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Research into practice:

acutely ill children

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INTRODUCTION

Feverish illness is one of the most common reasons for children to consult primary care. Infections account for 40% of all new episodes in general practice, and 29% of all consultations. Childhood infections also continue to have a major impact on secondary care: there has been a 40% increase in the number of children presenting to the emergency department; 14% of children present with febrile illness. Emergency hospital admission rates have increased by 28% from 1999 to 2010, mostly for acute infections. Paradoxically, serious infections have become increasingly rare and are now estimated to constitute <1% of childhood infections presenting to primary care. Serious infections in primary care are dominated by pneumonia, with urinary tract infection in second place, and very few cases now of sepsis, meningitis, or osteomyelitis.

While most children suffer from self-limiting illnesses requiring little medical intervention, prompt recognition of the few children with a serious infection is essential to optimise prognosis. The key priority in primary care is therefore deciding whether a child is unwell enough to need immediate referral to hospital, or, whether they can be managed at home. One reason for the increasing pressure on health services is the difficulty in identifying serious infections, especially in the early stages of the disease when signs and symptoms are unspecific. Up to half of children with meningococcal disease are not identified at first contact.[1]

CLINICAL FEATURES

Symptoms and signs are the first and often only information available to support clinical decision making in primary care. Despite their central role, evidence on their value in primary care settings is surprisingly scarce. Of the 30 diagnostic studies on clinical features for serious infection in children identified in a systematic review, only a single study (of 4000 children in Belgium) was performed in primary care.[2] Given that initial assessment of children also occurs over the telephone, there is also very little research on how accurate such triage is.

Parental concern that the illness is different is a powerful predictor of serious infections: parental concern is 14 times more likely in children with a serious infection.[3] Yet, in describing children's symptoms and severity, something seems to get 'lost in translation'; for example, a study found that parental report of breathing difficulty was poorly predictive of later diagnosis of serious respiratory infection, and did not correlate with triage nurse findings.[4]

Some clinical features have been shown to be 'red flags', that is, they raise the likelihood of a serious infection when present. When a child presents in primary care with a temperature of ≥40°C, the likelihood of a serious infection increases substantially from <1% to 5%.[3] In addition, classic textbook signs such as cyanosis, poor peripheral circulation, rapid breathing, crackles on auscultation, diminished breath sounds, meningeal irritation, petechial rash, and decreased consciousness are all important red flags for serious infections. The National Institute for Health and Care Excellence (NICE) has incorporated many of these 'red flag' features into their traffic light system for assessing febrile children <5 years of age.[5]

However, no single clinical feature seems to have 'rule out' value, such that the absence of that feature makes a serious infection less likely. Combinations of clinical features may be slightly better at ruling out serious infection. Only one such clinical prediction rule has been developed in primary care, and can largely rule out serious infections when each of the following features are negative: clinician gut feeling, dyspnoea, temperature >39.5°C, and diarrhoea in a child aged 1–2.5 years. This clinical prediction rule has a sensitivity of 97% and a specificity of 87%.[3] Or rather, when the prediction rule is negative (none of the features are present), the likelihood

of a serious infection decreases from 1% to 0%; conversely when at least one feature is present, the likelihood of a serious infection increases to 6%. Other combinations or prediction rules are inferior to this.[6]

Meningococcal disease

Meningococcal disease has a mortality rate of 9–12%, making it one of the most lethal infections in childhood.[7] This fast-moving disease illustrates that serious infections are dynamic not static, with different features emerging over time which may or may not be present when a child is evaluated in primary care. For example, early features up until 8 hours after symptom onset are similar to that of self-limiting viral illnesses, such as fever, headache, coryza and sore throat.[1] Typical pathognomonic signs such as neck stiffness, bulging fontanelle, rash, seizures or unconsciousness only develop after 13–16 hours, at which point the disease has already progressed substantially. In addition, these features only occur in a minority of children with meningococcal disease. Additional features such as leg pain, cold hands and feet, and abnormal skin colour occur earlier in the course of illness and in a larger proportion of children, making them potentially more important than the classic signs which are rare and occur only late. However, cold hands and feet and pallor are of limited diagnostic value to distinguish between minor infections and meningococcal infections, because they are also present in a substantial number of children with minor febrile infections.[8]

Pneumonia

Pneumonia is the most common serious infection in children, representing approximately 80% of all cases of serious infections.

In an emergency department, pneumonia becomes more likely when the child appears ill, has an increased breathing rate, decreased oxygen saturation and increased C-reactive protein (CRP) levels.[9] The relevance of this prediction rule for primary care is uncertain as oxygen saturation and CRP are not routinely available in general practice, although the introduction of point-of-care tests may change this. The only prediction rule that has been developed in primary care consists of two clinical features, shortness of breath and clinician gut feeling[3] and has been tested in two independent cohorts.[10] The results show that when both features are absent, the risk of pneumonia requiring hospital admission decreases substantially (negative likelihood ratio ranges from 0.14 to 0.18). A large study funded by the NIHR is currently underway that will provide new information on the best rule in/out clinical features.[11]

HEART AND BREATHING RATE

Children with confirmed serious infections in secondary care settings typically have faster heart rates and breathing rates. Indeed, NICE recommends measuring heart and breathing rate in each feverish child[5] and cites age-dependent cut-offs for tachycardia and tachypnoea. However, a recent systematic review collating all available evidence on normal ranges for heart and breathing rate questioned these thresholds of 'what constitutes a normal value'.[12] For example, a heart rate of 140 beats/min in a 5-year old child as recommended by NICE as the cut-off for tachycardia is well above the 99th percentile, (99th percentile = 131 beats/min) suggesting that the NICE cut-off might lead to misclassifying tachycardic children as normal. Conversely, a breathing rate of 50 breaths/min in a child aged 6 months corresponds with the 75th percentile, suggesting that an overly large proportion of normal children would be wrongly classified as tachypnoeic. This is even more important in feverish children as research indicates that heart rate increases by about 10 beats/min[13] and breathing rates by 2 breaths/min[14] for every increase in body temperature with 1°C.

GUT FEELING

A clinician's feeling that 'something is wrong', also referred to as a gut feeling, has been found to be a specific marker of serious infection.[3] Whenever this feeling is present, the likelihood of a serious infection increases 10-fold, from <1% to 11% in a primary care setting. Its diagnostic value is consistent in children of all ages and is independent of the child's specific diagnosis or presence of fever.[15] Gut feeling is also a stronger red flag than clinical impression, probably because gut feeling is triggered not only by clinical features but also by contextual factors such as parental concern that the illness is different from previous illnesses. Especially in primary care where GPs may have a longstanding relation with their patients, such extra-clinical information provides doctors with an additional diagnostic tool.

BLOOD TESTS

In primary care, blood tests play only a marginal role in the diagnostic process of acutely ill children, mostly because decisions need to be taken before the result comes back from the laboratory. Point-of-

care tests allow results to become available within the timeframe of a single consultation, making them potentially useful for referral decisions or antibiotic prescribing.

Limited evidence on the value of laboratory tests in the ambulatory setting is available, none of which was obtained in primary care. Nonetheless, the evidence does suggest that CRP and procalcitonin provide the most diagnostic value, with CRP levels <20 mg/L and procalcitonin levels <0.5 ng/mL ruling out serious infections.[16]

SAFETY NETTING

The dynamic nature of infections emerging over hours or days with a varying constellation of symptoms means that some children with a serious infection will not be identified at first contact. This is especially important in children presenting early in the course of illness at which point no specific signs may have developed. Safety netting is an integral part of the diagnostic process, to deal with residual uncertainty when either the diagnosis is uncertain, complications of a certain diagnosis may occur, or the patient is at higher risk for developing complications.[17] GPs often provide advice on which symptoms parents should look for, where to go for further help, and expected illness trajectory.[18]

But, we don't know whether verbal advice, or patient leaflets, or new forms of communication or social media have the most impact, and what parents would find most useful.

CONCLUSION

The assessment of acutely ill children in primary care should focus on identifying children who can be safely managed in the community, and research in this area is catching up with what GPs need to inform their practice. Diagnostic tests can assist in this process in two ways: either a test is a useful red flag making a serious infection more likely when present (but not making it less likely when absent), or a test is able to rule out a serious infection when negative. Clinical features with high red flag value include classic signs such as neck stiffness or increased breathing rate. Ruling out serious infections requires a combination of clinical features. Laboratory tests such as CRP may be potentially useful but primary care evidence in children is currently lacking.

Although children are getting healthier, acute infections will remain common (although largely not serious) leading parents to inevitably worry about their child, and this perennial concern drives much of the continuing rise in attendances and admissions. The research that is needed now to further inform parents, NHS telephone advice, triage, and face to-face assessment needs to be based in primary care, and evaluate clinical features, laboratory tests, and safety netting, taking into account other diagnostic information such as contextual factors.

Provenance

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Competing interests

The authors have declared no competing interests.

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