Original articles

Analysis of blood tests in the emergency department of a tertiary care hospital

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Summary

There is ample evidence that many investigations sent from the accident and emergency department are inappropriate, thus affecting the quality of patient care. A study was designed to address this issue in the emergency department of a tertiary care hospital of a large city. A prospective cross-sectional study was carried out during the 3-month period 1 December 1996 to 28 February 1997. A set of guidelines was used to assess the appropriateness of different blood tests for the initial assessment of the patients presenting with common clinical conditions, although any investigation could be done if considered important for patient management. All other blood tests were considered inappropriate. A total of 6401 patients were seen in the emergency department and 14 300 blood tests were done on 3529 patients with diagnoses covered by the guidelines. Of these 62.2% were found to be inappropriate. Of the total 22 655 investigations done on all the 6401 patients seen, only 3.8% influenced the diagnosis, 3.0% influenced patient care in the emergency department, and 4.0% influenced the decision to admit or not. Amylase and arterial blood gases were found to be the most appropriate investigations. Analysis of reasons for unnecessary use of emergency tests suggested that improving supervision, decreasing the utilization of the emergency department as a phlebotomy service for the hospital, and abolition of routine blood tests would help to improve patient care.

Keywords: blood tests; accident and emergency medicine

With advances in the scope and accuracy of laboratory investigations, the importance of misuse of these tests has also been felt. Evidence suggests that many investigations requested from the accident and emergency department are inappropriate.[1–11] This practice has led to decreased utilization of the basic skills of history taking and physical examination. It affects the quality of patient care as 'quality' is meeting the needs and expectations of those whom we serve, most efficiently, with a minimum of waste. The most stringent criterion for appropriateness is "Did the test make any difference to the management of the patient?".[1] Inappropriate uses of laboratory services impose a burden not only on the patient but also on the healthcare system as a whole. Standards of care have been promul-

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Guideline for the use of blood tests in the ER for initial assessment of patients

Ischaemic chest pain: usually no blood tests are appropriate. Myoglobin and CK for follow-up
Arrhythmias: BUN and creatinine; electrolytes
Heart failure: arterial blood gases; BUN and creatinine; electrolytes
Cardiac arrest: arterial blood gases; creatinine and electrolytes in the post-resuscitation phase
Acute asthma: arterial blood gases, TLC and DLC
Chronic obstructive pulmonary disease: arterial blood gases, TLC and DLC.
Upper GI bleeding: CBC, blood group and crossmatch; clotting studies (PT and APTT)
Lower GI bleeding: CBC, blood group and crossmatch, clotting studies (PT and APTT)
Gastroenteritis: CBC, stool D/R. If greater than 24 hours: BUN and creatinine, electrolytes
Hypoglycaemia: RBS, BUN and creatinine, electrolytes.
Diabetic ketoacidosis: RBS, arterial blood gases, BUN and creatinine, electrolytes. WBC in selected cases.
Hyperosmolar nonketotic coma: RBS, arterial blood gases, BUN and creatinine, electrolytes. WBC in selected cases.
Acute febrile illness: less than 3 days duration: CBC and malarial parasite; more than 3 days duration: add blood culture and sensitivity
Drug overdose: drug levels, occasionally RBS, BUN and creatinine, electrolytes.
Poly trauma: CBC, blood group and crossmatch
Single trauma: CBC, blood group and crossmatch in selected cases.
Acid peptic disease, pancreatitis, perforation and non-specific abdominal pain: CBC, amylase. BUN and creatinine and electrolytes if significant vomiting and diarrhoea
Per-vaginal bleeding: blood group and crossmatch. Beta-human chorionic gonadotropin in selected cases

Other blood tests may be appropriate for the acute management of a patient but should be focused on the clinical needs of the individual

Abbreviations: CK, creatine kinase; BUN, blood urea nitrogen; TLC, total leucocyte count; DLC, differential leucocyte count; GI, gastrointestinal, CBC, complete blood count; PT, prothrombin time; APTT, activated partial thromboplastin time; D/R, detailed report; RBS, random blood sugar

Box 1

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Information recorded each time a blood test was requested

1 Type of test(s) undertaken and its clinical indication
2 Provisional diagnosis prior to the samples being taken
3 Did the results of the test(s) fulfill the following criteria (per test):
  • help achieve the final diagnosis?
  • influence the decision to admit the patient?
  • change the ER management?
4 The patient's final diagnosis on leaving the ER after the results of the tests were known
5 Was the patient admitted to the hospital? Yes/No
6 If the patient was admitted, under which specialty?

Box 2

gated for specific clinical situations, in the hope of eliminating unnecessary laboratory testing and decreasing the use of tests with low yield, without compromising patient care.[1–11] Data are lacking on this issue from our part of the world, and a study in the Emergency Room (ER) of our hospital, a tertiary care centre catering for the population of a large city in a developing country, was conducted to address this problem.

Methods

The Aga Khan University Hospital Karachi is a tertiary care referral centre. The Emergency Department of the hospital has an average of 35 000 patient visits a year. A prospective cross-sectional study was designed to assess the use of laboratory investigations for patients seen in the ER. During the period 1 December 1996 to 28 February 1997, all patients above the age of 14 years (the cut-off point used in the hospital for pediatric patients) were included in the study. Guidelines were used as a tool to determine the appropriateness of investigations, as used in other studies.[1 2] A Guideline was written (adapted from the study done by Pennycook[2]), which outlined the appropriate tests required for the initial assessment of patients with the most common clinical conditions seen in the ER, although it was permitted to do any test if important for patient management. The Guideline (box 1) was discussed with the ER physicians, who remained the same during the period of the study. Any other investigation for the listed common clinical conditions was considered inappropriate. A questionnaire, designed to address the hypothesis that most investigations carried out in an emergency department for the initial assessment of patient are inappropriate and do not affect patient care, (box 2) was completed by the primary physician responsible for the patient's care in the ER. The data were entered in SPSS for Windows version 7.5 and Microsoft Excel version 97, and analysed.

Results

During the period 1 December 1996 to 28 February 1997, 6401 patients were seen in the emergency department. Out of these, 4006 were sent home, 2317 were admitted, and 78

Table 1 Systemic distribution of clinical problems in medicine and allied specialties

Diagnosis according to system	*Diagnosis*	*Patients seen*	*Patients admitted*	*Patients discharged*
Cardiovascular	Ischaemic chest pain	570	570	None
	Atypical chest pain	290	60	230
	Heart failure	90	87	3
	Arrhythmia	60	10	50
	Hypertension	40	10	30
	Cardiac arrest	88	10	none
Respiratory	Acute asthma	180	40	140
	COPD	135	55	80
	Pleuritic pain	90	60	30
Neurological	Motor weakness	355	180	175
	Seizures	63	26	37
	Vertigo, dizziness, syncope	105	12	93
	Headache	180	20	160
Gastrointestinal and hepatic	Acid peptic disease	300	10	290
	Upper GI bleed	75	75	None
	Gastroenteritis	384	24	360
	Hepatitis	30	2	28
	Hepatic encephalopathy	62	48	14
Diabetes	Hypoglycaemia	62	60	None
	Ketoacidosis	12	12	None
	Hyperosmolar nonketotic coma	28	28	None
Infections	Acute febrile illness	520	44	476
	Gross sepsis (multi-organ failure)	40	40	40
Electrolyte imbalance	Hyponatraemia	138	106	32
	Hypernatraemia	10	10	10
	Hypokalaemia	60	30	30
	Hyperkalaemia	32	28	4
Metabolic	Uraemia	24	20	4
	Hypercalcaemia	4	4	None
Haematology/oncology		270	190	80
Drug overdose		180	8	172
Psychiatry		180	10	170
Miscellaneous	Anaphylaxis, stings, urticaria	65	10	55
	Arthralgias	30	None	30

Table 2 Systemic distribution of clinical problems in surgery and allied specialties

Diagnosis according to system	Diagnosis	Patients seen (n)	Patients admitted (n)	Patients discharged (n)
Trauma	Major/poly trauma	40	40	None
	Isolated/single trauma	365	40	325
Acute abdomen	Pancreatitis	15	15	None
	Perforation	25	25	None
	Non-specific	85	60	25
Urology	Renal/ureteric colic	190	15	175
	Haematuria	34	4	30
Superficial wounds		120	None	120
Cutaneous	Infections	20	12	8
	Abscesses	40	4	36
Per-vaginal bleeding		290	180	110
Spine	Cervical spondylosis	60	3	57
	Backache	90	8	82
Miscellaneous	Lower GI bleed	25	5	20
	Bites	40	None	40
	Burns	30	3	27
	ENT	105	3	102
	Eye	45	1	44
	Dental	30	None	30

Figure 1 Number of appropriate investigations according to the Guidelines for the assessment of common clinical conditions (*n*=3529).
Key: 1 ischaemic chest pain, 2 arrhythmia, 3 heart failure, 4 cardiac arrest, 5 acute asthma, 6 chronic obstructive pulmonary disease, 7 upper GI bleed, 8 lower GI bleed, 9 gastro-enteritis, 10 hypoglycaemia, 11 diabetic keto-acidosis, 12 hyperosmolar nonketotic coma, 13 acute febrile illness, 14 drug overdose, 15 poly trauma, 16 single trauma, 17 acid peptic disease, 18 pancreatitis, 19 perforation, 20 non-specific abdominal pain, 21 per vaginal bleeding

died. The total numbers of female patients were 2944 (46%). The patient population was divided into two groups, Medicine and allied (table 1) and Surgery and allied (table 2). Table 3 lists the investigations done and the appropriateness of these tests for diagnosis according to the guidelines. Figure 1 is a representation of the results of table 3.
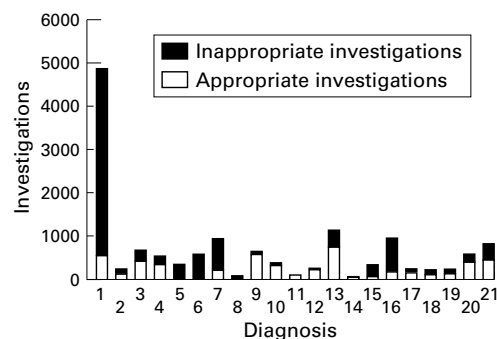
DIAGNOSIS AND INVESTIGATIONS
In total, 14 300 investigations were done on the 3529 patients with one of the clinical conditions covered by the guidelines. Of these, only 37.8% were appropriate.

Ischaemic heart disease was the most common clinical problem seen in the ER. The highest number of inappropriate investigations was associated with acute asthma and chronic obstructive pulmonary disease. Ischaemic chest pain, upper and lower gastrointestinal bleed, poly trauma and single trauma had more than 75% inappropriate investigations. Diabetic keto-acidosis was the diagnosis with the highest number of appropriate investiga-

tions. Hyperosmolar non-ketotic coma, gastro-enteritis, hypoglycaemia and drug overdose had more than 75% of appropriate investigations.

Table 4 presents the usefulness of different investigations done on all the patients seen in the ER. These results are presented schematically in figure 2.

Total investigations done
In total, 22 655 investigations were done. The most common investigation was serum electrolytes, which influenced the diagnosis in only 2.7% of cases and influenced the management of only 2.6% of patients in the ER.

Investigations that influenced diagnosis
Amylase (53.0%) was found to be most helpful investigation while clotting studies, blood cross-match and cardiac enzymes (0% each) were not helpful in influencing the diagnosis. With the exception of arterial blood gases (18.8%), all other investigations were helpful in less than 10% of patients.

Investigations that changed patient care
The results were similar to those that influenced diagnosis except that arterial blood gases were as useful as amylase estimations (53.0%).

Investigations that influenced the decision to admit
The results were similar to those that influenced diagnosis except that cardiac enzymes helped in making a decision to admit 19.6% of patients.

Discussion

These results show that 62.2% of the 14 300 investigations done on 3529 patients seen in the ER with one of the diagnoses covered by the Guidelines were inappropriate for the ini-

Table 3 Percentage of appropriate investigations according to the Guidelines for the initial assessment of 3529 patients evaluated for common clinical conditions

Diagnosis (n)	Total investigations (n)	Inappropriate investigations (%)	Appropriate investigations (%)
Ischaemic chest pain (570)	4852	88.2	11.8
Arrhythmia (60)	246	43.0	57.0
Heart failure (90)	680	35.8	64.2
Cardiac arrest (88)	540	33.3	66.7
Acute asthma (180)	339	95.6	4.4
COPD (135)	579	95.3	4.7
Upper GI bleed (75)	945	76.2	23.8
Lower GI bleed (25)	78	83.3	16.7
Gastroenteritis (384)	648	8.31	91.7
Hypoglycaemia (62)	394	15.2	84.8
Diabetic keto-acidosis (12)	110	1.8	98.2
Hyperosmolar nonketotic coma (28)	256	7.0	93.0
Acute febrile illness (520)	1143	33.1	66.9
Drug overdose (180)	56	25.0	75.0
Poly trauma (40)	346	77.0	23.0
Single trauma (365)	969	82.5	17.5
Acid peptic disease (300)	250	36.8	63.2
Pancreatitis (15)	219	48.0	52.0
Perforation (25)	238	39.1	60.9
Non-specific abdominal pain (85)	588	29.6	70.4
Per-vaginal bleeding (290)	824	44.4	55.6
Total	14 300	62.2	37.8

Table 4 Influence of investigations on diagnosis and patient management (*n*=6401). Percentages in parentheses

Investigation	Number of investigations	Number of investigations which influenced the diagnosis	Number of investigations which changed patient care in ER	Number of investigations which influenced the decision to admit or not
Full blood count	3348	261 (7.8)	118 (3.5)	226 (6.8)
BUN and creatinine	5504	42 (0.8)	16 (0.3)	20 (0.4)
Electrolytes	6829	181 (2.7)	178 (2.6)	234 (3.4)
Liver function tests	1413	30 (2.1)	0	2 (0.1)
Cardiac enzymes	908	0	0	178 (19.6)
Clotting studies	927	0	0	0
Cross match	360	0	28 (7.8)	0
Blood glucose	2880	217 (7.5)	102 (3.5)	100 (3.5)
Amylase	189	78 (53.0)	100 (53.0)	65 (34.4)
Arterial blood gases	297	56 (18.8)	142 (53.0)	86 (29.0)
Total	22 655	865 (3.8)	684 (3.0)	911 (4.0)
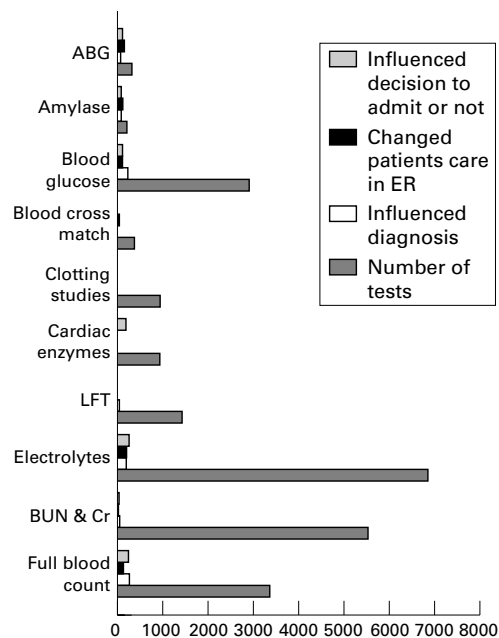
Figure 2 Influence of ER investigations on patient management (*n*=6401). ABG: arterial blood gases; LFT: liver function tests; BUN & Cr: blood urea nitrogen and creatinine

tial assessment of the patient. This is in concordance with the literature.[1–11] Of the total 22 655 investigations done on all the 6401 patients seen in the ER, only 3.8% influenced diagnosis, 3.0% influenced patient care in the ER and 4.0% influenced the decision to admit or not. This is much lower than the results seen in other studies.[2 3] This may be due to the in-patient clinical setting of the other studies. Sandler[2] in his study has concluded that less than a third of the investigations done helped in the diagnosis while a third helped in the treatment of patients. Pennycook[2] and Fowkes and co-workers[3] found similar results in their studies. Our results confirmed previous reports which showed amylase and arterial blood gases to be the most useful investigations performed, while the most inappropriate investigation was cardiac enzymes in ischaemic chest pain.[2 4]

The evaluation of the patient with suspected acute myocardial infarction (AMI) remains one of the greatest challenges to ER physicians. Several studies have reported that 1.9–8% of

AMI patients presenting with atypical symptoms may be discharged from the ER.[12] It is unusual for these patients to be discharged with a diagnosis of ischaemic chest pain. As a result, there is much interest in developing a rapid diagnostic tests that can identify AMI patients in the ER. Studies have documented the utility of creatine kinase (CK)-MB, myoglobin or troponin-T levels in the diagnosis of AMI within 2–3 hours of presentation.[13 14] CK-MB has a sensitivity of 90% 3 hours after presentation but is only 50% sensitive when measured at the time of presentation, as it rises to twice the normal level 6 hours post infarction and peaks at about 24 hours. Myoglobin is released more rapidly during AMI. Serum myoglobin levels reach twice normal values within 2 hours and peak within 4 hours post infarction. The measurement of cardiac-specific contractile protein troponin T is superior to CK-MB for the detection of minor myocardial injury. In many patients presenting with chest pain, these cardiac markers are measured in the early hours after the onset of symptoms, not primarily to detect AMI but rather to exclude it.

The large number of investigations found to be inappropriate could be due to a number of different reasons. It may be that the Guidelines were not followed, despite adequate supervision of the ER physicians. The Guidelines were not rigid and, if indicated for the patient, investigations other than those specified were allowed. Such investigations were then entered into the questionnaire as the tests that influenced the treatment of the patient, and hence were analysed as appropriate. The reason for inappropriate investigations could be the ER physicians themselves, but we believe that most of the time it is due to the fact that the ER is utilized as phlebotomy service for the rest of the hospital, as the turnaround time for the results of investigations is less for the ER. These investigations may be considered necessary by an admitting resident or consultant, but not in the initial assessment of patients, as discussed in literature.[1–10] Many of the investigations done in the ER may be more useful in the patient's care as an in-patient or on follow-up. Such investigations should be done in the in-patient facility to decrease the workload on the ER.

Analysis of reasons for unnecessary use of emergency tests suggested that improving supervision, decreasing the utilization of the ER as a phlebotomy service for the hospital, and abolition of routine blood tests would help in improving patient care.

The result of the audit has led to a change in departmental practice. Supervision has been increased and agreement has been reached with other departments to abolish 'routine blood tests'. Tests not included in the Guidelines are directed to the responsible ER physician. There has been a reduction of about 50% of investigations over the past 9 months with no adverse effect on patient care and no negative feedback from in-patient specialties. A further need to assess the importance of radiological procedures for patients seen in the ER has been identified and research work to address the issue is in progress.

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