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BestPractice

Evidence Based Practice Information Sheets for Health Professionals

Vital Signs

Acknowledgement

This Best Practice Information Sheet has been based on a systematic review of research relating to vital signs. If you wish to view the primary references on which this information sheet is based, they are available in the systematic review report published by the Joanna Briggs Institute.

Introduction

Patient observations are an important part of nursing care in that they allow the patient's progress to be monitored and also ensure prompt detection of adverse events or delayed recovery. Patient observations, or vital signs, traditionally consist of blood pressure, temperature, pulse rate and respiratory rate. A systematic review was recently conducted addressing issues such as the purpose of vital signs, the optimal frequency with which they should be conducted, what observations constitute vital signs and to identify issues related to the individual measures of temperature, pulse rate, respiratory rate and blood pressure.

This Best Practice Information Sheet summarises current best evidence on the topic. In this information sheet, the term observations refers to patient observations in general, while vital signs is used in reference specifically to temperature, pulse, respiration and blood pressure.

Vital Signs: General Issues

Vital Signs versus Observations

The measurement of temperature, pulse, heart rate and blood pressure is termed both vital signs and observations. Neither have been well defined and their use is inconsistent and at times inter-changeable. The term vital signs suggests measurement of vital or critical physiologic functions, where as the term "observations" implies broader range of measures. While there is no clear definition in the literature, the panel of experts which guided the systematic review process argued that observations is the more appropriate term, in that it more accurately reflects current clinical practice. This implies that patient observations need not be limited to the traditional four parameters but supplemented with other measures as indicated by the patient's clinical status.

This Practice Information Sheet Covers The Following Concepts

Levels of Evidence

All studies were categorised according to the strength of the evidence based on the following classification system.

Level I
Evidence obtained from a systematic review of all relevant randomised controlled trials.

Level II
Evidence obtained from at least one properly designed randomised controlled trial.

Level III.1
Evidence obtained from well designed controlled trials without randomisation.

Level III.2
Evidence obtained from well designed cohort or case control analytic studies preferably from more than one center or research group.

Level III.3
Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments.

Level IV
Opinion of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

What Constitutes Vital Signs

Traditionally, the term "vital signs" is used in reference to the measurement of temperature, respiratory rate, pulse rate and blood pressure. However, within the literature there are suggestions that these parameters could be supplemented with other useful measures such as nutritional status, smoking status, spirometry, orthostatic vital signs and pulse oximetry. However, only pulse oximetry and determining a patient's smoking status have been shown to actually change the practice of clinicians.

Studies have demonstrated that in some situations pulse oximetry is useful for detecting a deterioration in physiological function that might otherwise be missed. This has resulted in a reduction in the number of investigations undertaken and has changed the planned management of patients. On this basis, pulse oximetry has been recommended as a useful addition to the four traditional measures of physiologic status.

The use of the concept "smoking status is a vital sign" has been evaluated during the initial patient encounter and has been shown to increase the likelihood that counselling and smoking cessation advice would be provided by the health care worker. While this parameter does not fit within the traditional concept of vital signs or patient observations, it may still have an important role during the initial patient assessment.

Other proposed vital sign measurements, such as nutritional and orthostatic vital signs, have not been shown to have an influence on patient management. While many other measures and scales exist, their role within the framework of patient observations has yet to be determined. Indeed, in some situations simple visual observation of the patient may be all that is required in terms of monitoring the patient's progress and clinical status, yet this has still to be addressed.

Limitations

Based on the findings of a small number of studies, it appears that vital signs are quite limited in terms of detecting important physiologic changes. Examples of this include: their failure to detect large blood losses, to identify serious illness in infants, and their inability to detect an inadequate plasma volume in burn injury patients. One retrospective study of patients with severe thoracoabdominal injury found that normal or stabilised post injury vital signs did not signify that life threatening haemorrhage was absent. These studies suggest that the usefulness of vital signs is perhaps more as an indicator for the need of further more appropriate investigations. It is therefore important to note that normal vital sign parameters do not guarantee a stable physiological status.

Frequency of Vital Signs

There is only limited information regarding the frequency with which patient observation should be undertaken and much of this is based on surveys of nurses, clinical practice reports and expert opinion. Surveys of nurses have shown that many admit to carrying out frequent vital sign measurements on patients they believed did not require them, and that they had become a routine procedure unrelated to perceived individual patients needs.

Two studies evaluated the impact of reducing the frequency of post-operative observations, but both involved only minor changes to measurement frequency. One practice report describes the change from 15 and 30 minutely vital sign measurement during a blood transfusion, to vital signs only at commencement, at 15 minutes and on completion. This report used visual observation to monitor patient status at other times during the transfusion, and suggest there was no compromise to safe practice. However, the strength of this evidence is limited and so cannot be used to justify practice change. The "vital signs" systematic review concluded that there has been little serious evaluation of the optimal frequency of patient observations.

Vital Signs: Respiratory Rate

There is only limited research relating to monitoring respiratory rate, and these studies focused on issues such as the inaccuracy of respiratory rate measurement and respiratory rate as a marker for respiratory dysfunction.

Inaccuracies in respiratory measurement have been reported in the literature. One study compared respiratory rate counted using a 15 second count period, to a full minute, and found significant differences in the rates. Respiratory rates measurement in children under five years, for a 30 second or 60 second period, suggesting the 60 seconds resulted in the least variability. Another study found that rapid respiratory rates in babies, counted using a stethoscope, were 20% to 50% higher than those counted from beside the cot without the aid of the stethoscope.

The value of respiratory rate as an indicator of potential respiratory dysfunction has been investigated but findings suggest it is of limited value. One study found that only 33% of people presenting to an emergency department with a oxygen saturation below 90% had an increased respiratory rate. An evaluation of respiratory rate for the differentiation of the severity of illness in babies under 6 months found it not to be very useful. Approximately half of the babies had a respiratory rate above 50 breaths per minute, thereby questioning the value of having a "cut-off" at 50 breaths per minute as the indicator of serious respiratory illness. It has also been reported that factors such as crying, sleeping, agitation and age have a significant influence on the respiratory rate. As a result of these and similar studies the value of respiratory rate as an indicator of serious illness is limited.

Vital Signs: Pulse Rate

There has been very little research evaluating the measurement of pulse rates. It is likely, that when heart rate is of concern, cardiac monitors are used to determine not only rate, but also rhythm. The role of the "pattern of the pulse", for example regular pulse versus irregular pulse or strong pulse versus weak pulse, have not been addressed in the context of vital signs or patient observations. On this basis, an important role of pulse rate monitoring will likely be to identify when more advanced monitoring is required.

Measurement of a person's pulse rate in the presence of atrial fibrillation was evaluated and results suggest that pulse rate, measured apically using a stethoscope for a 60 second count period, is likely to be the most accurate rate. This study noted that 86% of nurses underestimated the pulse rate, and that as the heart rate increased the magnitude of error also increased. Another study recommended a 30 second count period as the most accurate and efficient way of measuring pulse rate, noting that the 15 second count time was the least accurate. A third study found that there was no advantage in using the longer 60 seconds, over the 15 or 30 second count periods. These researchers suggest that counting an accurate pulse rate may be more difficult than commonly recognised.

A study assessing infants apical pulse rate using a stethoscope, suggested that length of time may not be the primary factor in errors, and that like respiratory rate, pulse rate also appears to be influenced by infant states in addition to illness.

While these studies have identified that the accuracy of pulse rate measurements is influenced by the number of seconds that the pulse is counted, the clinical significance of these findings is unclear. The contradictory findings of studies suggest that the count period used to determine pulse rate is of only limited significance.

Vital Signs: Blood Pressure

Studies addressing the measurement of blood pressure with a sphygmomanometer have focused on issues such as the accuracy of indirect blood pressure, palpation versus auscultation cuff size, position of arm during measurements and health care workers technique.

Direct versus Indirect

Several studies have compared direct (intra-arterial) and indirect (auscultation) measurements of blood pressure. There appears to be little significant difference in systolic pressures measured by either method, with differences ranging from 3 mmHg in two studies to 12mmHg in a third. Differences in diastolic blood pressure are greater, and are influenced by the reference point that is used. When the phase V Korotkoff's sound is used (disappearance of the sound), both methods provide similar pressures. However when the phase IV Korotkoff's sound (muffling), is used, auscultated measurements are significantly greater than intra-arterial pressures (see table one). A study in children reported the use of either auscultation or palpation overestimated systolic pressure. See table two for current recommended practice for the measurement of blood pressure.

Palpation versus Auscultation

A comparison between systolic blood pressure measurements taken by auscultation and palpation found both were within 8 mmHg. While palpation has been commonly limited to the measurement of systolic blood pressure, one study reported that diastolic pressures could be accurately palpated using the brachial artery to identify the sharp phase IV Korotkoff's sound, However, the value of this technique in clinical practice, and its accuracy when used by health care workers, has yet to be demonstrated.

Cuff Size

The length and width of the inflatable cuff (bladder) that is used during the measurement of blood pressure may be a source of error. Much of the research has focused on cuff width, (the dimension across along the bladder) as the potential source of this error. The standard width of currently available cuffs is approximately 12cm, with both larger and smaller sizes also available. Studies have shown that the use of a cuff that is too narrow results in an overestimation of blood pressure, and a cuff that is too wide underestimates blood pressure. Length of cuff appears to have little influence on accuracy.

For obese people it has been suggested that large cuffs (15cm width) will be required when the person's arm circumferences is between 33 –35cm, and a thigh cuff (18cm width) may be needed if the arm circumferences is greater than 41cm. However, difficulties in applying thigh cuffs to large arms have been reported. Cuff width may also be important when measuring blood pressure in neonates and a cuff width equal to approximately 50% of the arm circumference has been recommended.

Arm and Body Position

Comparisons of blood pressures measured in the sitting person with their arm supported horizontally or with the arm resting at their side, have found an average difference in systolic pressure of 11mmHg and diastolic pressure of 12mmHg. When the arm was placed above or below the level of the heart, blood pressure measurements changed by as much as 20mmHg. As a result of this, it has been recommended that blood pressures be taken in the sitting position with arm supported horizontally at approximately heart level.

Bell versus Diaphragm

The accuracy of blood pressures measured with the bell or the diaphragm of the stethoscope have been investigated. One study found the bell of the stethoscope resulted in higher readings than those taken using the diaphragm. These results were supported by another study, with researchers recommending the use of the bell for all blood pressure measurements.

Health Care Workers Technique

The technique used by health care workers to measure blood pressure has been shown to differ from recommended practice. Using the American Heart Association Guidelines as the standard, one study found that 57% of nursing students failed to comply with these guidelines in areas such as cuff placement, estimation of systolic pressure by palpation, calculation of proper inflation pressure, and proper stethoscope placement. Another study of 172 health care workers concluded that nurses and physicians evaluated blood pressure in an inadequate, incorrect and inaccurate way, and that only 3% of general practitioners and 2% of nurses obtained reliable results. Two studies evaluating the impact of education programs on blood pressure measurement, found they increased agreement between the different blood pressure readings and also significantly reduced differences in operator technique.

Limitations

A descriptive study of blood pressures in critically ill patients who had suffered a cardiac arrest highlighted some limitations to these measurements. Of the 15 patients investigated, 5 patients had adequate intra-arterial blood pressures, but unreadable cuff pressures. Four patients had cuff pressures approaching normal, but had an inadequate cardiac output. This study suggests that indirect blood pressure measurements do not always accurately reflect haemodynamic status of critically ill people.

Table One
Korotkoff's Sounds

Measurement of blood pressure by auscultation is based on the sounds produced as a result of changes in blood flow, termed Korotkoff's sounds, and are:

1. Phase I The pressure level at which the first faint, clear tapping sounds are heard, which increase as the cuff is deflated (reference point for systolic BP).
2. Phase II During cuff deflation when a murmur or swishing sounds are heard.
3. Phase III The period during which sounds are crisper and increase in intensity.
4. Phase IV When a distinct, abrupt, muffling of sound is heard
5. Phase V The pressure level when the last sound is heard (reference point for diastolic BP).

Table Two
Recommended Blood Pressure Measurement Technique
Based on published information, below is a summary of the recommended practice

- Patient should be seated and have rested for 5 minutes and have arm supported at heart level.
- Appropriate cuff size should be used, and the bladder should nearly (at least 80%) or completely encircle arm.
- Patients should not have smoked or ingested caffeine within 30 minutes before measurements.
- Measurements should be taken with a mercury sphygmomanometer, a recently calibrated aneroid manometer, or a calibrated electronic device.
- Both systolic and diastolic blood pressure should be recorded.
- Korotkoff's phase V (disappearance of sound) should be used for the diastolic reading.
- Two or more readings, separated by 2 minutes, should be averaged, and more taken if they differ by more than 5mmHg.

Vital Signs : Temperature

The largest volume of research identified during the literature search addressed various aspects of temperature measurement. These studies highlight the large range of methods and body sites that are used for the measurement of temperature (see table three). Because of the volume of research, comparisons of different temperature measurement methods will be summarised as a separate systematic review. Summarised in this practice information sheet are studies addressing aspects of oral, rectal axillary and tympanic temperatures.

General Issues

While much attention has focused on measurement accuracy, one study evaluated touch as a screen for fever and found that while mothers and medical students overestimated the incidence of fever when using touch, they rarely missed its presence in a child. The results of this study perhaps challenge the current focus of research on the accuracy of measurements using tenths of a degree, when simple touch is an accurate measure for fever. The use of temperature as a discharge criterion for an ambulatory surgical unit has been studied, but results suggest it is not useful in differentiating readiness for discharge.

Oral Temperatures

Studies evaluating measurements from the different areas of the mouth recommend using either the right or left posterior sublingual pocket, as these result in higher recorded temperatures.

Evaluation of the impact of oxygen therapy on oral temperatures have reported contradictory results regarding its statistical significance, however no study reported a clinically significant effect. Similarly, different rates of oxygen flow, from 2 litres to 6 litres per minute, and warmed or cooled inspired gas, were found not to have an influence on oral temperature measurements. Two studies found that rapid respiratory rates had a small influence on oral temperatures, but these results were contradicted by another study that found neither rapid or deep breathing, alone or in combination, had any significant effect on oral temperatures.

Studies have shown that drinking hot or cold water has a significant impact on recorded oral temperatures, and it has been suggested waiting 15 to 20 minutes after drinks to ensure accuracy. Smoking does not change oral temperature measurements.

Researchers have evaluated the time required for mercury thermometers to accurately record the person's oral temperature. One study found that with healthy adults, using a two minute insertion time resulted in 27% of the temperature readings having an error of at least 0.3°C. A study assessing thermometer insertion time in afebrile and febrile adults, suggested a six minute insertion time as a compromise between optimal time and clinical practicality while another recommended a seven minute insertion time to ensure the majority of afebrile and febrile temperatures are correctly recorded. However, a survey of nurses showed that most left the mercury thermometer in the mouth for less than 3 minutes.

Axillary Temperature

There has been only limited research focusing on axillary temperatures. One study evaluated axillary temperature measurements in elderly females, and found great variation between individuals. While the mean axillary temperatures were approximately 36°C, the wide range of temperatures encountered prevented the identification of a single figure that could be considered the "normal" axillary temperature. Another study evaluated the influence of intravenous infusions, via upper limbs of neonates, on axillary temperatures and found there was little significance in terms of the temperature accuracy.

Tympanic Temperature

There has been considerable research addressing tympanic temperature measurements ranging from the influence of infection and cerumen on measurement accuracy, to optimal technique. Studies have evaluated the impact of otitis media on tympanic temperatures and suggest it has little effect. While some studies have reported a statistically significant difference in tympanic temperatures between ears in people with unilateral otitis media, this difference was approximately 0.1°C and so of little clinical importance. The presence of cerumen does influence tympanic temperature readings, and while results are variable, they suggest a significant proportion of the temperature readings taken from the occluded ear will be more than 0.3°C lower than the ear that is not occluded.

Studies evaluating technique suggest an ear tug should be used during the measurement of tympanic temperatures, as this is reported to straighten the external auditory canal. Failure to use the ear tug means infrared thermometers are only partially directed at the tympanic membrane. The tug technique in adults has been described as pulling the pinna (auricle of ear) in an upward and backward direction, and in infants it is pulling the pinna in a backward direction.

Evaluations of the impact of ambient temperatures on tympanic temperatures suggest that while a hot environment can significantly affect readings, cold appears to have little effect.

Cost analyses of the different temperature measurement methods suggest infrared measurements may be the most cost effective despite the greater initial costs. These savings are the result of the rapid reading capabilities of these instruments, and the labour cost savings that result.

Rectal Temperature

Many studies have compared the different methods of temperature measurement, and commonly rectal temperatures are used as the standard comparison. However, these studies will be summarised in a separate systematic review. The most common reported issue related to rectal temperature measurement is that of rectal perforation, which appears to be a risk primarily for the newborn and very young. Other reported complications include peritonitis secondary to rectal perforation, and one case of intra-spinal migration of a rectal thermometer in a two year old, which broke during routine rectal temperature measurement. A ten year review of hospital records identified 16 children admitted to a surgical unit with broken or retained rectal thermometers. In response to this problem axillary temperature measurements have been recommended in preference to the rectal measurements. With the advent of infrared tympanic thermometers, these complications are likely to become less common.

Table Three

Temperature Measurement

The different body areas that have been used for the measurement of body temperature include:

- mouth
- axilla
- tympanic membrane
- rectum
- skin surface
- pulmonary artery
- nose
- groin
- oesophagus
- trachea
- urinary bladder
- urine

A wide range of instruments have been used to measure these temperatures, and include:

- glass mercury thermometer
- electronic thermometer
- pulmonary artery catheter
- endotracheal tube with temperature probe
- urinary catheter with temperature probe
- liquid crystal thermometer strip
- disposable thermometers
- infrared (tympanic) thermometers

Implications For Practice

While much research has been undertaken on specific aspects of patient observations, such as the accuracy of individual measurements, there is little research addressing the broader issues of the most effective and efficient way to monitor patient progress. However, there is a need for clinical areas to determine the role of patient observations within their setting, with particular reference to the four traditional vital sign parameters, to ensure:

1. observations are appropriate as determined by the patient's clinical status;
2. available technologies are utilised appropriately, to complement or even replace less effective methods of patient observation; and
3. inappropriate observations, based on habit rather than need, should be minimised.

Other issues identified during the systematic review that impact on clinical practice include:

1. the term "observations" should be used in preference to "vital signs", as this better reflects the diversity of what may constitute patient monitoring;
2. the rectum should not be the first site of choice for the measurement of temperature;
3. normal vital sign parameters do not guarantee normal physiologic status;
4. education programs will likely be effective in improving health care workers blood pressure measurement technique; and
5. while many factors can have a small influence on the accuracy of vital sign measurements, there may be a cumulative effect, and so organisations should promote a standardised method for all measurements.

Recommendations

Because of the lack of evidence relating to most of the broader issues of patient observation, these recommendations have been generated by the expert panel, and have been rated level IV evidence (expert opinion)

- The specific patient observations, their frequency and duration, should be based on clinical assessment rather than protocol alone.
- Patient observations should be performed as often as indicated by the patient's clinical status.
- Beginner practitioners should validate their clinical assessment with a more experienced practitioner.
- Vital signs should not be used as a way to ensure frequent visits by the nurse.
- When visual checks or inspection of the patient are all that is indicated by the patient's clinical status, this should be an acceptable form of patient observation.
- Health care workers should be trained to perform patient observations in a standardised manner within each institution, and be made aware of the risks and limitations associated with this activity.
- Pulse oximetry should be considered a vital sign in situations where accurate assessment and monitoring is critical.

Other issues of importance noted by the panel of experts include:

- Clinical areas should identify who has responsibility for determining the frequency and nature of patient observations.
- Trends in observations will likely be more important than single measures.
- What happens to the information after it is collected is as important as the accuracy of individual parameters.

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