

# Are routine investigations in acute paediatric admissions justified?

David Pace, Valerie Said Conti, Simon Attard Montalto

## Abstract:

**Aim:** To assess the appropriateness of investigations and their impact on management of acute paediatric admissions.

**Method:** All investigations performed within the first six hours in all consecutive paediatric admissions ( $n=138$ ) over a 6 week period, in a teaching general hospital, were recorded retrospectively and the results were analysed for normality/abnormality and effect on patient management.

**Results:** Out of a total of 480 emergency investigations performed on 89 patients, the complete blood count, electrolytes and chest X-rays were the three investigations most likely to be deranged and influenced management in 5% ( $n=3$ ), 25% ( $n=8$ ) and 46% ( $n=6$ ) of subjects with an abnormal result, respectively. Impact on management was more evident on analysing a subgroup admitted with mild gastroenteritis, in whom serum electrolytes were abnormal in 50% ( $n=19$ ), and 42% ( $n=8$ ) of these needed a change in their management.

**Conclusion:** Rationalising the number of investigations in acute paediatric admissions would result in less discomfort to children and in a significant cost benefit.

## Key words

Acute admissions, gastroenteritis, paediatrics, routine investigations

**Simon Attard Montalto\*** MD, FRCPCH  
Department of Paediatrics, St Luke's Hospital,  
Guardamangia, Malta  
Email: simon.attard-montalto@gov.mt

**David Pace** MD, MRCPCH  
Department of Paediatrics, St Luke's Hospital,  
Guardamangia, Malta

**Valerie Said Conti** MD, MRCP  
Department of Paediatrics, St Luke's Hospital,  
Guardamangia, Malta

\* corresponding author

## Introduction

More than 90% of children admitted to our general hospital have an acute medical condition, and are investigated using the emergency laboratory services. The choice of investigations for some disorders is guided by protocols, that have been formulated on internationally accepted recommendations, and which are readily available to paediatric staff. Those admissions whose work up is not guided by a protocol are managed according to the clinical judgment of the admitting paediatrician, a practice that may lead to an appropriate or inappropriate number of investigations. Under investigation may result in a missed/wrong diagnosis and over investigation may upset the child unnecessarily and results in misuse of resources. This retrospective observational study was set up with the specific aim of auditing the number and type of acute investigations in the paediatric age-group, their impact on management and use of health care resources.

## Methods

The case notes of all children ( $n=153$ ) admitted consecutively over a period of six weeks (July to August 2000) to two general paediatric wards were retrieved. Children who were: a) admitted to the medical ward because of lack of space on the paediatric surgical ward ( $n=7$ ), b) transferred from the neonatal/paediatric intensive care unit ( $n=2$ ), and c) admitted for planned day-case management were not included in the study ( $n=6$ ), since these children were not suffering from an acute medical condition. In order to ascertain that the admissions included during the study period were representative of the general workload of the unit, the study cohort was compared with the total number and diagnostic spread of admissions for the whole year.<sup>1</sup>

The following data was recorded: age, sex, clinical signs, diagnosis, investigations and results, management and change in management. The results of the investigations were compared with accepted normal values according to age and standard references.<sup>2,3</sup> Change in management was documented whenever a result had an impact on the treatment of the child. Those patients who were investigated according to the hospital protocols were excluded from the study. Protocols were available for the management of urinary tract infections, seizures, diabetic ketoacidosis, visceral leishmaniasis, febrile neutropenia and poisoning. The rest of the subjects were included in the study group which was also subdivided into smaller subgroups according to diagnosis.

## Statistical analysis

The percentage of abnormal results was calculated for the investigations performed on all the subjects as well as for any subgroup with sufficient numbers. The impact of any abnormal result on subsequent management was analysed and compared between one investigation and another, using chi-squared analysis. Yates correction (Y) or Fisher's Exact (FE) test was applied when comparing small numbers. A *p* value of <0.05 was taken to represent statistical significance.

## Results

During the six week study period there were 138 eligible admissions of which 16 were excluded since their management was guided by established hospital protocols. Of the remaining 122 subjects, data was incomplete in 4, leaving a total of 118 that were included in the study group. The diagnostic spread, mean age and gender distribution of the subjects in the study group was compared with the total number of paediatric admissions (*n*=3149) for the whole year (1 January 2000 to 31 December 2000).<sup>1</sup> On analysis, the relative percentages of all these parameters were not significantly different in the group over the six week study period and all patients admitted over twelve months. However, significance may not have been achieved due to the relatively small number in the study group.

## Study group

A total of 118 children were recruited. Of these, 67 were males and 51 females and their ages varied from 3 days to 13 years (mean 4.3 years). Whereas 29 children did not require any investigations, a total of 480 investigations were carried out in the remaining 89 children. This group was analysed as (a) a whole and (b) by subspeciality if numbers were sufficiently large.

### a. Total cohort

As shown in table 1, the following investigations were most frequently carried out: electrolytes in 81% of cases, complete blood count (CBC) in 79%, serum creatinine in 72%, urea in 68%, blood glucose in 50%, blood cultures in 31%, chest X-ray in 29% and stool cultures in 21%. Considerable variations were observed in the percentage of abnormal results. CBC was abnormal in 77% (54/70), serum electrolytes in 44% (32/72), urea in 5% (3/61) and blood glucose in 9% (4/45). There were no abnormal results for serum creatinine (0/64). Micro-organisms were identified from blood cultures in 25% (7/28), of which only one was clinically significant (1/28 = 4%), urine cultures in 27% (4/15) and stool cultures in 16% (3/19). Chest X-rays were found to be abnormal in 50% (13/26).

### The effect of abnormal results on management

Most of the abnormalities in the CBC amounted to very minor deviations from the normal range for haemoglobin. Management was only influenced in 5% (Table 1), who were coincidentally found to have a low haemoglobin concentration and were subsequently investigated for iron deficiency or

for  $\beta$  thalassaemia trait. In contrast, serum electrolytes were abnormal in 44% (Table 1) but, of these, management was altered in 25% (8/32). Alterations in management included the addition of potassium supplements or a change in the sodium content of the intravenous fluid. Similarly, although chest X-rays were carried out in a relatively small number of patients, the image was reported as abnormal by the admitting doctor in 50%

**Table 1: Investigations carried out in the Study Group\***

Investigation	Total N	Abnormal result		Change in management	
		N	%	N	%
<b>Haematology</b>					
Complete blood count	70	54	77	3	5
Blood picture	5	4	80	0	0
APTT	1	0	0	0	0
INR	1	0	0	0	0
<b>Biochemistry</b>					
Urea	61	3	5	0	0
Electrolytes	72	32	44	8	25
Creatinine	64	0	0	0	0
Random glucose	45	4	9	0	0
Liver function tests	4	1	25	0	0
Direct bilirubin	1	0	0	0	0
Amylase	1	1	100	0	0
VBG	2	0	0	0	0
Complement, C3, C4	1	1	100	0	0
CSF biochemistry	3	0	0	0	0
Urinalysis and microscopy	17	7	41	0	0
<b>Microbiology</b>					
Blood cultures	28	7	25	0	0
Urine C&S	15	4	27	0	0
Stool C&S	19	3	16	0	0
Stool rotavirus	9	2	22	0	0
CSF C&S	3	0	0	0	0
CRP	9	1	11	0	0
ESR	3	2	67	0	0
EBV antibodies	4	0	0	0	0
Mycoplasma IgM	9	3	33	0	0
TORCH	1	0	0	0	0
ASOT	1	0	0	0	0
<b>Imaging/other</b>					
Chest X-ray	26	13	50	6	46
X-ray lower limb	1	0	0	0	0
ECG	1	0	0	0	0
CSF cytology	3	1	33	1	100
<b>Total</b>	<b>480</b>	<b>143</b>		<b>18</b>	

\*Total number of subjects=89

N: number of subjects

APTT=Activated Partial Thromboplastin Time;

ASOT=Antistreptolysin O titre; C&S=Culture and Sensitivities;

CRP=C-Reactive Protein; CSF=Cerebrospinal fluid; EBV=Epstein

Barr Virus; ECG=Electrocardiogram; ESR=Erythrocyte

Sedimentation Rate; IgM=Immunoglobulin M; INR=International

Normalised Ratio; TORCH=Toxoplasma, Rubella,

Cytomegalovirus, Hepatitis antibodies; VBG=Venous Blood Gases

and influenced the initiation of antibiotics in those with a lower respiratory tract infection in 46% (6/13). Abnormal electrolyte results were more likely to result in a change in treatment than abnormal CBC values ( $\chi^2$  (FE)=5.1,  $p<0.05$ ).

### b. Subgroups within the study group

The whole study cohort was broken down into different diagnostic categories, namely gastroenteritis, asthma, upper and lower respiratory tract infections, other infections, feeding problems, cardiac problems and miscellaneous diagnoses. Only the subgroup of children admitted with gastroenteritis was sufficiently large to allow further analysis. Out of a total of 45 children (25 males and 20 females, aged between 5 months and 12 years, with a mean age of 4.8 years) admitted with acute gastroenteritis, all had mild to moderate dehydration (3-5%)<sup>4</sup>, and 38 underwent urgent investigations (Table 2). Deranged results were seen in 80% (28/35) of the CBC, 50% (19/38) of the serum electrolytes and 5% (2/38) of the serum urea.

### The effect of abnormal results on management

Complete blood counts were more likely to be abnormal than serum electrolytes. However, analysis of these abnormal blood counts revealed that none were clinically significant as the derangements were only slight deviations from the normal range and did not influence any of the patients' management. In contrast, the sodium content of the intravenous fluid (i.e. 5% dextrose in 0.45% saline or 5% dextrose in 0.225% saline or 5% dextrose in 0.18% saline) was changed or potassium supplements were added in 42% (8/19) of the subjects with abnormal electrolytes. The difference in the change in management as a result of deranged electrolytes was statistically significant when compared to the effect on management resulting from deranged CBC results ( $\chi^2$ (FE)=12,  $p<0.001$ ).

### Discussion

The aim of this study was to audit the current practice of acute investigations in children admitted to two general paediatric wards, where there is a tendency for investigations to be taken 'routinely' once intravenous access is established. This study has shown that 75% (89/118) of all acute paediatric admissions undergo some form of investigation. Out of a total of 480 investigations, just 143 (30%) were abnormal and, more importantly, a small minority of just 18 (4%) had any bearing on the acute management of the child. The complete blood count and electrolyte assay were the two investigations most commonly requested. Whilst the CBC was noted to be frequently deranged, the abnormalities were only minor deviations in haemoglobin, white cell or platelet counts and were almost totally ignored when it came to influencing management. In contrast, serum electrolytes were abnormal in 44% (32/72) of subjects but, of these, management was altered in 25% (8/32). Incidentally these 8 subjects all suffered from gastroenteritis and were the same 8 children who made up 42% of the children in the gastroenteritis subgroup (8/19) in whom management was altered as a result of abnormal electrolytes. Similarly, chest X-rays were abnormal

in half of the cases investigated and affected the initiation of antibiotics in 46% (the number of abnormal chest X-rays could have possibly been overestimated as these were not reported by a radiologist). Although 22% of the 101 microbiological tests taken were abnormal, almost all of these results were available more than 24 hours after admission and, as a result, few had a bearing on the *immediate* acute management of the patient. However, microbiological investigations are still essential in the management of infections as they might influence the *subsequent* management of the infected child and will be required for Public Health surveillance.

This study allowed for a detailed assessment of those admitted with gastroenteritis with approximately 3-5% dehydration<sup>4</sup>. At present, children admitted to our hospital with this diagnosis and in whom an intravenous infusion is set up, are 'routinely' investigated by means of a CBC, urea, electrolytes and creatinine. This study has shown that, in these patients, serum electrolytes affected management in 42% of patients. This observation is similar, if not more pronounced, when compared with similar studies<sup>5,6</sup> and systematic reviews on the management of gastroenteritis in children.<sup>7-9</sup> Moreover, the findings in this study are consistent with guidelines recommended by the American Academy of Paediatrics in justifying routine serum electrolytes in children with mild/moderate gastroenteritis in whom intravenous fluids are commenced, particularly to identify problems with hypernatraemia.<sup>7,8,10,11</sup> This position would not be that dissimilar, though may support rather more intervention, when compared with guidelines issued by the Royal College of Paediatrics and Child Health.<sup>12</sup> In contrast, although many CBC results were marginally 'abnormal', this investigation had virtually no bearing on acute management. Similarly, serum urea and creatinine results were rarely or never abnormal and neither was instrumental in management. Hence, this study

**Table 2:** Investigations carried out in children admitted with gastroenteritis\*

Investigation	Total	Abnormal result		Change in management	
		N	%	N	%
Urea	38	2	0	0	0
Electrolytes	38	19	8	0	0
Complete blood count	35	28	0	0	0
Creatinine	33	0	0	0	0
Random blood glucose	24	3	0	0	0
Stool rotavirus	9	2	0	0	0
Stool culture	18	3	0	0	0
Urinalysis & microscopy	2	1	0	0	0
Urine culture	1	1	0	0	0
Blood cultures	4	1	0	0	0
<b>Total</b>	<b>202</b>	<b>60</b>	<b>8</b>		

\* Out of a total of 45 children admitted with gastroenteritis, 38 underwent urgent investigations

**Table 3:** Cost saving for subgroup with gastroenteritis

<b>Investigation</b>	<b>Cost per emergency test (Lm)</b>	<b>Number of investigations in 45 subjects</b>	<b>Cost saving (Lm)</b>	<b>Projected saving per annum (all admissions with gastroenteritis*) (Lm)</b>
Complete blood count	5.50	35	193	1283
Urea	4.50	38	171	1140
Creatinine	4.50	33	149	990
Random blood glucose	4.50	24	108	720
Total	-	135	621	4,133

Lm: Malta liri

\*: Number of children admitted with gastroenteritis amounts to 300 per year

Note: Cost of emergency tests obtained from Billing Section, St. Luke's Hospital, Malta. All totals may be reduced by 25% if investigative tests are costed as non-urgent rather than urgent/emergency investigations.

would strongly support the argument that the routine request for CBC, urea and creatinine in this subgroup of patients is totally unnecessary. A restriction of routine investigations to just electrolytes alone, in those with gastroenteritis with 3-5% dehydration, would have resulted in a cost saving of Lm621 in this particular cohort of patients (table 3) and, given approximately 300 patients with gastroenteritis per year, would translate into a saving of approximately Lm4,130 per annum. By limiting investigations to only those which are likely to have an influence on patient management would result in a much higher overall cost saving for the entire study group.

Hospital protocols help in standardising the management of diseases and guide doctors to carry out only the necessary blood investigations. Although automated blood analysers perform multiple tests on single blood specimens, even on small volume capillary samples, the process of blood extraction remains a cause of too much distress in children. Pain at the site of needle puncture may be reduced by the application of a local anaesthetic and distraction procedures may help in reducing distress<sup>13</sup>, however on many occasions blood sampling is still emotionally traumatic to children. Limiting the number of blood investigations to only those which are really necessary, might help in alleviating some of the associated psychological distress.

## Conclusion

Although the number of subjects included in our observational retrospective study was small and biased by the lack of a control group, several important points can be observed. For those conditions without a designated protocol, routine investigations are often inappropriate and unnecessary. Many of these investigations, although marginally abnormal, have no bearing whatsoever on patient management. This study would support routine electrolytes alone in children with mild/moderate gastroenteritis but all the other tests should only be carried out on the basis of a specific clinical indication and not simply 'routinely.' Altering practice as a result of evidence-based audit would result in a significant cost saving for the unit in our hospital and, similarly, in those hospitals with a comparable acute paediatric practice.

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