Impact of a chest-pain guideline on clinical decision-making

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THE EFFECTIVENESS of clinical practice guidelines continues to be debated, with an editorial in the Journal suggesting that "guidelines have only modest effects in practice".[1] However, there is good evidence that guidelines can be effective if they are developed and implemented appropriately.[2] For example, involving the clinicians who will use the guidelines in their development is more likely to promote a sense of ownership and has the greatest chance of changing clinical behaviour.[3]

Two-thirds of patients presenting to emergency departments (EDs) with chest pain are admitted to hospital, with only 15% confirmed to have had an acute myocardial infarction (AMI).[4] Of the patients not admitted, it is estimated that up to 5% have a missed AMI, and that these patients have four times greater mortality than admitted patients.[5] To reduce the risk of missing AMIs while minimising unnecessary hospital admissions, the National Health and Medical Research Council (NHMRC) developed clinical practice guidelines that recommend using risk-stratification algorithms to triage patients with chest pain.[6] The risk-stratification principle is consistent with an emerging focus on the safety of the management strategy rather than establishing a diagnosis.[7,8]

The NHMRC unstable angina guidelines were adapted to local circumstances in southwestern Sydney, New South Wales, by the Coronary Heart Disease Advisory Committee of the South Western Sydney Area Health Service, which included cardiologists, emergency medicine physicians and cardiac nurses. This study aimed to evaluate the effects of introducing this chest-pain guideline on clinical decision-making and on the medium-term outcomes of patients presenting to EDs with chest pain.

ABSTRACT

Objective: To evaluate the impact of a chest-pain guideline on clinical decision-making and medium-term outcomes of patients presenting to a hospital emergency department (ED) with non-traumatic chest pain.

Design: Before-and-after guideline implementation study.

Setting: Bankstown–Lidcombe Hospital, Sydney, NSW (454-bed metropolitan teaching hospital), in the six-month periods before and after guideline implementation in February 2001.

Participants: Patients presenting to the ED with non-traumatic chest pain who had chest-pain assessment forms completed by ED doctors, comprising 422/768 (54.9%) of those presenting before and 461/691 (66.7%) after guideline implementation.

Main outcome measures: Appropriateness of admission/discharge decisions compared with decision of senior cardiologist based on guideline; death, recurrent chest pain, ED re-presentation and hospital readmission in the ensuing three months.

Results: After guideline implementation, appropriate admission/discharge decisions increased significantly from 180/265 (68%) to 261/324 (81%) (difference, 13%; 95% CI, 6%–20%). The largest increase was for patients at moderate risk of death or acute myocardial infarction within six months, from 39/96 (38%) to 57/103 (55%) (difference, 18%; 95% CI, 4%–31%). Increases were seen for both junior doctors (interns and resident medical officers) (18%; 95% CI, 7%–30%) and senior doctors (11%; 95% CI, 2%–19%). Logistic regression showed that implementation of the guideline, seniority of assessing doctor and patient history of coronary disease were independent predictors of appropriate decisions. There was a significant decline in re-presentations to ED with recurrent chest pain in patients previously presenting with cardiac or possibly cardiac pain, from 46/201 (23%) before implementation to 32/247 (13%) after (difference, −10%; 95% CI, −17% to −3%).

Conclusions: The chest-pain guideline resulted in a significant improvement in clinical decision-making in the ED and reduced re-presentations with cardiac/possibly cardiac chest pain.

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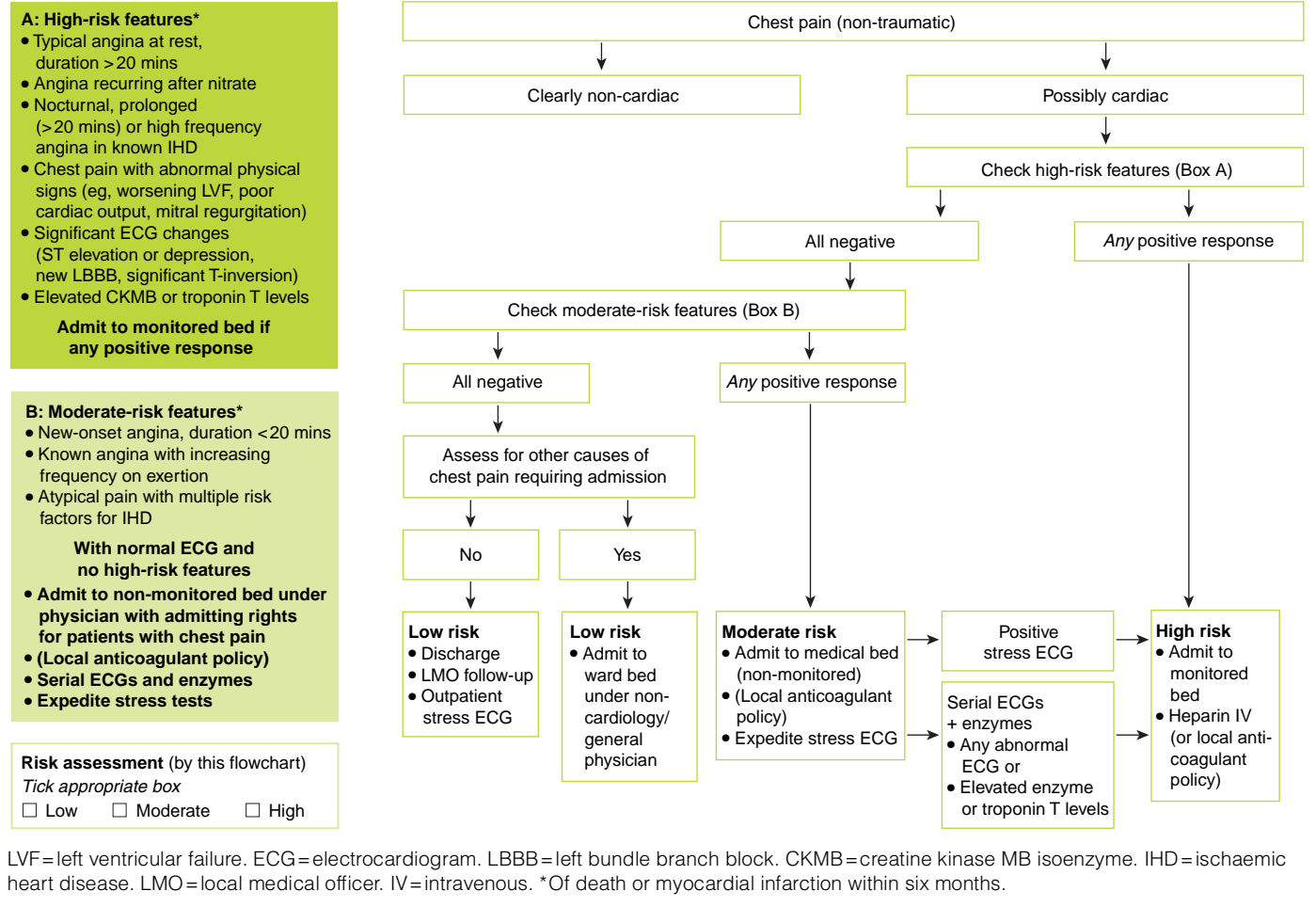**Bankstown–Lidcombe Hospital, Bankstown, NSW.**
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METHODS

This was a study of ED doctors' decisions and patient outcomes in the six months before and after implementation of a chest-pain guideline in early February 2001. The study was undertaken at Bankstown–Lidcombe Hospital, Sydney, New South Wales, a 454-bed metropolitan university teaching

1: South Western Sydney Area Health Service chest pain risk-stratification guideline

A: High-risk features*
- Typical angina at rest, duration >20 mins
- Angina recurring after nitrate
- Nocturnal, prolonged (>20 mins) or high frequency angina in known IHD
- Chest pain with abnormal physical signs (eg, worsening LVF, poor cardiac output, mitral regurgitation)
- Significant ECG changes (ST elevation or depression, new LBBB, significant T-inversion)
- Elevated CKMB or troponin T levels

Admit to monitored bed if any positive response

B: Moderate-risk features*
- New-onset angina, duration <20 mins
- Known angina with increasing frequency on exertion
- Atypical pain with multiple risk factors for IHD

With normal ECG and no high-risk features
- Admit to non-monitored bed under physician with admitting rights for patients with chest pain
- (Local anticoagulant policy)
- Serial ECGs and enzymes
- Expedite stress tests

Risk assessment (by this flowchart)
Tick appropriate box
☐ Low ☐ Moderate ☐ High

Chest pain (non-traumatic)
→ Clearly non-cardiac
→ Possibly cardiac
  → Check high-risk features (Box A)
    → All negative
      → Check moderate-risk features (Box B)
        → All negative
          → Assess for other causes of chest pain requiring admission
            → No
              → **Low risk**
              - Discharge
              - LMO follow-up
              - Outpatient stress ECG
            → Yes
              → **Low risk**
              - Admit to ward bed under non-cardiology/general physician
        → *Any* positive response
          → **Moderate risk**
          - Admit to medical bed (non-monitored)
          - (Local anticoagulant policy)
          - Expedite stress ECG
          → Positive stress ECG
          → Serial ECGs + enzymes
            - Any abnormal ECG or
            - Elevated enzyme or troponin T levels
    → *Any* positive response
      → **High risk**
      - Admit to monitored bed
      - Heparin IV (or local anti-coagulant policy)

LVF = left ventricular failure. ECG = electrocardiogram. LBBB = left bundle branch block. CKMB = creatine kinase MB isoenzyme. IHD = ischaemic heart disease. LMO = local medical officer. IV = intravenous. *Of death or myocardial infarction within six months.

hospital. It was approved by the South Western Sydney Area Health Service Research Ethics Committee.

Pre-implementation phase

All ED staff (doctors, nurses and clerks), cardiology staff (junior and senior doctors) and other hospital doctors who might work in the ED were informed about the objectives of the study by the medical ED and cardiology directors.

To assess decision-making by ED doctors, all doctors working in the ED were asked to complete a one-page chest-pain assessment form for all patients who presented to the ED with non-traumatic chest pain, beginning in September 2000. The form was attached to the ED medical record and was to be completed by the ED doctor who initially saw the patient. It asked about features of the chest pain, cardiac risk factors, physical findings, electrocardiogram changes, diagnostic tests performed, diagnosis made (non-cardiac pain, possibly cardiac pain, or cardiac pain, subdivided into angina, unstable angina or acute myocardial infarction), admission destination, and seniority of the doctor who made the management decisions. Interns and resident medical officers were classified as "junior staff", and registrars, career medical officers and specialists as "senior staff".

Guideline implementation

The chest-pain guideline introduced into the ED and cardiology departments comprised a one-page risk-stratification flow chart defining groups at "high", "medium" and "low" risk for death or myocardial infarction within six months, with admission/discharge recommendations (Box 1). During the post-implementation phase (mid-February to August 2001), this flow chart was printed on the reverse of the chest-pain assessment form. A range of strategies were used to ensure guideline uptake:[9,10]

■ The clinical directors of cardiology and EDs ("opinion leaders") involved in development of the local guidelines promoted their implementation.

■ The guidelines and risk-stratification flow chart were formally presented at hospital medical grand rounds and teaching sessions for junior medical officers.

■ Multidisciplinary educational sessions about the guideline and the appropriateness of chest-pain risk-stratification were held throughout the implementation phase for ED, cardiology and other hospital staff involved in management of chest pain in the ED.

■ Monthly feedback on the percentage of patients who had the guideline flow

2: Characteristics and admission destinations of patients with complete chest-pain forms before and after guideline implementation

Characteristic	Pre-implementation (n = 422)	Post-implementation (n = 461)	Difference* (95% CI)
All patients			
Mean age, in years (SD)	59.9 (17.3)	60.8 (17.8)	0.92 (−1.42 to 3.22)
Men	254 (60%)	258 (56%)	−4% (−11% to 2%)
Patients with cardiac/possibly cardiac pain	265/422 (63%)	324/461 (70%)	8% (1% to 14%)
Mean age, in years (SD)	63.3 (15.7)	64.3 (16.0)	1.0 (−1.4 to 3.6)
Men	169 (64%)	185 (57%)	−7% (−15% to 1%)
Assessed by junior medical staff	110 (42%)	173 (53%)	12% (4% to 20%)†
Risk stratification (by cardiologist)			
Low risk	27 (10%)	42 (13%)	3% (−3% to 8%)
Medium risk	96 (36%)	103 (32%)	−4% (−12% to 3%)
High risk	142 (54%)	179 (55%)	2% (−6% to 10%)
Admitted to			
Hospital	189 (71%)	256 (79%)	8% (0.7% to 15%)
Coronary care unit	40 (21%)	51 (20%)	−1% (−9% to 6%)
Subacute bed	124 (66%)	157 (61%)	−4% (−13% to 5%)
Non-monitored bed	25 (13%)	48 (19%)	6% (−2% to 12%)
Mean days of stay (SD)	5.1 (4.5)	5.0 (4.6)	0.1 (−0.8 to 1.0)

*Post-implementation value – pre-implementation value.
†Difference is significantly different from zero.

chart used was provided on noticeboards and at regular clinical meetings.

Post-implementation, ED medical staff were asked by the ED and cardiology directors to use the chest-pain guideline flow-chart to inform their admission/discharge decisions, as well as to complete the chest-pain assessment form.

Decision-making

Chest-pain assessment forms for ED patients diagnosed by medical staff with "cardiac" or "possibly cardiac" pain were reviewed at the end of the study by a senior cardiologist (P W K) who was blinded to the patient's admission/discharge destination and study phase. The cardiologist made admission/discharge and risk-stratification decisions in accordance with the chest-pain guideline flow chart.

ED doctors' admission/discharge decisions were then compared with this standard and classified as appropriate (if concordant), underadmission (patient discharged when the guideline recommended admission or patient admitted to a non-monitored bed when the guideline recommended a monitored bed) or overadmission (patient admitted when the guideline recommended discharge or patient admitted to a monitored bed when the guideline recommended a non-monitored bed).

Chest-pain assessment forms with insufficient data for independent review were returned to the study research officer (S B) for completion from medical records. ED and hospital patient electronic databases were interrogated for all study patients to determine numbers admitted to hospital and to monitored beds and length of hospital stay, and to confirm the accuracy of reported ED re-presentations or readmissions for chest pain within the ensuing three months.

Patient outcomes

Telephone follow-up to assess medium-term outcome was planned for all patients in both study phases (including those diagnosed with non-cardiac pain). All patients were sent a standard letter seeking consent. Structured interviews were conducted by the study research officer (S B) asking about further episodes of chest pain, re-presentations to an ED and readmissions to hospital for chest pain (excluding admissions for tests, such as angiography). Deaths within the three-month follow-up period were recorded, with the cause ascertained from the family for patients who died at home and from death certificates for those who died in hospital. Cardiovascular deaths were classified as due to heart failure, acute myocardial infarction or cardiac arrest.

Data analysis

To determine proportions of patients with non-traumatic chest pain who had a completed chest-pain assessment form, ED electronic records were searched for all patients with chest pain as a symptom. Those with a diagnosis of injury recorded in the ED database were excluded (ICD-10-AM diagnosis codes S00–T98[11]). To validate the accuracy of the derived denominators, the study research officer manually reviewed 100 consecutive medical records of patients with non-traumatic chest pain. High agreement between the electronic data and medical records was found for the main symptom (89%), principal diagnosis (79%) and destination of the patient (93%).

Admission/discharge decisions were compared before and after guideline implementation for patients assessed as low, medium and high risk by the cardiologist.

Statistical analyses used SAS[12] or StatsDirect[13] statistical software. Comparisons before and after guideline implementation were made by χ^2 tests (for categorical outcome variables and proportions) and t tests (for continuous and normally distributed variables, such as age and length of stay). Logistic regression analysis was used to determine the predictors of appropriate admission/discharge decisions.

RESULTS

Chest-pain assessment forms were completed for 422 of 768 patients (54.9%) who presented to the ED with non-traumatic chest pain before implementation and for 461 of 691 patients (66.7%) who presented after implementation.

3: Appropriateness of admission/discharge decisions for patients with cardiac or possibly cardiac pain compared with the "gold standard"*

Decision	Pre-implementation (n = 265)	Post–implementation (n = 324)	Difference in %[†] (95% CI)
Appropriate decision	180 (68%)	261 (81%)	13% (6% to 20%)[‡]
Underadmission	54 (20%)	32 (10%)	−10% (−16% to −5%)[‡]
Overadmission	31 (12%)	31 (10%)	−2% (−7% to 3%)
Appropriate decision, by staff seniority			
Junior staff	63/110 (57%)	131/173 (76%)	18% (7% to 30%)[‡]
Senior staff	117/155 (75%)	130/151 (86%)	11% (2% to 19%)[‡]
Appropriate decision, by patient risk			
Low risk	22/27 (82%)	40/42 (95%)	14% (−1% to 33%)
Medium risk	36/96 (38%)	57/103 (55%)	18% (4% to 31%)[‡]
High risk	122/142 (86%)	164/179 (92%)	6% (−1% to 13%)

*Decision made by senior cardiologist based on risk stratification using the chest-pain clinical guideline.
†Post-implementation value – pre-implementation value. ‡Difference is significantly different from zero.

4: Predictors of appropriate admission/discharge decisions

Category	Adjusted odds ratio (95% CI)
Guideline-implementation	
No*	1
Yes	2.12 (1.43–3.13)
Assessing doctor	
Junior doctors*	1
Senior doctors	2.12 (1.43–3.14)
History of coronary heart disease	
No*	1
Yes	1.54 (1.03–2.29)

* Reference category.

Patient characteristics and destinations

Characteristics of patients with complete assessment forms are shown in Box 2. There were no significant differences between these patients and those who presented with non-traumatic chest pain but did not have completed forms in mean age, hospital admissions, hospital bed destination or mean length of stay in either study phase (data not shown).

Among patients with complete assessment forms, there were no significant differences pre- and post-implementation in age (59.9 years pre-implementation v 60.8 years post-implementation) or sex distribution (60% men pre-implementation v 56% post-implementation). Most patients were assessed by the senior cardiologist as being at moderate or high risk of acute myocardial infarction and death, with no significant difference between study phases.

However, the proportion of patients who were diagnosed with cardiac or possibly cardiac pain was significantly higher post-implementation (increasing from 63% to 70%), as was the proportion of patients assessed by junior medical staff (increasing from 42% to 53%) and the proportion admitted to hospital (increasing from 71% to 79%). There were no significant differences for monitored/non-monitored bed destinations or overall mean length of stay between the two study phases.

Appropriateness of decisions

Appropriateness of admission/discharge decisions for patients with cardiac or possibly cardiac pain is shown in Box 3. Appropriate decisions increased significantly from 68% of decisions pre-implementation to 81% post-implementation. Most of the change was attributable to a significant decrease in underadmission decisions, from 20% to 10%.

Significant increases in appropriate decisions were seen for both junior and senior staff. Although appropriate decisions increased for patients in all risk categories, the change was statistically significant only for patients in the moderate-risk group.

The effects of patient and doctor characteristics on the appropriateness of decisions were examined simultaneously with the effects of guideline implementation using logistic regression. Patient age, sex and risk factors for cardiovascular disease were not significant predictors, leaving guideline implementation, patient history of coronary disease and seniority of the assessing doctor as the only independent predictors of appropriate decisions in the final model (Box 4).

Patient outcomes

Telephone follow-up was successful in 319 of 422 patients pre-implementation and 349 of 461 patients post-implementation (both 76%). The remaining patients either refused follow-up (21 pre-implementation and 29 post-implementation, respectively) or were unable to be contacted because of wrong or missing telephone numbers or no answer after five attempts. There were no significant differences between those who were followed up and those who were not in mean age, sex distribution, and percentage with cardiac or possibly cardiac pain in both study phases (not shown).

Outcomes at three-month follow-up are shown in Box 5. There were 11 deaths pre-implementation, six from a cardiovascular cause (five in the cardiac/possibly cardiac pain group and one in the non-cardiac pain group). Post-implementation, there were seven deaths, two from a cardiovascular cause (both in the cardiac/possibly cardiac pain group).

While a similar proportion of patients reported experiencing chest pain in both study phases, re-presentations to the ED with recurrent chest pain in patients with cardiac and possibly cardiac pain declined significantly, from 23% pre- to 13% post-implementation. The rate of ED re-presentations for patients with non-cardiac pain was low in both study phases (3% and 2%, respectively). Most hospital readmissions were in the cardiac/possibly cardiac chest pain group, with no significant difference between study phases.

DISCUSSION

Implementation of our guideline resulted in significant improvement in appropriate admission/discharge decisions for patients with chest pain, most improve-

5: Outcomes at three-month follow-up for patients with different categories of chest pain

Outcome	Cardiac/possibly cardiac pain			Non-cardiac pain		
	Pre-implementation ($n = 201$)	Post-implementation ($n = 247$)	Difference in %* (95% CI)	Pre-implementation ($n = 118$)	Post-implementation ($n =102$)	Difference in %* (95% CI)
Further chest pain	64 (32%)	73 (30%)	−2% (−11% to 6%)	17 (14%)	20 (20%)	5% (−5% to 16%)
Re-presentation to ED	46 (23%)	32 (13%)	−10% (−17% to −3%)†	4 (3%)	2 (2%)	−1% (−7% to 4%)
Readmission to hospital	36 (18%)	31 (13%)	−5% (−12% to 1%)	3 (3%)	2 (2%)	−0.6% (−6% to 5%)
All deaths	8 (4%)	5 (2%)	−2% (−6% to1%)	3 (3%)	2 (2%)	−0.6% (−6% to 5%)
Cardiovascular deaths	6 (3%)	2 (0.8%)	−2% (−6% to 0.4%)	1 (0.8%)	0	0.8% (−5% to 3%)

ED = emergency department. *Post-implementation value – pre-implementation value.
†P = 0.006 for fewer re-presentations to the ED for patients who originally presented with cardiac/possibly cardiac pain post-implementation.
†Difference is significantly different from zero.

ment being in patients at moderate risk of death or myocardial infarction within six months. Independent predictors of appropriate decisions were implementation of the guideline, degree of seniority of the assessing doctor and patient history of coronary disease. Guideline implementation resulted in an 8% increase in hospital admissions, counterbalanced by a 10% decrease in re-presentations to the ED with cardiac and possibly cardiac pain.

The strengths of our study were that it was prospective, used blinded "gold standard" assessment of appropriateness of decisions, assessed secondary endpoints in follow-up, and used logistic regression to define factors related to appropriate decisions.

However, study limitations need to be considered in evaluating the results. The chest-pain assessment form was our main data source, rather than patient examination and interview. The relatively low completion rates for this form and loss of about a third of patients with completed forms to follow-up raise questions about the validity of the results. However, there were no significant differences in patient demographics, hospital admission rates, bed destination or hospital length of stay between patients with or without completed forms in either study phase. Nor were there significant differences in patient demographics or prevalence of cardiac or possibly cardiac pain between patients with and without follow-up. This suggests that the low response and follow-up rates were unlikely to have affected our findings.

We used a before-and-after study design rather than a randomised controlled trial for logistical reasons, owing to the difficulty in blinding our medical workforce to patient status, and to allow in-depth analysis of our intervention. Every effort was made to minimise biases. In particular, the senior cardiologist was blinded to all patient data, study phase and outcomes, had minimal direct patient contact, and undertook his assessment at the end of the study using a consistent method.

ED doctor decisions disagreed with those of the cardiologist in 45% of patients assessed at moderate risk after guideline implementation. Most high-risk patients are easily recognised on the basis of history, resting electrocardiogram, and cardiac enzyme levels.[14] The situation is less clear for moderate-risk patients. Our results may be due to the failure of ED staff to recognise that patients with multiple coronary risk factors and possibly cardiac chest pain have an intermediate risk of adverse events. For accurate risk assessment, they need observation over eight to 12 hours with serial ECGs and cardiac enzyme testing, as highlighted in a previous study.[15]

It has been suggested that the introduction of chest-pain risk-stratification guidelines might not decrease hospital admissions.[16] However, other studies have shown ED chest pain protocols to be cost effective, with shorter hospital stays.[17,18] The rise in hospital admissions in our study did not result in longer hospital stay and was counterbalanced by a significant decrease in the rate of re-presentation to the ED with chest pain.

Our study shows that adapting a national chest-pain guideline to local needs can improve clinical decision-making for patients with chest pain, with improved medium-term patient out-comes. To sustain these gains, we plan to review and refine the guidelines, with particular emphasis on the contentious moderate-risk group.

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COMPETING INTERESTS

None identified.

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snapshot

Medical history and the European Union: Papanicolaou and Asklepios

IN JANUARY 2002, 12 European Union countries introduced a new common currency, the euro, which soon afterwards displaced the national currencies of the member states. With that historical act, along with the loss of monetary individuality, we lost an unusual "document" of medical history: the Greek 10 000-drachma note.

The front of this banknote shows George Papanicolaou, the "father" of exfoliative cytology (Box, A). Born in Kymi, Greece, in 1883, he studied medicine in Athens and graduated with honours. After emigration to the United States in 1913, he began to study the ovarian cycle in animals (and later in humans), using vaginal smears. He identified the female sexual cycle[1] and, in 1928, presented his results of "possible diagnosis of certain conditions, especially malignancy" by vaginal smear.[2] Through his studies, he became aware that "carcinoma of the fundus and carcinoma of the cervix are to some extent exfoliative lesions, in the sense that cells at the free surface of the growth tend to be dislodged and subsequently find their way into the vagina".[3] In 1941, he presented the method of taking and staining vaginal smears and described the cellular appearance in carcinoma of the uterus.[3] His method was validated and adopted worldwide as the "Papanicolaou test". Papanicolaou died in Miami, Florida, in 1962. Nowadays, cervical cancer, once the most lethal of gynaecological carcinomas, is rare in Western countries, but still the first cause of death among women in most developing countries, where few women receive Pap smears.[4]

The reverse side of the banknote shows the god of healing, Asklepios (also called Asclepius or Aesculapius), who lived around 1200 BC in Thessaly, Greece (Box, B). In Greek mythology he was the son of Apollo and the nymph Koronis (Coronis, Cronis). Apollo entrusted the education of Asklepios to the centaur Chiron, who taught him how to treat wounds and how to use herbs for healing. Zeus, who was afraid that Asklepios's great healing powers might render all men immortal and thus challenge the power of the gods, killed Asklepios with a thunderbolt. (Another version of the myth relates that Asklepios was made immortal.)

The symbol of Asklepios is the staff with a serpent coiled around it. Besides being mystical and symbolic animals, sacred snakes played an important role in healing rituals. Current biological knowledge suggests that growth factors, which are present in the saliva of certain snakes, may have stimulated healing processes at the site of wounds.[5]

The historic 10 000-drachma note

A. The front of the 10 000-drachma note, showing George Papanicolaou (1883–1962), with his microscope and famous *Atlas of exfoliative cytology*, published in 1954.

B. The reverse side of the 10 000-drachma note, showing Asklepios, the god of healing, with his symbol, the staff with a serpent coiled around it. Beside him, a healing scene depicts a sacred snake licking or biting the right shoulder of a sleeping patient.

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