tiab] OR "Inventor*"[tiab] OR "instrument*"[tiab] OR "apparat*"[tiab] OR "determin*"[tiab] OR "measur*"[tiab] OR "calculat*"[tiab] OR "techniq*"[tiab] OR "equipment*"[tiab] OR "monitor*"[tiab] OR "examinat*" OR "analy*"[tiab] OR "test*"[tiab])) OR ("Vital Signs"[Mesh:NoExp] OR "Vital Sign*"[tiab] OR "Heart Rate"[Mesh:NoExp] OR "Heart Rate*"[tiab] OR "Cardiac Rate*"[tiab] OR "Pulse Rate*"[tiab] OR "Heartbeat*"[tiab] OR "Heart beat*"[tiab] OR "Cardiac Chronotrop*"[tiab] OR “ventricle rate” [tiab] OR "heart frequenc*"[tiab] OR "cardiac frequenc*"[tiab] OR “resting heart rate”[tiab] OR "Respiratory Rate"[Mesh] OR "Respiratory Rate*"[tiab] OR "Respiration Rate*"[tiab] OR "respiratory frequenc*"[tiab] OR "respiration frequenc*"[tiab] OR "Oximetry"[Mesh] OR "Oximetr*"[tiab] OR "transcutaneous capnometr*"[tiab] OR "PtcO2"[tiab] OR "TcPCO2"[tiab] OR "SaO2"[tiab] OR “TcPO2"[tiab] OR "transcutaneous oxygen"[tiab] OR "Oxygen Saturation"[Mesh] OR "Oxygen Saturation"[tiab] OR "Blood Oxygen Level*"[tiab] OR "Saturation of Peripheral Oxygen"[tiab] OR “peripheral oxygen saturation”[tiab] OR "SpO2"[tiab] OR "O2 saturation"[tiab])

AND

“Point-of-Care Testing"[Mesh:NoExp] OR “Point of Care”[tiab] OR "Bedside*"[tiab] OR "Bed side*"[tiab] OR "Bed-side*"[tiab] OR “Near patient*”[tiab] OR "Rapid On-site Evaluation"[Mesh] OR "Rapid diagnostic*"[tiab] OR "ROSE Technique*"[tiab] OR "ROSE diagnos*"[tiab] OR “onsite”[tiab] OR “On Site”[tiab] OR “On-Site”[tiab] OR “POCT”[tiab] OR “Spot measurement*”[tiab] OR "Emergency Medical Services"[Mesh:NoExp] OR "Emergency Medical Service*"[tiab] OR "Medical Emergency Service*"[tiab] OR "Emergicenter*"[tiab]

OR "Emergency Care"[tiab] OR "Emergency Health Service*"[tiab] OR "Emergency cent*"[tiab] OR "Emergency dispensary"[tiab:~0] OR "Emergency Health care"[tiab] OR "Emergency Healthcare"[tiab] OR "Emergency Service, Hospital"[Mesh] OR “Emergency Service*”[tiab] OR "Emergency Hospital Service*"[tiab] OR "Hospital Service Emergency"[tiab:~0] OR "Hospital Service Emergencies"[tiab:~0] OR "Emergency Unit*"[tiab] OR "Emergency Ward*"[tiab] OR "Emergency Department*"[tiab] OR “Emergency room*"[tiab] OR “acute care”[tiab] OR “acute medical care”[tiab] OR “pre-hospital Care”[tiab] OR “prehospital patient Care”[tiab] OR “prehospital Care”[tiab] OR “pre-hospital patient Care”[tiab] OR “emergency outpatient clinic*”[tiab] OR “acute medicine”[tiab] OR “acute medical service*”[tiab] OR “acute medical department*”[tiab] OR “acute medical ward*”[tiab] OR “acute medical hospital*”[tiab] OR “acute medical unit*”[tiab] OR "Triage"[Mesh] OR "Triage*"[tiab] OR “preadmission physical examination*”[tiab] OR "Ambulatory Care"[Mesh:NoExp] OR "Ambulatory*"[tiab] OR "Outpatient*”[tiab] OR “Out Patient*”[tiab] OR “Out-Patient*”[tiab] OR "Urgent Care"[tiab] OR "Clinic Visit*"[tiab] OR "day clinic*"[tiab] OR "day hospital*"[tiab] OR "outdoor clinic*"[tiab] OR "polyclinic*"[tiab] OR "policlinic*"[tiab] OR "Ambulatory Care Facilities"[Mesh] OR “Clinic Activit*”[tiab] OR “Free-Standing Clinic*”[tiab] OR "Community Health Cent*"[tiab] OR “Satellite Cent*”[tiab] OR “Neighborhood Health Cent*”[tiab] OR “Neighbourhood Health Cent*”[tiab] OR "Maternal-Child Health Cent*"[tiab] OR “Maternal Child Health Cent*”[tiab] OR “walk-in cent*”[tiab] OR “out-of-hour*”[tiab] OR “after-hours care”[tiab] OR "General Practice"[Mesh] OR "General Practice*"[tiab] OR "Family Practice*"[tiab] OR “GP"[tiab] OR "General Practitioners"[Mesh] OR “General Practitioner*”[tiab] OR “General medicine”[tiab] OR “General physician*”[tiab] OR "House Calls"[Mesh] OR “House Call*”[tiab] OR “Home Visit*”[tiab] OR "Office Visits"[Mesh:NoExp] OR "Office Visit*"[tiab] OR "Family Practice"[Mesh] OR “Family Practice*”[tiab] OR “Family medicine"[tiab] OR “Family practitioner*”[tiab] OR “Family doctor*”[tiab] OR “Family physician*”[tiab] OR “primary care doctor*”[tiab] OR “primary care physician*”[tiab] OR "Primary Health Care"[Mesh] OR "Primary Health Care"[tiab] OR "Primary Healthcare"[tiab] OR "Primary Care"[tiab] OR “first-line*"[tiab] OR "office-based physician*"[tiab] OR "office-based setting*"[tiab]

EMBASE

#1

'infant'/de OR ‘Infant*’:ti,ab,kw OR ‘child'/de OR 'child*':ti,ab,kw OR 'preschool child'/exp OR 'preschool*':ti,ab,kw OR 'pre-school*':ti,ab,kw OR 'girl'/exp OR 'girl*':ti,ab,kw OR 'boy':ti,ab,kw OR 'boys':ti,ab,kw OR 'toddler'/exp OR 'toddler*':ti,ab,kw OR ‘3 months old’:ti,ab,kw OR ‘4 months old’:ti,ab,kw OR ‘5 months old’:ti,ab,kw OR ‘6 months old’:ti,ab,kw OR ‘7 months old’:ti,ab,kw OR ‘8 months old’:ti,ab,kw OR ‘9 months old’:ti,ab,kw OR ‘10 months old’:ti,ab,kw OR ‘11 months old’:ti,ab,kw OR ‘ three months old’:ti,ab,kw OR ‘four months old’:ti,ab,kw OR ‘five months old’:ti,ab,kw OR ‘six months old’:ti,ab,kw OR ‘seven months old’:ti,ab,kw OR ‘eight months old’:ti,ab,kw OR ‘nine months old’:ti,ab,kw OR ‘ten months old’:ti,ab,kw OR ‘eleven months old’:ti,ab,kw OR ‘3 month old’:ti,ab,kw OR ‘4 month old’:ti,ab,kw OR ‘5 month old’:ti,ab,kw OR ‘6 month old’:ti,ab,kw OR ‘7 month old’:ti,ab,kw OR ‘8 month old’:ti,ab,kw OR ‘9 month old’:ti,ab,kw OR ‘10 months old’:ti,ab,kw OR ‘11 month old’:ti,ab,kw OR ‘three month old’:ti,ab,kw OR ‘four month old’:ti,ab,kw OR ‘five month old’:ti,ab,kw OR ‘six month old’:ti,ab,kw OR ‘seven month old’:ti,ab,kw OR ‘eight month old’:ti,ab,kw OR ‘nine month old’:ti,ab,kw OR ‘ten month old’:ti,ab,kw OR ‘eleven month old’:ti,ab,kw OR ‘1 year old’:ti,ab,kw OR ‘2 years old’:ti,ab,kw OR ‘3 years old’:ti,ab,kw OR ‘4 years old’:ti,ab,kw OR ‘5 years old’:ti,ab,kw OR ‘6 years old’:ti,ab,kw OR ‘one year old’:ti,ab,kw OR ‘two years old’:ti,ab,kw OR ‘three years old’:ti,ab,kw OR ‘four years old’:ti,ab,kw OR ‘five years old’:ti,ab,kw OR ‘six years old’:ti,ab,kw OR ‘2 year old’:ti,ab,kw OR ‘3 year old’:ti,ab,kw OR ‘4 year old’:ti,ab,kw OR ‘5 year old’:ti,ab,kw OR ‘6 year old’:ti,ab,kw OR ‘one year old’:ti,ab,kw OR ‘two year old’:ti,ab,kw OR ‘three year old’:ti,ab,kw OR ‘four year old’:ti,ab,kw OR ‘five year old’:ti,ab,kw OR ‘six year old’:ti,ab,kw OR ‘aged 1’:ti,ab,kw OR ‘aged 2’:ti,ab,kw OR ‘aged 3’:ti,ab,kw OR ‘aged 4’:ti,ab,kw OR ‘aged 5’:ti,ab,kw OR ‘aged 6’:ti,ab,kw OR ‘aged one’:ti,ab,kw OR ‘aged two’:ti,ab,kw OR ‘aged three’:ti,ab,kw OR ‘aged four’:ti,ab,kw OR ‘aged five’:ti,ab,kw OR ‘aged six’:ti,ab,kw OR ‘1 year of age’:ti,ab,kw OR ‘2 years of age’:ti,ab,kw OR ‘3 years of age’:ti,ab,kw OR ‘4 years of age’:ti,ab,kw OR ‘5 years of age’:ti,ab,kw OR ‘6 years of age’:ti,ab,kw OR (‘age’ NEAR/3 ‘1’):ti,ab,kw OR (‘age’ NEAR/3 ‘2’):ti,ab,kw OR (‘age’ NEAR/3 ‘3’):ti,ab,kw OR (‘age’ NEAR/3 ‘4’):ti,ab,kw OR (‘age’ NEAR/3 ‘5’):ti,ab,kw OR (‘age’ NEAR/3 ‘6’):ti,ab,kw OR (‘age’ NEAR/3

‘one’):ti,ab,kw OR (‘age’ NEAR/3 ‘two’):ti,ab,kw OR (‘age’ NEAR/3 ‘three’):ti,ab,kw OR (‘age’ NEAR/3 ‘four’):ti,ab,kw OR (‘age’ NEAR/3 ‘five’):ti,ab,kw OR (‘age’ NEAR/3 ‘six’):ti,ab,kw

#2
(('hypoxia'/de OR 'hypoxia':ti,ab,kw OR 'hypoxemia':ti,ab,kw OR 'anoxia':ti,ab,kw OR 'anoxemia':ti,ab,kw OR 'tachypnea'/de OR 'tachypnea*':ti,ab,kw OR 'tachypnoea*':ti,ab,kw OR 'hypercapnia'/exp OR 'hypercapnia*':ti,ab,kw OR 'bradycardia'/de OR 'bradycard*':ti,ab,kw OR 'tachycardia'/de OR 'tachycard*':ti,ab,kw) AND (‘equipment and supplies’:ti,ab,kw OR 'device*':ti,ab,kw OR 'suppl*':ti,ab,kw OR 'inventor*':ti,ab,kw OR 'instrument*':ti,ab,kw OR 'apparat*':ti,ab,kw OR 'determin*':ti,ab,kw OR ‘measur*':ti,ab,kw OR 'calculat*':ti,ab,kw OR 'techniq*':ti,ab,kw OR 'equipment*':ti,ab,kw OR 'monitor*':ti,ab,kw OR 'examinat*':ti,ab,kw OR 'analys*':ti,ab,kw OR 'test*':ti,ab,kw)) OR ('vital sign'/exp OR 'vital sign*':ti,ab,kw OR 'heart rate*':ti,ab,kw OR 'cardiac rate*':ti,ab,kw OR 'pulse rate*':ti,ab,kw OR ‘heartbeat*’:ti,ab,kw OR 'heart beat*':ti,ab,kw OR 'cardiac chronotrop*':ti,ab,kw OR 'ventricle rate':ti,ab,kw OR 'heart frequenc*':ti,ab,kw OR 'cardiac frequenc*':ti,ab,kw OR 'resting heart rate'/exp OR 'Respiratory Rate*':ti,ab,kw OR ‘respiration rate*’:ti,ab,kw OR 'respiratory frequenc*':ti,ab,kw OR 'respiration frequenc*':ti,ab,kw OR 'oximetry'/exp OR 'oximetr*':ti,ab,kw OR 'transcutaneous capnometr*':ti,ab,kw OR 'ptco2':ti,ab,kw OR 'tcpco2':ti,ab,kw OR 'sao2':ti,ab,kw OR 'tcpo2':ti,ab,kw OR 'transcutaneous oxygen':ti,ab,kw OR 'oxygen saturation'/exp OR 'oxygen saturation':ti,ab,kw OR 'blood oxygen level*':ti,ab,kw OR 'saturation of peripheral oxygen':ti,ab,kw OR 'peripheral oxygen saturation':ti,ab,kw OR 'spo2':ti,ab,kw OR 'o2 saturation':ti,ab,kw)

#3
'point of care testing'/exp OR 'point-of-care':ti,ab,kw OR ‘point of care’:ti,ab,kw OR ‘bedside*’:ti,ab,kw OR ‘bed side*’:ti,ab,kw OR ‘bed-side*’:ti,ab,kw OR ‘near patient*’:ti,ab,kw OR ‘rapid on-site evaluation’:ti,ab,kw OR ‘rapid diagnostic*’:ti,ab,kw OR ‘ROSE technique*':ti,ab,kw OR ‘ROSE diagnos*':ti,ab,kw OR ‘onsite':ti,ab,kw OR ‘on site’:ti,ab,kw OR ‘on-site’:ti,ab,kw OR ‘POCT':ti,ab,kw OR ‘spot measurement*':ti,ab,kw OR 'emergency medical service*’:ti,ab,kw OR ‘medical emergency service*’:ti,ab,kw OR ‘emergicenter*’:ti,ab,kw OR 'emergency care'/de OR ‘emergency care’:ti,ab,kw OR 'emergency health service'/de OR 'emergency health service*’:ti,ab,kw OR 'emergency cent*’:ti,ab,kw OR 'emergency dispensary’:ti,ab,kw OR 'emergency health care’:ti,ab,kw OR 'emergency healthcare’:ti,ab,kw OR 'hospital emergency service'/exp OR 'emergency service*':ti,ab,kw OR 'emergency hospital service*':ti,ab,kw OR 'hospital service emergenc*':ti,ab,kw OR 'emergency unit*':ti,ab,kw OR 'emergency ward*'/exp OR 'emergency ward*':ti,ab,kw OR 'emergency department*':ti,ab,kw OR 'emergency room*':ti,ab,kw OR 'acute care':ti,ab,kw OR 'acute medical care':ti,ab,kw OR 'pre-hospital care':ti,ab,kw OR 'pre-hospital patient care':ti,ab,kw OR 'prehospital care':ti,ab,kw OR 'prehospital patient care':ti,ab,kw OR 'emergency outpatient clinic'/exp OR ‘emergency outpatient clinic*’:ti,ab,kw OR 'acute medicine':ti,ab,kw OR 'acute medical service*':ti,ab,kw OR 'acute medical department*':ti,ab,kw OR 'acute medical ward*':ti,ab,kw OR 'acute medical hospital*':ti,ab,kw OR 'acute medical unit*':ti,ab,kw OR 'patient triage'/de OR 'triage*':ti,ab,kw OR ‘preadmission physical examination*':ti,ab,kw OR 'ambulatory care'/de OR ‘ambulatory*’:ti,ab,kw OR ‘outpatient*’:ti,ab,kw OR ‘out patient*’:ti,ab,kw OR ‘out-patient*’:ti,ab,kw OR ‘urgent care’:ti,ab,kw OR ‘clinic visit*’:ti,ab,kw OR ‘day clinic*’:ti,ab,kw OR ‘day hospital*’:ti,ab,kw OR ‘outdoor clinic*’:ti,ab,kw OR ‘polyclinic*’:ti,ab,kw OR ‘policlinic*’:ti,ab,kw OR ‘ambulatory care facility*’:ti,ab,kw OR 'outpatient department'/exp OR ‘clinic activit*’:ti,ab,kw OR ‘free-standing clinic*’:ti,ab,kw OR ‘community health cent*’:ti,ab,kw OR ‘satellite cent*’:ti,ab,kw OR ‘Neighborhood Health Cent*’:ti,ab,kw OR ‘Neighbourhood Health Cent*’:ti,ab,kw OR ‘Maternal-Child Health Cent*’:ti,ab,kw OR ‘Maternal Child Health Cent*’:ti,ab,kw OR ‘walk-in cent*’:ti,ab,kw OR 'out-of-hours care'/exp OR 'out-of-hour*':ti,ab,kw OR ‘after-hours care':ti,ab,kw OR ‘general practice*':ti,ab,kw OR ‘family practice*':ti,ab,kw OR ‘GP':ti,ab,kw OR 'general practitioner'/exp OR 'general practitioner*':ti,ab,kw OR ‘general medicine':ti,ab,kw OR ‘general physician*':ti,ab,kw OR ‘house call*’:ti,ab,kw OR 'home visit'/exp OR 'home visit*':ti,ab,kw OR 'office visit*':ti,ab,kw OR ‘family practice*’:ti,ab,kw OR ‘family medicine':ti,ab,kw OR ‘family practitioner*':ti,ab,kw OR ‘family doctor*':ti,ab,kw OR ‘family physician*':ti,ab,kw OR ‘primary care doctor*':ti,ab,kw OR ‘primary care physician*':ti,ab,kw OR 'primary health care'/exp OR 'primary health care':ti,ab,kw OR ‘primary

healthcare':ti,ab,kw OR ‘primary care':ti,ab,kw OR ‘first-line*’:ti,ab,kw OR ‘office-based physician*’:ti,ab,kw OR ‘office-based setting*':ti,ab,kw

#1 AND #2 AND #3 NOT 'conference abstract':it

WEB OF SCIENCE

TS=(“Infant*” OR “child*” OR “preschool*” OR “pre-school*” OR “girl*” OR “boy” OR “boys” OR “toddler*” OR “3 months old” OR “4 months old” OR “5 months old” OR “6 months old” OR “7 months old” OR “8 months old” OR “9 months old” OR “10 months old” OR “11 months old” OR “ three months old” OR “four months old” OR “five months old” OR “six months old” OR “seven months old” OR “eight months old” OR “nine months old” OR “ten months old” OR “eleven months old” OR “3 month old” OR “4 month old” OR “5 month old” OR “6 month old” OR “7 month old” OR “8 month old” OR “9 month old” OR “10 monts old” OR “11 month old” OR “three month old” OR “four month old” OR “five month old” OR “six month old” OR “seven month old” OR “eight month old” OR “nine month old” OR “ten month old” OR “eleven month old” OR “1 year old” OR “2 years old” OR “3 years old” OR “4 years old” OR “5 years old” OR “6 years old” OR “one year old” OR “two years old” OR “three years old” OR “four years old” OR “five years old” OR “six years old” OR “2 year old” OR “3 year old” OR “4 year old” OR “5 year old” OR “6 year old” OR “one year old” OR “two year old” OR “three year old” OR “four year old” OR “five year old” OR “six year old” OR “aged 1” OR “aged 2” OR “aged 3” OR “aged 4” OR “aged 5” OR “aged 6” OR “aged one” OR “aged two” OR “aged three” OR “aged four” OR “aged five” OR “aged six” OR “1 year of age” OR “2 years of age” OR “3 years of age” OR “4 years of age” OR “5 years of age” OR “6 years of age” OR “one year of age” OR “two years of age” OR “three years of age” OR “four years of age” OR “five years of age” OR “six years of age” OR (“age” NEAR/3 “1”) OR (“age” NEAR/3 “2”) OR (“age” NEAR/3 “3”) OR (“age” NEAR/3 “4”) OR (“age” NEAR/3 “5”) OR (“age” NEAR/3 “6”) OR (“age” NEAR/3 “one”) OR (“age” NEAR/3 “two”) OR (“age” NEAR/3 “three”) OR (“age” NEAR/3 “four”) OR (“age” NEAR/3 “five”) OR (“age” NEAR/3 “six”))

AND

TS=(((“hypoxia” OR “hypoxemia” OR “anoxia” OR “anoxemia” OR “tachypnea*” OR “tachypnoea*” OR “hypercapnia*” OR “bradycard*” OR “tachycard*”) AND (“equipment and supplies” OR “device*” OR “suppl*” OR “inventor*” OR “instrument*” OR “apparat*” OR “determin*” OR “measur*” OR “calculat*” OR “techniq*” OR “equipment*” OR “monitor*” OR “examinat*” OR “analys*” OR “test*”)) OR (“vital sign*” OR “heart rate*” OR “cardiac rate*” OR “pulse rate*” OR “heartbeat*” OR “heart beat*” OR “cardiac chronotrop*” OR “ventricle rate” OR “heart frequenc*” OR “cardiac frequenc*” OR “Respiratory Rate*” OR “respiration rate*” OR “respiratory frequenc*” OR “respiration frequenc*” OR “oximetr*” OR “transcutaneous capnometr*” OR “ptco2” OR “tcpco2” OR “sao2” OR “tcpo2” OR “transcutaneous oxygen” OR “oxygen saturation” OR “blood oxygen level*” OR “saturation of peripheral oxygen” OR “peripheral oxygen saturation” OR “spo2” OR “o2 saturation”))

AND

TS=(“point of care” OR “bedside*” OR “bed side*” OR “near patient*” OR “rapid on-site evaluation” OR “rapid diagnostic*” OR “ROSE technique*” OR “ROSE diagnos*” OR “onsite” OR “on site” OR “POCT” OR “spot measurement*” OR “emergency medical service*” OR “medical emergency service*” OR “emergicenter*” OR “emergency care” OR “emergency health service*” OR “emergency cent*” OR “emergency dispensary” OR “emergency health care” OR “emergency healthcare” OR “emergency service*” OR “emergency hospital service*” OR “hospital service emergenc*” OR “emergency unit*” OR “emergency ward*” OR “emergency department*” OR “emergency room*” OR “acute care” OR “acute medical care” OR “pre-hospital care” OR “pre-hospital patient care” OR “prehospital care” OR “prehospital patient care” OR “emergency outpatient clinic*” OR “acute medicine” OR “acute medical service*” OR “acute medical department*” OR “acute medical ward*” OR “acute medical hospital*” OR “acute medical unit*” OR “triage*” OR “preadmission physical examination*” OR “ambulatory*” OR “outpatient*” OR “out patient*” OR “out-patient*” OR “urgent care” OR “clinic visit*” OR “day clinic*” OR “day hospital*” OR “outdoor clinic*” OR

“polyclinic*” OR “policlinic*” OR “ambulatory care facility*” OR “clinic activit*” OR “free-standing clinic*” OR “community health cent*” OR “satellite cent*” OR “Neighborhood Health Cent*” OR “Neighbourhood Health Cent*” OR “Maternal-Child Health Cent*” OR “Maternal Child Health Cent*” OR “walk-in cent*” OR “out-of-hour*” OR “after-hours care” OR “general practice*” OR “family practice*” OR “GP” OR “general practitioner*” OR “general medicine” OR “general physician*” OR “house call*” OR “home visit*” OR “office visit*” OR “family practice*” OR “family medicine” OR “family practitioner*” OR “family doctor*” OR “family physician*” OR “primary care doctor*” OR “primary care physician*” OR “primary health care” OR “primary healthcare” OR “primary care” OR “first-line*” OR “office-based physician*” OR “office-based setting*”)

COCHRANE (via Cochrane library)

#1:[mh ^"Infant"] OR [mh "Child"]

#2: (Infant* OR Child* OR Preschool* OR (Pre NEXT school*) OR Girl* OR “Boy” OR “Boys” OR toddler* OR "3 months old" OR "4 months old" OR "5 months old" OR "6 months old" OR "7 months old" OR "8 months old" OR "9 months old" OR "10 months old" OR "11 months old" OR "three months old" OR "four months old" OR "five months old" OR "six months old" OR "seven months old" OR "eight months old" OR "nine months old" OR "ten months old" OR "eleven months old" OR "3 month old" OR "4 month old" OR "5 month old" OR "6 month old" OR "7 month old" OR "8 month old" OR "9 month old" OR "10 months old" OR "11 month old" OR "three month old" OR "four month old" OR "five month old" OR "six month old" OR "seven month old" OR "eight month old" OR "nine month old" OR "ten month old" OR "eleven month old" OR "1 year old" OR "2 years old" OR “3 years old" OR "4 years old" OR "5 years old" OR "6 years old" OR "one year old" OR "two years old" OR "three years old" OR "four years old" OR "five years old" OR "six years old" OR "2 year old" OR “3 year old" OR "4 year old" OR "5 year old" OR "6 year old" OR "one year old" OR "two year old" OR "three year old" OR "four year old" OR "five year old" OR "six year old" OR "aged 1" OR "aged 2" OR "aged 3" OR "aged 4" OR "aged 5" OR "aged 6" OR "aged one" OR "aged two" OR "aged three" OR "aged four" OR "aged five" OR "aged six" OR "1 year of age" OR "2 years of age" OR "3 years of age" OR "4 years of age" OR "5 years of age" OR "6 years of age" OR "one year of age" OR "two years of age" OR "three years of age" OR "four years of age" OR "five years of age" OR "six years of age" OR ("age” NEAR/3 “1") OR ("age” NEAR/3 “2") OR ("age” NEAR/3 “3") OR ("age” NEAR/3 “4") OR ("age” NEAR/3 “5") OR ("age” NEAR/3 “6") OR ("age” NEAR/3 “one") OR ("age” NEAR/3 “two") OR ("age” NEAR/3 “three") OR ("age” NEAR/3 “four") OR ("age” NEAR/3 “five") OR ("age” NEAR/3 “six")):ti,ab,kw

#3: #1 OR #2

#4: [mh ^”Hypoxia"] OR [mh ^"Tachypnea"] OR [mh "Hypercapnia"] OR [mh “Bradycardia"] OR [mh ^"Tachycardia"]

#5: (“Hypoxia” OR "Hypoxemia" OR "anoxia" OR "anoxemia" OR Tachypnea* OR Tachypnoea* OR Hypercapnia* OR Bradycard* OR Tachycard*):ti,ab,kw

#6: [mh ^"Equipment and Supplies"]

#7: (Device* OR suppl* OR Inventor* OR instrument* OR apparat* OR determin* OR measur* OR calculat* OR techniq* OR equipment* OR monitor* OR examinat* OR analys* OR test*):ti,ab,kw

#8: [mh ^"Vital Signs"] OR [mh ^"Heart Rate"] OR [mh "Respiratory Rate"] OR [mh "Oximetry"] OR [mh "Oxygen Saturation"]

#9: ((“Vital” NEXT Sign*) OR ("Heart” NEXT Rate*) OR ("Cardiac” NEXT Rate*) OR ("Pulse” NEXT Rate*) OR Heartbeat* OR ("Heart” NEXT beat*) OR ("Cardiac” NEXT Chronotrop*) OR “ventricle rate” OR ("heart” NEXT frequenc*) OR (“cardiac” NEXT frequenc*) OR “resting heart rate” OR ("Respiratory” NEXT Rate*) OR ("Respiration” NEXT Rate*) OR (“respiratory” NEXT frequenc*) OR ("respiration” NEXT frequenc*) OR Oximetr* OR ("transcutaneous” NEXT capnometr*) OR "PtcO2" OR "TcPCO2" OR "SaO2" OR “TcPO2" OR

"transcutaneous oxygen" OR "Oxygen Saturation" OR ("Blood Oxygen" NEXT Level*) OR "Saturation of Peripheral Oxygen" OR "peripheral oxygen saturation" OR "SpO2" OR "O2 saturation"):ti,ab,kw

#10: ((#4 OR #5) AND (#6 OR #7)) OR (#8 OR #9)

#11: [mh ^"Point-of-Care Testing"] OR [mh ^"Emergency Medical Services"] OR [mh "Emergency Service, Hospital"] OR [mh ^"Ambulatory Care"] OR [mh "General Practitioners"] OR [mh "General Practice"] OR [mh ^"Office Visits"] OR [mh "Triage"] OR [mh "Ambulatory Care Facilities"] OR [mh "House Calls"] OR [mh "Family Practice"] OR [mh "Primary Health Care"]

#12: ("Point of Care" OR Bedside* OR ("Bed" NEXT side*) OR ("Near" NEXT patient*) OR ("Rapid" NEXT diagnostic*) OR ("ROSE" NEXT Technique*) OR ("ROSE" NEXT diagnos*) OR "onsite" OR "On Site" OR "POCT" OR ("Spot" NEXT measurement*) OR ("Emergency Medical" NEXT Service*) OR ("Medical Emergency" NEXT Service*) OR Emergicenter* OR "Emergency Care" OR ("Emergency Health" NEXT Service*) OR ("Emergency" NEXT cent*) OR "Emergency dispensary" OR "Emergency Health care" OR "Emergency Healthcare" OR ("Emergency" NEXT Service*) OR ("Emergency Hospital" NEXT Service*) OR ("Hospital Service" NEXT Emergenc*) OR ("Emergency" NEXT Unit*) OR ("Emergency" NEXT Ward*) OR ("Emergency" NEXT Department*) OR ("Emergency" NEXT room*) OR "acute care" OR "acute medical care" OR "pre-hospital Care" OR "prehospital patient Care" OR "prehospital Care" OR "pre-hospital patient Care" OR ("emergency outpatient" NEXT clinic*) OR "acute medicine" OR ("acute medical" NEXT service*) OR ("acute medical" NEXT department*) OR ("acute medical" NEXT ward*) OR ("acute medical" NEXT hospital*) OR ("acute medical" NEXT unit*) OR Triage* OR ("preadmission physical" NEXT examination*) OR Ambulatory* OR Outpatient* OR ("Out" NEXT Patient*) OR "Urgent Care" OR ("Clinic" NEXT Visit*) OR ("day" NEXT clinic*) OR ("day" NEXT hospital*) OR ("outdoor" NEXT clinic*) OR polyclinic* OR policlinic* OR ("Clinic" NEXT Activit*) OR ("Free-Standing" NEXT Clinic*) OR ("Community Health" NEXT Cent*) OR ("Satellite" NEXT Cent*) OR ("Neighborhood Health" NEXT Cent*) OR ("Neighbourhood Health" NEXT Cent*) OR ("Maternal-Child Health" NEXT Cent*) OR ("Maternal Child Health" NEXT Cent*) OR ("walk-in" NEXT cent*) OR ("out-of" NEXT hour*) OR "after-hours care" OR ("General" NEXT Practice*) OR ("Family" NEXT Practice*) OR "GP" OR ("General" NEXT Practitioner*) OR "General medicine" OR ("General" NEXT physician*) OR ("House" NEXT Call*) OR ("Home" NEXT Visit*) OR ("Office" NEXT Visit*) OR ("Family" NEXT Practice*) OR "Family medicine" OR ("Family" NEXT practitioner*) OR ("Family" NEXT doctor*) OR ("Family" NEXT physician*) OR ("primary care" NEXT doctor*) OR ("primary care" NEXT physician*) OR "Primary Health Care" OR "Primary Healthcare" OR "Primary Care" OR (first NEXT line*) OR ("office-based" NEXT physician*) OR ("office-based" NEXT setting*)):ti,ab,kw

#13: #11 OR #12

#14: #3 AND #10 AND #13

SCOPUS (scopus.com)

TITLE-ABS ("Infant*" OR "child*" OR "preschool*" OR "pre-school*" OR "girl*" OR "boy" OR "boys" OR "toddler*" OR "3 months old" OR "4 months old" OR "5 months old" OR "6 months old" OR "7 months old" OR "8 months old" OR "9 months old" OR "10 months old" OR "11 months old" OR " three months old" OR "four months old" OR "five months old" OR "six months old" OR "seven months old" OR "eight months old" OR "nine months old" OR "ten months old" OR "eleven months old" OR "3 month old" OR "4 month old" OR "5 month old" OR "6 month old" OR "7 month old" OR "8 month old" OR "9 month old" OR "10 monts old" OR "11 month old" OR "three month old" OR "four month old" OR "five month old" OR "six month old" OR "seven month old" OR "eight month old" OR "nine month old" OR "ten month old" OR "eleven month old" OR "1 year old" OR "2 years old" OR "3 years old" OR "4 years old" OR "5 years old" OR "6 years old" OR "one year old" OR "two years old" OR "three years old" OR "four years old" OR "five years old" OR "six years old" OR "2 year old" OR "3 year old" OR "4 year old" OR "5 year old" OR "6 year old" OR "one year old" OR "two year old" OR "three year old" OR "four year old" OR "five year old" OR "six year old" OR "aged 1" OR "aged

2” OR “aged 3” OR “aged 4” OR “aged 5” OR “aged 6” OR “aged one” OR “aged two” OR “aged three” OR “aged four” OR “aged five” OR “aged six” OR “1 year of age” OR “2 years of age” OR “3 years of age” OR “4 years of age” OR “5 years of age” OR “6 years of age” OR “one year of age” OR “two years of age” OR “three years of age” OR “four years of age” OR “five years of age” OR “six years of age” OR (“age” W/3 “1”) OR (“age” W/3 “2”) OR (“age” W/3 “3”) OR (“age” W/3 “4”) OR (“age” W/3 “5”) OR (“age” W/3 “6”) OR (“age” W/3 “one”) OR (“age” W/3 “two”) OR (“age” W/3 “three”) OR (“age” W/3 “four”) OR (“age” W/3 “five”) OR (“age” W/3 “six”)) OR AUTHKEY (“Infant*” OR “child*” OR “preschool*” OR “pre-school*” OR “girl*” OR “boy” OR “boys” OR “toddler*” OR “3 months old” OR “4 months old” OR “5 months old” OR “6 months old” OR “7 months old” OR “8 months old” OR “9 months old” OR “10 months old” OR “11 months old” OR “ three months old” OR “four months old” OR “five months old” OR “six months old” OR “seven months old” OR “eight months old” OR “nine months old” OR “ten months old” OR “eleven months old” OR “3 month old” OR “4 month old” OR “5 month old” OR “6 month old” OR “7 month old” OR “8 month old” OR “9 month old” OR “10 monts old” OR “11 month old” OR “three month old” OR “four month old” OR “five month old” OR “six month old” OR “seven month old” OR “eight month old” OR “nine month old” OR “ten month old” OR “eleven month old” OR “1 year old” OR “2 years old” OR “3 years old” OR “4 years old” OR “5 years old” OR “6 years old” OR “one year old” OR “two years old” OR “three years old” OR “four years old” OR “five years old” OR “six years old” OR “2 year old” OR “3 year old” OR “4 year old” OR “5 year old” OR “6 year old” OR “one year old” OR “two year old” OR “three year old” OR “four year old” OR “five year old” OR “six year old” OR “aged 1” OR “aged 2” OR “aged 3” OR “aged 4” OR “aged 5” OR “aged 6” OR “aged one” OR “aged two” OR “aged three” OR “aged four” OR “aged five” OR “aged six” OR “1 year of age” OR “2 years of age” OR “3 years of age” OR “4 years of age” OR “5 years of age” OR “6 years of age” OR “one year of age” OR “two years of age” OR “three years of age” OR “four years of age” OR “five years of age” OR “six years of age” OR (“age” W/3 “1”) OR (“age” W/3 “2”) OR (“age” W/3 “3”) OR (“age” W/3 “4”) OR (“age” W/3 “5”) OR (“age” W/3 “6”) OR (“age” W/3 “one”) OR (“age” W/3 “two”) OR (“age” W/3 “three”) OR (“age” W/3 “four”) OR (“age” W/3 “five”) OR (“age” W/3 “six”))

AND

((TITLE-ABS (“hypoxia” OR “hypoxemia” OR “anoxia” OR “anoxemia” OR “tachypnea*” OR “tachypnoea*” OR “hypercapnia*” OR “bradycard*” OR “tachycard*”) OR AUTHKEY (“hypoxia” OR “hypoxemia” OR “anoxia” OR “anoxemia” OR “tachypnea*” OR “tachypnoea*” OR “hypercapnia*” OR “bradycard*” OR “tachycard*”)) AND (TITLE-ABS (“equipment and supplies” OR “device*” OR “suppl*” OR “inventor*” OR “instrument*” OR “apparat*” OR “determin*” OR “measur*” OR “calculat*” OR “techniq*” OR “equipment*” OR “monitor*” OR “examinat*” OR “analys*” OR “test*”) OR AUTHKEY (“equipment and supplies” OR “device*” OR “suppl*” OR “inventor*” OR “instrument*” OR “apparat*” OR “determin*” OR “measur*” OR “calculat*” OR “techniq*” OR “equipment*” OR “monitor*” OR “examinat*” OR “analys*” OR “test*”)) OR (TITLE-ABS (“vital sign*” OR “heart rate*” OR “cardiac rate*” OR “pulse rate*” OR “heartbeat*” OR “heart beat*” OR “cardiac chronotrop*” OR “ventricle rate” OR “heart frequenc*” OR “cardiac frequenc*” OR “Respiratory Rate*” OR “respiration rate*” OR “respiratory frequenc*” OR “respiration frequenc*” OR “oximetr*” OR “transcutaneous capnometr*” OR “ptco2” OR “tcpco2” OR “sao2” OR “tcpo2” OR “transcutaneous oxygen” OR “oxygen saturation” OR “blood oxygen level*” OR “saturation of peripheral oxygen” OR “peripheral oxygen saturation” OR “spo2” OR “o2 saturation”)) OR (AUTHKEY (“vital sign*” OR “heart rate*” OR “cardiac rate*” OR “pulse rate*” OR “heartbeat*” OR “heart beat*” OR “cardiac chronotrop*” OR “ventricle rate” OR “heart frequenc*” OR “cardiac frequenc*” OR “Respiratory Rate*” OR “respiration rate*” OR “respiratory frequenc*” OR “respiration frequenc*” OR “oximetr*” OR “transcutaneous capnometr*” OR “ptco2” OR “tcpco2” OR “sao2” OR “tcpo2” OR “transcutaneous oxygen” OR “oxygen saturation” OR “blood oxygen level*” OR “saturation of peripheral oxygen” OR “peripheral oxygen saturation” OR “spo2” OR “o2 saturation”)))

AND

TITLE-ABS (“point-of-care” OR “point of care” OR “bedside*” OR “bed side*” OR “near patient*” OR “rapid on-site evaluation” OR “rapid diagnostic*” OR “ROSE technique*” OR “ROSE diagnos*” OR “onsite” OR “on

site” OR “POCT” OR “spot measurement*” OR “emergency medical service*” OR “medical emergency service*” OR “emergicenter*” OR “emergency care” OR “emergency health service*” OR “emergency cent*” OR “emergency dispensary” OR “emergency health care” OR “emergency healthcare” OR “emergency service*” OR “emergency hospital service*” OR “hospital service emergenc*” OR “emergency unit*” OR “emergency ward*” OR “emergency department*” OR “emergency room*” OR “acute care” OR “acute medical care” OR “pre-hospital care” OR “pre-hospital patient care” OR “prehospital care” OR “prehospital patient care” OR “emergency outpatient clinic*” OR “acute medicine” OR “acute medical service*” OR “acute medical department*” OR “acute medical ward*” OR “acute medical hospital*” OR “acute medical unit*” OR “triage*” OR “preadmission physical examination*” OR “ambulatory*” OR “outpatient*” OR “out patient*” OR “urgent care” OR “clinic visit*” OR “day clinic*” OR “day hospital*” OR “outdoor clinic*” OR “polyclinic*” OR “policlinic*” OR “ambulatory care facility*” OR “clinic activit*” OR “free-standing clinic*” OR “community health cent*” OR “satellite cent*” OR “Neighborhood Health Cent*” OR “Neighbourhood Health Cent*” OR “Maternal-Child Health Cent*” OR “Maternal Child Health Cent*” OR “walk-in cent*” OR “out-of-hour*” OR “after-hours care” OR “general practice*” OR “family practice*” OR “GP” OR “general practitioner*” OR “general medicine” OR “general physician*” OR “house call*” OR “home visit*” OR “office visit*” OR “family practice*” OR “family medicine” OR “family practitioner*” OR “family doctor*” OR “family physician*” OR “primary care doctor*” OR “primary care physician*” OR “primary health care” OR “primary healthcare” OR “primary care” OR “first-line*” OR “office-based physician*” OR “office-based setting*”) OR AUTHKEY (“point-of-care” OR “point of care” OR “bedside*” OR “bed side*” OR “bed-side*” OR “near patient*” OR “rapid on-site evaluation” OR “rapid diagnostic*” OR “ROSE technique*” OR “ROSE diagnos*” OR “onsite” OR “on site” OR “on-site” OR “POCT” OR “spot measurement*” OR “emergency medical service*” OR “medical emergency service*” OR “emergicenter*” OR “emergency care” OR “emergency health service*” OR “emergency cent*” OR “emergency dispensary” OR “emergency health care” OR “emergency healthcare” OR “emergency service*” OR “emergency hospital service*” OR “hospital service emergenc*” OR “emergency unit*” OR “emergency ward*” OR “emergency department*” OR “emergency room*” OR “acute care” OR “acute medical care” OR “pre-hospital care” OR “pre-hospital patient care” OR “prehospital care” OR “prehospital patient care” OR “emergency outpatient clinic*” OR “acute medicine” OR “acute medical service*” OR “acute medical department*” OR “acute medical ward*” OR “acute medical hospital*” OR “acute medical unit*” OR “triage*” OR “preadmission physical examination*” OR “ambulatory*” OR “outpatient*” OR “out patient*” OR “out-patient*” OR “urgent care” OR “clinic visit*” OR “day clinic*” OR “day hospital*” OR “outdoor clinic*” OR “polyclinic*” OR “policlinic*” OR “ambulatory care facility*” OR “clinic activit*” OR “free-standing clinic*” OR “community health cent*” OR “satellite cent*” OR “Neighborhood Health Cent*” OR “Neighbourhood Health Cent*” OR “Maternal-Child Health Cent*” OR “Maternal Child Health Cent*” OR “walk-in cent*” OR “out-of-hour*” OR “after-hours care” OR “general practice*” OR “family practice*” OR “GP” OR “general practitioner*” OR “general medicine” OR “general physician*” OR “house call*” OR “home visit*” OR “office visit*” OR “family practice*” OR “family medicine” OR “family practitioner*” OR “family doctor*” OR “family physician*” OR “primary care doctor*” OR “primary care physician*” OR “primary health care” OR “primary healthcare” OR “primary care” OR “first-line*” OR “office-based physician*” OR “office-based setting*”)

CINAHL (via EBSCOhost)

S1

(MH "Child+") OR TI (“Infant*” OR “child*” OR “preschool*” OR “pre-school*” OR “girl*” OR “boy” OR “boys” OR “toddler*” OR “3 months old” OR “4 months old” OR “5 months old” OR “6 months old” OR “7 months old” OR “8 months old” OR “9 months old” OR “10 months old” OR “11 months old” OR “ three months old” OR “four months old” OR “five months old” OR “six months old” OR “seven months old” OR “eight months old” OR “nine months old” OR “ten months old” OR “eleven months old” OR “3 month old” OR “4 month old” OR “5 month old” OR “6 month old” OR “7 month old” OR “8 month old” OR “9 month old” OR “10 monts old” OR “11 month old” OR “three month old” OR “four month old” OR “five month old” OR “six month old” OR “seven month old” OR “eight month old” OR “nine month old” OR “ten month old” OR “eleven month old” OR “1 year old” OR “2 years old” OR “3 years old” OR “4 years old” OR “5 years old” OR “6 years old” OR “one year old” OR “two years old” OR “three years old” OR “four years old” OR “five years

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S2
(MH "Anoxemia") OR (MH "Tachypnea") OR (MH "Hypercapnia") OR (MH "Bradycardia") OR (MH "Tachycardia") OR TI (“hypoxia” OR “hypoxemia” OR “anoxia” OR “anoxemia” OR “tachypnea*” OR “tachypnoea*” OR “hypercapnia*” OR “bradycard*” OR “tachycard*”) OR AB (“hypoxia” OR “hypoxemia” OR “anoxia” OR “anoxemia” OR “tachypnea*” OR “tachypnoea*” OR “hypercapnia*” OR “bradycard*” OR “tachycard*”)

S3
(MH "Equipment and Supplies") OR TI (“equipment and supplies” OR “device*” OR “suppl*” OR “inventor*” OR “instrument*” OR “apparat*” OR “determin*” OR “measur*” OR “calculat*” OR “techniq*” OR “equipment*” OR “monitor*” OR “examinat*” OR “analys*” OR “test*”) OR AB (“equipment and supplies” OR “device*” OR “suppl*” OR “inventor*” OR “instrument*” OR “apparat*” OR “determin*” OR “measur*” OR “calculat*” OR “techniq*” OR “equipment*” OR “monitor*” OR “examinat*” OR “analys*” OR “test*”)

S4: S2 AND S3

S5
(MH "Vital Signs") OR (MH "Heart Rate") OR (MH "Respiratory Rate") OR (MH "Oximetry+") OR (MH "Oxygen Saturation") OR TI (“vital sign*” OR “heart rate*” OR “cardiac rate*” OR “pulse rate*” OR “heartbeat*” OR “heart beat*” OR “cardiac chronotrop*” OR “ventricle rate” OR “heart frequenc*” OR “cardiac frequenc*” OR “Respiratory Rate*” OR “respiration rate*” OR “respiratory frequenc*” OR “respiration frequenc*” OR “oximetr*” OR “transcutaneous capnometr*” OR “ptco2” OR “tcpco2” OR “sao2” OR “tcpo2” OR “transcutaneous oxygen” OR “oxygen saturation” OR “blood oxygen level*” OR “saturation of peripheral oxygen” OR “peripheral oxygen saturation” OR “spo2” OR “o2 saturation”) OR AB (“vital sign*” OR “heart rate*” OR “cardiac rate*” OR “pulse rate*” OR “heartbeat*” OR “heart beat*” OR “cardiac chronotrop*” OR

“ventricle rate” OR “heart frequenc*” OR “cardiac frequenc*” OR “Respiratory Rate*” OR “respiration rate*” OR “respiratory frequenc*” OR “respiration frequenc*” OR “oximetr*” OR “transcutaneous capnometr*” OR “ptco2” OR “tcpco2” OR “sao2” OR “tcpo2” OR “transcutaneous oxygen” OR “oxygen saturation” OR “blood oxygen level*” OR “saturation of peripheral oxygen” OR “peripheral oxygen saturation” OR “spo2” OR “o2 saturation”)

S6: S4 OR S5

S7
(MH "Point-of-Care Testing+" OR (MH "Emergency Medical Services") OR (MH "Emergency Service") OR (MH "Triage") OR (MH "Ambulatory Care") OR (MH "Ambulatory Care Facilities+") OR (MH "Family Practice") OR (MH "Physicians, Family") OR (MH "Home Visits") OR (MH "Office Visits") OR (MH "Primary Health Care") OR TI (“point-of-care” OR “point of care” OR “bedside*” OR “bed side*” OR “bed-side*” OR “near patient*” OR “rapid on-site evaluation” OR “rapid diagnostic*” OR “ROSE technique*” OR “ROSE diagnos*” OR “onsite” OR “on site” OR “on-site” OR “POCT” OR “spot measurement*” OR “emergency medical service*” OR “medical emergency service*” OR “emergicenter*” OR “emergency care” OR “emergency health service*” OR “emergency cent*” OR “emergency dispensary” OR “emergency health care” OR “emergency healthcare” OR “emergency service*” OR “emergency hospital service*” OR “hospital service emergenc*” OR “emergency unit*” OR “emergency ward*” OR “emergency department*” OR “emergency room*” OR “acute care” OR “acute medical care” OR “pre-hospital care” OR “pre-hospital patient care” OR “prehospital care” OR “prehospital patient care” OR “emergency outpatient clinic*” OR “acute medicine” OR “acute medical service*” OR “acute medical department*” OR “acute medical ward*” OR “acute medical hospital*” OR “acute medical unit*” OR “triage*” OR “preadmission physical examination*” OR “ambulatory*” OR “outpatient*” OR “out patient*” OR “out-patient*” OR “urgent care” OR “clinic visit*” OR “day clinic*” OR “day hospital*” OR “outdoor clinic*” OR “polyclinic*” OR “policlinic*” OR “ambulatory care facility*” OR “clinic activit*” OR “free-standing clinic*” OR “community health cent*” OR “satellite cent*” OR “Neighborhood Health Cent*” OR “Neighbourhood Health Cent*” OR “Maternal-Child Health Cent*” OR “Maternal Child Health Cent*” OR “walk-in cent*” OR “out-of-hour*” OR “after-hours care” OR “general practice*” OR “family practice*” OR “GP” OR “general practitioner*” OR “general medicine” OR “general physician*” OR “house call*” OR “home visit*” OR “office visit*” OR “family practice*” OR “family medicine” OR “family practitioner*” OR “family doctor*” OR “family physician*” OR “primary care doctor*” OR “primary care physician*” OR “primary health care” OR “primary healthcare” OR “primary care” OR “first-line*” OR “office-based physician*” OR “office-based setting*”) OR AB (“point-of-care” OR “point of care” OR “bedside*” OR “bed side*” OR “bed-side*” OR “near patient*” OR “rapid on-site evaluation” OR “rapid diagnostic*” OR “ROSE technique*” OR “ROSE diagnos*” OR “onsite” OR “on site” OR “on-site” OR “POCT” OR “spot measurement*” OR “emergency medical service*” OR “medical emergency service*” OR “emergicenter*” OR “emergency care” OR “emergency health service*” OR “emergency cent*” OR “emergency dispensary” OR “emergency health care” OR “emergency healthcare” OR “emergency service*” OR “emergency hospital service*” OR “hospital service emergenc*” OR “emergency unit*” OR “emergency ward*” OR “emergency department*” OR “emergency room*” OR “acute care” OR “acute medical care” OR “pre-hospital care” OR “pre-hospital patient care” OR “prehospital care” OR “prehospital patient care” OR “emergency outpatient clinic*” OR “acute medicine” OR “acute medical service*” OR “acute medical department*” OR “acute medical ward*” OR “acute medical hospital*” OR “acute medical unit*” OR “triage*” OR “preadmission physical examination*” OR “ambulatory*” OR “outpatient*” OR “out patient*” OR “out-patient*” OR “urgent care” OR “clinic visit*” OR “day clinic*” OR “day hospital*” OR “outdoor clinic*” OR “polyclinic*” OR “policlinic*” OR “ambulatory care facility*” OR “clinic activit*” OR “free-standing clinic*” OR “community health cent*” OR “satellite cent*” OR “Neighborhood Health Cent*” OR “Neighbourhood Health Cent*” OR “Maternal-Child Health Cent*” OR “Maternal Child Health Cent*” OR “walk-in cent*” OR “out-of-hour*” OR “after-hours care” OR “general practice*” OR “family practice*” OR “GP” OR “general practitioner*” OR “general medicine” OR “general physician*” OR “house call*” OR “home visit*” OR “office visit*” OR “family practice*” OR “family medicine” OR “family practitioner*” OR “family doctor*” OR “family physician*” OR “primary care doctor*” OR “primary care physician*” OR “primary health care” OR

“primary healthcare” OR “primary care” OR “first-line*” OR “office-based physician*” OR “office-based setting*”)

S8: S1 AND S6 AND S7

Supplementary table 1: Concept groups

Concept 1: Population (3m-6y)	Concept 2: Vital sign determination and technology	Concept 3: Ambulatory care
Infant	Hypoxia	Point-of-Care Testing
(Preschool) Child	Tachypnea	Rapid On-site Evaluation
Girl	Hypercapnia	(Hospital) Emergency (Medical) Service(s)
Toddler	Bradycardia	Emergency (health) Service, (Hospital)
	Tachycardia	(Patient) Triage
	Equipment and Supplies	Ambulatory Care (Facilities)
	Vital sign(s)	General Practitioner(s)
	Respiratory Rate	House Calls
	Oximetry	Office/ Home Visit(s)
	Oxygen Saturation	Family/General Practice
	(Resting) Heart Rate	Primary Health Care
	Anoxemia	Emergency Care/ Ward
		Outpatient Department
		Emergency Outpatient Clinic
		Out-of-hours Care
		Physicians, Family
		Primary health care

The three concept groups from which search terms were used for data extraction from the mentioned databases.

Supplementary table 2: Study information and device/participant characteristics

Study Information						Device characteristics						Participant characteristics			Statistical Analyses
First Author	Title	Journal	Year	Country	Study design	Device	Parameter	Method of use	Portability Size	Duration	Pros/cons	# patients	Age range	Pathology	
Goldman R.	Measuring tissue oxygen saturation via spectrometer in children	Journal of Trauma: Injury, Infection & Critical Care	2010	Canada	Prospective study	Masimo Pulse oximeter "Rad-ical 7"	SpO2	Finger	Phone size with finger clip	30s	Con: Inability to detect saturations below 83% with the same degree of accuracy and precision seen at higher saturations, inability to quantitatively report degree of hyperoxemia present, inability to document oxygen saturation in states of low perfusion	310	0-17y	Children with no respiratory distress	□
Patino M.	Accuracy of acoustic respiration rate monitoring in paediatric patients	Paediatric Anesthesia	2013	USA	Unclear	Masimo Rad-87 + (RAS 125, revision C) + paediatric SpO2 finger sensor	RR, SpO2	Patch on neck and finger	Size of a band-aid	instant		57	12m-18y	Post-operation	■
Van Dijk A.	Measuring cardiac autonomic nervous system (ANS) activity in children	Journal of Visualized Experiments	2013	Netherlands	Prospective, longitudinal cohort	U-AMS5fs ambulatory recording device	HR	Electrodes on chest	Phone size, PC required	2x4minutes	Pro: Recordings could be done in various locations without differences in signal recording quality	3097	5y-7y	Not reported	□
Karlen W.	Improving the Accuracy and Efficiency of Respiratory Rate Measurements in Children Using Mobile Devices	PLOS ONE	2014	Canada	Unclear	Smartphone with Rrate app	RR	Screentapping	Phone size	+/- 8.1s	Pro: 6-fold increase in mean efficacy compared to 60s counting ; Cost and widespread use smartphones Con: Error of 2.2 breaths/min at the critical RR of 40 breaths/min which is the diagnostic threshold for fast breathing in children aged 1 to 5 years	23	0-5y	Anesthesized children	■

Black J.	Can simple mobile phone applications provide reliable counts of respiratory rates in sick infants and children? An initial evaluation of three new applications	International journal of Nursing Studies	2015	Australia	Unclear	Java Mobile Edition (J2ME) on Nokia mobile phone C1-01	RR	Screentapping	Phone size	60sec	Pro: Free Cons: Need to e-mail to get app. Still manually count	5 videos to 70 students	<5y	Respiratory illnesses	□
Cunningham S.	Bronchiolitis of Infancy Discharge Study (BIDS): a multicentre, parallel-group, double-blind, randomised controlled, equivalence trial with economic evaluation	Health technology assessment	2015	UK	RCT	Masimo Rad-8 with LNC	SpO2	Not specified	Size comparable to a book	Continuously	Cons: £1800, heavy	584	6w-12m	bronchiolitis	□
Görges M.	An Ethnographic Observational Study to Evaluate and Optimize the Use of Respiratory Acoustic Monitoring in Children Receiving Postoperative Opioid Infusions	Anesthesia and analgesia	2016	USA	Observational-mixed methods	Masimo rad-87	RR	Around neck	Not mentioned	Continuously	Pro: Can measures all three vital signs (but only one tested in this study) Con: Small sample and older age of participants (only 13 children younger than 10 years)	49	4.4y-18.8y	Post operation	□
Garde A.	Respiratory rate and pulse oximetry deri ved information as predictors of hospital admission in young children in Bangladesh: a prospective observational study	BMJ Open	2016	Bangladesh	Prospective observational	Xpod OEM pulse oximeter	SpO2, HR, RR	Fingertip	Phone size	60s segments	Pro: Easy to use without requiring additional training Con: 39% of the cases had to be excluded because they did not meet quality criteria	2051	<5y	Healthy	□

Tomlinson S.	Accuracy of Smartphone-Based Pulse Oximetry Compared with Hospital-Grade Pulse Oximetry in Healthy Children	Telemedicine journal and e-health	2017	USA	Unclear	Smartphone with external plug)in probe (MasimoiSpO2)	SpO2, HR	Fingertip	Phone size	Not reported	Pro: Good reliability; uses technology to reduce motion artefact	81	2y-13y	Afebrile patients + English speaking + SpO2 +/- 97% in triage	■
						Smartphone with digiDoc app	SpO2, HR	Fingertip	Phone size	Not reported	Pro: Low cost; These app could be used by individuals without substantial medical knowledge Con: Low reliability				
Pelizzo G.	Accuracy of a Wrist-Worn Heart Rate Sensing Device during Elective Paediatric Surgical Procedures	Children (Basil)	2018	Italy	Unclear	Fitbit Charge HR	HR	Smartwatch	Watch size	Instant	Pro: small, cheap, easily readible. Con: In children less than 8 years of age, the diameter of the wrist on which the device is to be placed is smaller than wristband size; however, correct positioning of the optical sensor allowed correct measurement of HRs	30	5y-11y	Pre- and during operation	■
Uong A.	Pleth Variability Index to Assess Course of Illness in Children with Asthma	The Journal of emergency medicine	2018		Unclear	Masimo Rad-7	SpO2, HR, RR	Fingertip	Phone size + finger clip	6 minutes	Con: Not validated for patients <10kg, therefore exclusion of patiens under 2 years	28	2y-18y	Respiratory distress, but not secondary to other diseases	□
Boyd N.	Usability Testing of a Reusable Pulse Oximeter Probe Developed for Health-Care Workers Caring for Children < 5 Years Old in Low-Resource Settings	The American Journal of Tropical Medicine and Hygiene	2018	Malawi, Bangladesh, UK	Unclear	Lifeboxoximeter (version 1.5) with pulse oximeter probe (LB-01)	SpO2, HR	Foot	Box size	30sec	Pro: Reusable, low cost Con: Dependent on age different time to result. Only 38% of respondents agreeing that it is easy to get a reading in a moving child.	536	0-59 months	Patients who were clinically unstable or SpO2 <95% were excluded	□

Garbern S.	Validation of a wearable biosensor device for vital sign monitoring in septic emergency department patients in Rwanda	Digital Health	2019	Rwanda	Prospective, observational	The VitalPatch	HR, RR	Patch on left upper chest	1.15x3.6x0.8cm	Continuous	Pro: small, easily readible Con: limited study sample, cost-effectiveness not determined	42	5m-16y (and 18-87y)	Not reported	■
Ward C.	Determining the agreement between an automated respiratory rate counter and a reference standard for detecting symptoms of pneumonia in children	JMIR research protocols	2019		Cross-sectional	chARM device	RR	Band around the waist	Small, not specified	60sec to 5 minutes	Pro: small Cons: result can take up to 5 minutes Results not yet available	Not reported	2m-59m	Cough and/or difficulty breathing	□
Baker K.	Performance of Four Respiratory Rate Counters to Support Community Health Workers to Detect the Symptoms of Pneumonia in Children in Low Resource Settings: A Prospective, Multicentre, Hospital-Based, Single-Blinded, Comparative Trial	EClinicalMedicine	2019	Cambodia, Ethiopia, Uganda, South Sudan	Prospective, comparative trial	Automated respiratory rate counter	RR	Manual counting	Stopwatch size	60sec	Con: Low agreement with reference test	454	2m-59m	Children with cough and/or difficulty breathing	■
						MK2 ARI timer vs Masimo Root	RR	Manual counting	Stopwatch size	60sec					
						Phone with RRate app vs Masimo Root	RR	screentapping	Phone size	3 to 6 breaths					
						Phone with Respirometer vs Masimo Root	RR	screentapping	Phone size	intermittent					

King C.	Performance of a novel reusable paediatric pulse oximeter probe	Pediatr Pulmonol.	2019	Malawi	Prospective cross-over study	Masimo Rad-87 with Lifebox LB-01 probe	SpO2	Toe or finger	Box size	52sec	Pro: Lifebox Probe cheaper, all ages Con: This combination not available in the market: Plausible SpO2 measurement in less than 1 minute was associated with an age of 12 to 35 months ; more than 10 kg and being asleep	572	0-35m	All patients, excluded those who receive oxygen and/or with congenital limb malformation	□
						Lifebox V1.5 box with Lifebox LB-01 probe	SpO2	Toe or finger	Box size	61sec	Pro: Lifebox Probe cheaper, all ages Con: This combination not available in the market: Plausible SpO2 measurement in less than 1 minute was associated with an age of 12 to 35 months ; more than 10 kg and being asleep				
						Masime Rad-87 with LNCSY-I wrap and LNCS SCI-P paediatric clip probe	SpO2	Toe or finger	Box size	52sec	Con: This combination not available in the market: Plausible SpO2 measurement in less than 1 minute was associated with an age of 12 to 35 months ; more than 10 kg and being asleep				
Balasubramaniam S.L.	Age-related ranges of respiratory inductance plethysmography (RIP) reference values for infants and children	Paediatric respiratory reviews	2019	USA	Review	PneuRIP	RR	Band on chest and abdomen	Two bands and tablet	Instant	Con: Child needs to be in supine position	3750	6m-19y	Healthy or range of diagnoses	□
Baker K.	Usability and acceptability of a multimodal respiratory rate and pulse oximeter device in case management of children with symptoms of pneumonia: A cross-sectional study in Ethiopia	Acta Paediatrica	2020	Ethiopia	Cross-sectional	Masimo Rad-G	SpO2, HR, RR	Finger or toe	Phone size	7min	Pro: Durability, no batteries, faster and easier than manual counting Con: Probe only for suitable for children above 3 kg. Reasons for unsuccessful attempts were that the child was not calm or was moving (44.6%) and the Rad-G displayed an error or 'motion detected' message (52.3%).	599	0-59m	Illness or cough or difficulty breathing	□

Duncan H.P.	Wireless monitoring and real-time adaptive predictive indicator of deterioration	Scientific Reports	2020	UK	Prospective, cohort study	LifeTouch	HR	ECG derived	Not reported	continuous	Con: Data loss due to removel, power loss, disconnection, signal noise	982	0-17y	(a)cyanotic patients with or without cardiac conditions	□
						WristOx2	HR, SpO2	Wrist and finger	Wrist band	intermittent	Con: Data loss due to removel, power loss, disconnection, signal noise				
Alwadhi V.	Measuring accuracy of plethysmography based respiratory rate measurement using pulse oximeter at a tertiary hospital in India	Pneumonia (Nathan)	2020	India	Unclear	Masimo Rad-G	SpO2, HR, RR	Toe	Phone size with clip	Continuous	Pro: accurate and reliable	97	2-59m	Exclusion of children with shock or toe deformities	■
Baker K.	Performance of five pulse oximeters to detect hypoxaemia as an indicator of severe illness in children under five by frontline health workers in low resource settings: A prospective, multicentre, single-blinded, trial in Cambodia, Ethiopia, South Sudan, and Uganda	eClinicalMedicine	2021	Cambodia, Ethiopia, Uganda, South Sudan	Prospective	Contec fingertip paediatric pulse oximeter (Model: CMS50QB)	HR, SpO2	Finger or toe	Dimensions: 46x 40x 29 mm Weight: 35 g	Instant	Con: Highlighted the need for adequate training for all cadres of health workers to ensure the effective scale-up of pulse oximeters, as measurement is generally easy to do, but the interpretation of the result being more nuanced	1313	0-59m	<2months: all infants >2months: cough or difficulty breathing	■
						Devon fingertip pulse oximeter (Model: PC600)	HR, SpO2	Finger or toe	Dimensions: 55x40x30 mm Weight: 80 g	Instant	Con: Highlighted the need for adequate training for all cadres of health workers to ensure the effective scale-up of pulse oximeters, as measurement is generally easy to do, but the interpretation of the result being more nuanced				

						Lifebox handheld pulse oximeter (Model: AH-M1)	HR, SpO2	Finger or toe	Dimensions: 58x 123x 28 mm Weight: 200 g	Instant	Pro: Visual and audible alarms. Can be used on adults, paediatric and neonatal patients. Con: Highlighted the need for adequate training for all cadres of health workers to ensure the effective scale-up of pulse oximeters, as measurement is generally easy to do, but the interpretation of the result being more nuanced				
						Utech handheld pulse oximeter (Model: UT100)	HR, SpO2	Finger or toe	Dimensions: 75x135 x 28 mm Weight: 158 g	Instant	Pro: Visual and audible alarms. Can be used on adults, paediatric and neonatal patients. Con: Highlighted the need for adequate training for all cadres of health workers to ensure the effective scale-up of pulse oximeters, as measurement is generally easy to do, but the interpretation of the result being more nuanced				
						Masimo handheld /mobile phone pulse oximeter (Model: iSpO2 Rx)	HR, RR,SpO2	Finger or toe	Dimensions: 25x10x5 mm Weight: 30 g	Instant	Pro: Can be used on adults, paediatric and neonatal patients. Has motion software supporting SpO2 assessments. Con: highlighted the need for adequate training for all cadres of health workers to ensure the effective scale-up of pulse oximeters, as measurement is generally easy to do, but the interpretation of the result being more nuanced				
Donati M.	Exploiting Biomedical Sensors for a Home Monitoring System for Paediatric Patients with Congenital Heart Disease	Technologies	2021		Prospective	Sensor GIMA OXY10	HR, SpO2	Finger	60x33x30mm Weight: 35g	continuous	Pro: affordable	45	1d-7y	CHD patients	□

Kumar H.	Experiences From an Implementation Model of ARI Diagnostic Device in Pneumonia Case Management Among Under-5 Children in Peripheral Healthcare Centers in India	Clinical Medicine Insights: Paediatrics	2021	India	Unclear	Masimo Rad-G	RR, SpO2, HR	Toe	Size not specified	1 to 2 min	Pro: Robustness, ease of usability, durable, affordable	4846	2m-5y	ARI symptoms	□
Kruizinga M.D.	Postdischarge Recovery after Acute Paediatric Lung Disease Can Be Quantified with Digital Biomarkers	Karger	2021	Netherlands	Pilot	Withings steel HR smartwatch	HR	Wrist	Wrist band	continuous	Con: Not suitable for children <4 years: drop out due to smartwatch discomfort	71	2y-12y	Children with CAP, PW and AE	□
Tack B.	Performance of Automated Point-of-Care Respiratory Rate Counting versus Manual Counting in Children under Five Admitted with Severe Febrile Illness to Kisantu Hospital, DR Congo	Diagnostics	2021	DR. Congo	Unclear	Masimo Rad-G	RR	Finger	Phone size	Continuous	Con: When compared to the target product profile for automated RR counting developed by UNICEF, the automated method performed insufficiently. Underestimation of RR in fast breathing children	202	<5y	Hospitalized children with severe febrile illness	■
Rahman A.E.	Success and time implications of SpO2 measurement through pulse oximetry among hospitalised children in rural Bangladesh: Variability by various device-, provider- and patient-related factors	Journal of Global Health	2022	Bangladesh	Observational	Masimo Rad-5V device	SpO2	Finger	Phone size wit finger clip	+/- 27s	Con: Difficulty keeping baby calm and probe placement	739	2-59m	Children admitted to paediatric inpatient unit	■
						Lifebox AH-M1 device	SpO2	Finger	Phone size with finger clip	+/- 36s	Con: Difficulty keeping baby calm and probe placement				

Stevens W.R.	Inclusive community playgrounds benefit typically developing children: An objective analysis of physical activity	Frontiers in Sports and Active Living	2023	USA	Unclear	Polar V800 sport watch with polar H10 chest strap and Polar flow app	HR	Wrist and chest band	Wrist size	continuous		85	5-9y	Paediatric patiens with neurological or orthopedic condition were excluded	□
Khan S.R.	Multi-Modal Portable Respiratory Rate Monitoring Device for Childhood Pneumonia Detection	Micromachines	2023	UK, Bangladesh	Unclear	Multi-modal portable RR monitoring device	RR	Hand on chest	Glove	continuous	Pro: Accurate, easy to use, affordable, in the future ECG possible Con: new device, small sample, charged after 10h	10	3y-33y	Healthy	□
Pfurtscheller T.	Usability of pulse oximeters used by community health and primary care workers as screening tools for severe illness in children under five in low resource settings: A crosssectional study in Cambodia, Ethiopia, South Sudan, and Uganda	PLOS Global Public Health	2023	Cambodia, Ethiopia, Uganda, South Sudan	Cross-sectional	Contec fingertip paediatric pulse oximeter (Model: CMS50QB)	SpO2	Finger or toe	Dimensions: 46x 40x 29 mm Weight: 35 g	Instant	Con: highest failure rate of 8,8% with U-Tech Satisfaction: 80 health workers, no difference between devices; A significant difference in checklist completion rates between fingertip and handheld devices, and between infants <12 months and children 12–59 months,	Not reported	Not reported	Not reported	□
						Devon fingertip pulse oximeter (Model: PC600)	HR, SpO2	Finger or toe	Dimensions: 55x40x 30mm Weight: 80 g	Instant					
						Lifebox handheld pulse oximeter (Model: AH-M1)	HR, SpO2	Finger or toe	Dimensions: 58x 123x 28 mm Weight: 200 g	Instant					

						Utech handheld pulse oximeter (Model: UT100)	HR, SpO2	Finger or toe	Dimensions: 75x135x28 mm Weight: 158 g	Instant					
						Masimo handheld /mobile phone pulse oximeter (Model: iSpO2 Rx)	HR, RR, SpO2	Finger or Toe	Dimensions: 25x 10x5 mm Weight: 30 g	Instant					
Ghomrawi H.M.	Clinicians' perspectives on wearable sensor technology as an alternative bedside monitoring tool in two West African countries	International journal of Medicine	2023	West-africa	Unclear	Biosensor Northwestern University	HR, RR	Variety of places	Size comparable to band-aid	Continuous	Pro: small, airtight, low-cost (0,05-0,07USD/pt) Con: result needs to be transmitted to smartphone	Not reported	Paediatric, not specified	Not reported	□
Pham A.	Assessing Passive Leg Raise Test in Paediatric Shock Using Electrical Cardiometry	Journal of paediatric intensive care	2023	USA	Prospective, observational	ICON device	HR	Four adhesive skin sensors	Phone size	Continuous	Con: delivers real-time hemodynamic measurements Analyses time-dependent changes in blood conductivity within the aorta and throughout the cardiac cycle. Hereby a lot of specific outcomes (MAP, cardiac output, stroke index, stroke volume, LVET,…)	68	0-20y	Range of diagnoses, most commonly hypovolemic shock	□
Ghomrawi H.M.	Applying machine learning to consumer wearable data for the early detection of complications	NPJ digital medicine	2023	USA	Unclear	Fitbit Inspire 2	HR	smartwatch	Watch	Continuous	Pro: Proven reliability in children Con: not for small children (not further specified)	162	3y-17y	Post-appendectomy	□

	after paediatric appendectomy					Fitbit Inspire HR	HR	smartwatch	Watch	Continuous					
Rawat A.	Health System Considerations for Community-Based Implementation of Automated Respiratory Counters to Identify Childhood Pneumonia in 5 Regions of Ethiopia: A Qualitative Study	International Journal of Health Policy and Management	2023	Ethiopia	Interview	charm by Philips	RR	Not mentioned	Not mentioned	Continuous	Pro: More accurate than manual counting; easy to use; age specific and standardized breathing counts shown in the device	Not reported	Not reported	Not reported	□
						Masimo Rad-G	RR	Not mentioned	Not mentioned	Continuous	Pro: More accurate than manual counting; (participants opinion); Con: Device malfunction and charging (device not being usable while charging)				
Garbern S.	A novel digital health approach to improving global paediatric sepsis care in Bangladesh using wearable technology and machine learning	PLOS Health	2024	Bangladesh	Prospective, observational	VitalPatch	HR, RR	Torso	Phone size	Continuous	Pro: Small, easily readable Con: limited study sample, cost-effectiveness not determined	100	2m-17y	Not reported	■
Weaver R.	Jerks are Useful: Extracting pulse rate from wrist-placed accelerometry jerk during sleep in children	Sleep	2024	USA	Unclear	ActiGraph GT9X link	HR	Wrist	Wrist band	Continuous	Con: Signal artefact twice in a second; Tested during sleep, so unsure if applicable while awake	Not reported	5-12y	Not reported	■
						Apple watch series 7	HR	Wrist	Wrist band	Continuous	Pro: Actigraphy data collected via AWS7 consistently outperformed data collected via the GT9X			Children with suspected disrupted sleep	

Overview of studies evaluating medical devices for measuring heart rate (HR), Respiratory rate (RR) and Oxygen saturation (SpO2).
Abbreviations: ■ (Yes), □ (No)

Supplementary table 3: Study information and statistical analyses

Study Information						Statistical analyses				
First Author	Title	Journal	Year	Country	Study design	Spec.	Sens.	Accuracy	Odds ratio	Others
Patino M.	Accuracy of acoustic respiration rate monitoring in paediatric patients	Paediatric Anesthesia	2013	USA	Unclear	Not reported	Not reported	When compared to nasal capnography, RRa showed similar accuracy	Not reported	Reliability: 90% (95% CI 22.8% to 100%)
Karlen W.	Improving the Accuracy and Efficiency of Respiratory Rate Measurements in Children Using Mobile Devices	PLOS ONE	2014	Canada	Unclear	Not reported	Not reported	NRMSE = 5.6% +- 1.1	Not reported	
Tomlinson S.	Accuracy of Smartphone-Based Pulse Oximetry Compared with Hospital-Grade Pulse Oximetry in Healthy Children	Telemedicine journal and e-health	2017	USA	Unclear	Not reported	Not reported	Not reported	Not reported	Inter-rater reliability for SpO2: 0.73; for HR: 0.99; Lower SpO2 (+-2 points) and HR (mean -3bpm) compared to triage measures
						Not reported	Not reported	Not reported	Not reported	Inter-rater reliability for SpO2 was -0.24, for HR, the ICCs was 0.62; Lower SpO2 (+-4 points) and HR (mean -12bpm) compared to triage measures

Pelizzo G.	Accuracy of a Wrist-Worn Heart Rate Sensing Device during Elective Paediatric Surgical Procedures	Children (Basil)	2018	Italy	Unclear	Not reported	Not reported	PFT accuracy was similar preoperatively (cECG r = 0.99; 0.1 bpm, 95% CI 2.7–2.5; SpO2R r = 0.99; 0.06 bpm, 95% CI 2.9–3) and during surgery (cECG r = 0.99; 0.005 bpm, 95% CI 2.4–2.4; SpO2R r = 0.99; 0.04 bpm, 95% CI 2.7–2.6), p = 0.4; there were no differences between laparoscopy and traditional open surgery (p = 0.2).	Not reported	Lin's concordance correlation coefficient (CCC). The limits of agreement were similar for the PFT method in comparison with the cECG and SpO2R methods, even when HR was lower than 70 bpm (cECG r = 0.95, 0.26 bpm, 95% CI 1.6–2.1;SpO2R r = 0.91; 0.54 bpm, 95% CI 2.0–3.1) or higher than 140 bpm (cECG r = 0.95, 0.26 bpm, 95% CI 1.6–2.1; SpO2R r = 0.99, 0.08 bpm, 95% CI 2.2–2.0)
Garbern S.	Validation of a wearable biosensor device for vital sign monitoring in septic emergency department patients in Rwanda	Digital Health	2019	Rwanda	Prospective, observational	Not reported	Not reported	Correlation between the biosensor and manual measurements was strong for HR (r¼0.87, p<0.001) and RR (r¼0.75, p<0.001).	Not reported	The ICC was 0.97 (95% CI 0.90–0.99) for HR, 0.85 (95% CI 0.54–0.96) for RR and 0.79 (95% CI 0.44–0.94) for temperature, indicating good to excellent reliability for all vital sign measurements.
Baker K.	Performance of Four Respiratory Rate Counters to Support Community Health Workers to Detect the Symptoms of Pneumonia in Children in Low Resource Settings: A Prospective,	EClinicalMedicine	2019	Cambodia, Ethiopia, Uganda, South Sudan	Prospective, comparative trial	NPA=93 %	PPA=66 %	Not reported	Not reported	Mean difference −0.6 bpm; RR measurements by health workers that were ± 2 bpm from the reference standard 32%
						NPA=92 %	PPA=41 %	Not reported	Not reported	Mean difference −1.9 bpm; RR measurements by health workers that were ± 2 bpm from the reference standard. 35%

	Multicentre, Hospital-Based, Single-Blinded, Comparative Trial					NPA= 84%	PPA= 73%	Not reported	Not reported	Mean difference 5.5 bpm; RR measurements by health workers that were ± 2 bpm from the reference standard. 34%
						NPA=83 %	PPA=65 %	Not reported	Not reported	Mean difference −0.5 bpm; RR measurements by health workers that were ± 2 bpm from the reference standard. 26%
Alwadhi V.	Measuring accuracy of plethysmography based respiratory rate measurement using pulse oximeter at a tertiary hospital in India	Pneumonia (Nathan)	2020	India	Unclear	94% for fast breathing (RR)	95% for fast breathing (RR)	95% (RR)	Not reported	97% agreement for RR by both measurement methods: +- 97% (Pearson correlation; concordance correlation coefficient)
Baker K.	Performance of five pulse oximeters to detect hypoxaemia as an indicator of severe illness in children under five by frontline health workers in low resource settings: A prospective, multicentre, single-blinded, trial in Cambodia, Ethiopia, South Sudan, and Uganda	eClinicalMedicine	2021	Cambodia, Ethiopia, Uganda, South Sudan	Prospective	Not reported	Not reported	Compared to reference standard (Masimo Radical 7): 31% of observations being within 2%	Not reported	Mean difference or bias (Kappa value for agreement of classification of SpO2 as normal or hypoxaemia): K = 0,19
						Not reported	Not reported	Compared to reference standard (Masimo Radical 7): 47% of observations being within 2%	Not reported	Mean difference or bias (Kappa value for agreement of classification of SpO2 as normal or hypoxaemia): K = 0,38
						Not reported	Not reported	Compared to reference standard (Masimo Radical 7): 56% of observations being within 2%	Not reported	Mean difference or bias (Kappa value for agreement of classification of SpO2 as normal or hypoxaemia): K = 0,48

						Not reported	Not reported	Compared to reference standard (Masimo Radical 7): 58% of observations being within 2%	Not reported	Mean difference or bias (Kappa value for agreement of classification of SpO2 as normal or hypoxaemia): K = 0,46
						Not reported	Not reported	Compared to reference standard (Masimo Radical 7): 68% of observations being within 2%	Not reported	Mean difference or bias (Kappa value for agreement of classification of SpO2 as normal or hypoxaemia): K = 0,67
Tack B.	Performance of Automated Point-of-Care Respiratory Rate Counting versus Manual Counting in Children under Five Admitted with Severe Febrile Illness to Kisantu Hospital, DR Congo	Diagnostics	2021	DR. Congo	Unclear	Negative percent agreement: 98.3%	Positive percent agreement: 75.9%	Not reported	Not reported	Pearson correlation coefficient: 0.77;Lins concordance correlation coefficient: 0.73; Type 3 intraclass correlation coefficient : 0.76, which can be interpreted as moderate to good reliability
Rahman A.E.	Success and time implications of SpO2 measurement through pulse oximetry among hospitalised children in rural Bangladesh: Variability by various device-, provider- and patient-related factors	Journal of Global Health	2022	Bangladesh	Observational	Not reported	Not reported	Not reported	Odds for successful measurement within 60s were 7.3x higher with Masimo device than Lifebox device. Assessors aged >25 years were 4.8x more likely to obtain successful measurement within 60s. Odds of for successful measurement was 2.6x higher among children aged 12-59 months compared to 2-11 months	Self-administered survey tool for assessors; Almost 98% successful measurement within 60s

									Odds for successful measurement within 60s were 7.3x higher with Masimo device than Lifebox device. Assessors aged >25 years were 4.8x more likely to obtain successful measurement within 60s. Odds of for successful measurement was 2.6x higher among children aged 12-59 months compared to 2-11 months	Self-administered survey tool for assessors; 87% successful measurement within 60s
Garbern S.	A novel digital health approach to improving global paediatric sepsis care in Bangladesh using wearable technology and machine learning	PLOS Health	2024	Bangladesh	Prospective, observational	Not reported	Not reported	Not reported	Not reported	Pearson's correlation excellent for HR and RR with Pearson's r = 0.93 for HR and r = 0.94 for RR. Mean difference (limits of agreement): 0.04 for HR, 0.29 for RR
Weaver R.	Jerks are Useful: Extracting pulse rate from wrist-placed accelerometry jerk during sleep in children	Sleep	2024	USA	Unclear	Not reported	Not reported	Not reported	Not reported	Low agreement: r= -0,12, Lin's Concordance Correlation Coefficient=-0,11, Mean absolute error= 16,8; Mean absolute percent error= 20,4
						Not reported	Not reported	Not reported	Not reported	Moderate agreement: r= 0.78, Lin's Concordance Correlation Coefficient=-0,77, Mean absolute error= 4.5; Mean absolute percent error= 5.7

Overview of study details and statistical analyses.

Supplementary table 4: Risk of bias

			Karlen 2014	Patino 2013	Tomlinson 2017	Pelizzo 2018	Baker 2019	Garbern 2019	Alwadhi 2020	Baker 2021	Tack 2021	Rahman 2022	Garbern 2024	Weaver 2024
Domain 1: patient selection	Risk of bias	Consecutive or random sample	Unclear	Unclear	Yes	Yes	No	No	Yes	Yes	Unclear	Unclear	Yes	Unclear
		Case-control design avoided	Unclear	Yes	No	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes
		Avoid inappropriate exclusions	No	Yes	No	Yes	No	No	Yes	Unclear	Unclear	Yes	Yes	Yes
		Selection bias?	**HIGH**	**LOW**	**HIGH**	**LOW**	**HIGH**	**HIGH**	**LOW**	**LOW**	**HIGH**	**LOW**	**LOW**	**LOW**
	Applicability	Concern that the included patients do not match review question?	**HIGH**	**LOW**	**HIGH**	**LOW**	**LOW**	**LOW**	**LOW**	**Unclear**	**HIGH**	**LOW**	**HIGH**	**HIGH**
Domain 2: index test	Risk of bias	Index test results interpreted without knowledge of the results of the reference standard	Unclear	No	No	No	Unclear	Unclear	No	No	No	Unclear	Unclear	Unclear
		Threshold pre-specified	Unclear	Unclear	Unclear	No	No	No	Unclear	Yes	Unclear	Yes	No	No
		Index test have introduced bias?	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**	**HIGH**
	Applicability	Concern that the index test, its conduct or interpretation differ	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**	**LOW**
Domain 3: reference standard	Risk of bias	Reference standard classify the target condition	Unclear	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes
		Results interpreted without knowledge of results index test	Yes	Unclear	Yes	No	Unclear	Unclear	Yes	Unclear	No	Unclear	Unclear	Unclear

		Reference standard induced bias?	LOW	Unclear	LOW	Unclear	LOW	LOW	LOW	LOW	Unclear	HIGH	LOW	LOW
	Applicability	Concern that the target condition as defined by reference standard does not match the review question	HIGH	LOW	HIGH	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW	LOW
Domain 4: flow and timing	Risk of bias	An appropriate interval between index test and reference standard	Unclear	Yes	Unclear	Unclear	Yes	Unclear	Yes	Yes	Yes	Unclear	Yes	Yes
		All patients receive reference standard	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Unclear	Yes	Yes
		Same reference standard	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes
		All patients included	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Unclear	No	Unclear	Yes	Yes
		Patient flow introduced bias?	LOW	LOW	Unclear	Unclear	LOW	LOW	LOW	LOW	LOW	HIGH	LOW	LOW

Risk of bias tool sorted by author and year of publication.

Ethical approval

Ethical approval was obtained in November 2023.
Dossiernr.: MP028237

Masterproef: Masterproef I HAIO, 2022-2025

Faculteit/opleiding: Faculteit Geneeskunde - Master in de huisartsgeneeskunde

Studiefase: eerste fase

Academiejaar: 2023-2024

Korte omschrijving / abstract: Veel richtlijnen voor de pediatrische populatie zijn gebaseerd op vitale en objectieve parameters zoals ademhalingsfrequentie, saturatie, hartfrequentie,… Echter is dit vaak moeilijk te beoordelen in de huisartsenpraktijk. Dit komt enerzijds door secundaire anamnese via familie, moeilijkere compliantie van het kind bij klinisch onderzoek en anderzijds een gebrek aan objectieve meetinstrumenten voor de pediatrische patiënt.

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De verstrekte informatie toont aan dat het onderzoek in het kader van de masterproef een zuivere literatuurstudie betreft en dat er op geen enkele wijze gebruik wordt gemaakt van proefdieren, proefpersonen of menselijk lichaamsmateriaal.

Dit type onderzoek vereist geen goedkeuring van een gemachtigde commissie voor medische ethiek.

Onder voorbehoud van de volledigheid en correctheid van de door u verstrekte gegevens, krijgt u hierbij het akkoord om het onderzoek in het kader van de masterproef te starten. Deze mail dient als bewijs van goedkeuring mocht u uw onderzoek wensen te publiceren.

Wij willen u erop attent maken dat u zelf verantwoordelijk blijft voor uw onderzoek. Bovendien doet elke wijziging aan de door u verstrekte gegevens omtrent de onderzoeksopzet deze goedkeuring vervallen. U dient in dat geval een amendement te maken aan uw huidig dossier.