SAFETY ALERTS

Reducing risks of tourniquets left on after finger and toe surgery: summary of a safety report from the National Patient Safety Agency

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This is one of a series of *BMJ* summaries of recommendations to improve patients' safety, based on reports of safety concerns, incident analysis, and other evidence. The articles will highlight the risks of incidents that have the potential for serious harm and are not well known, and for which clear preventive actions are available.
To report adverse events to the National Patient Safety Agency, go to www.nrls.npsa.nhs.uk/

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Previous safety alerts
- Improving the safety of oxygen therapy in hospitals: summary of a safety report from the National Patient Safety Agency (*BMJ* 2010;340:c187)
- Insertion of chest drains: summary of a safety report from the National Patient Safety Agency (*BMJ* 2009;339: b4923)
- Avoiding midazolam overdose: summary of a safety report from the National Patient Safety Agency (*BMJ* 2009;339:b4459)

Why read this summary?

Tourniquets are used in hand and foot surgery because of the need for a bloodless field to allow for careful dissection. They are used in a range of settings, such as operating theatres, emergency departments, community sites (for example, for minor surgery in podiatry clinics). Although rare, complications can lead to serious harm, including, at worst, irreversible ischaemia.

Between August 2005 and November 2009, healthcare staff in England and Wales reported 15 serious incidents in which tourniquets had been left on fingers or toes by mistake. Ten patients needed further surgery and two incidents resulted in amputation. At least six of the incidents related to surgical gloves being used as tourniquets. Fourteen litigation claims relating to tourniquets were also reported in this period.

A typical incident report reads: "Patient had termination of tip of right ring finger. He attended plastic dressing clinic for routine follow-up. When the dressing was removed, his ring finger was necrotic and still had what looked like a glove tourniquet in situ. Explained to patient he will require amputation."

In addition, two published case reports record amputations after retained tourniquets on fingers and toes.[1 2]

This summary is based on a safety report (known as a "rapid response report" or "RRR") from the National Patient Safety Agency (NPSA) on the risks of tourniquets left on fingers and toes, including use of gloves for this purpose, with key actions for staff.

Problems identified by the National Patient Safety Agency

Little good quality evidence exists to support different tourniquet techniques. The use of surgical gloves as tourniquets seems to be widespread as they are easily available and cheap, carry a low risk of infection, and are considered effective in achieving haemostasis. This practice is still recommended in manuals for emergency trainees and others.[3] But gloves are normally flesh coloured and may inadvertently be left on. Some clinicians have advocated use of coloured gloves,[4] and a widely cited paper by Smith and colleagues describes a modified technique using a glove and an artery clip.[5] However, risks still remain (as acknowledged by Smith and colleagues) with this or any other "home made" device—for example, the risk of neuropraxia as pressure is applied in a very narrow area. The broad safety principle is that devices should be used for their intended purpose only.[6]

The NPSA issued its RRR on the risks of tourniquets left on fingers and toes in December 2009 (NPSA/2009/RRR007, www.nrls.npsa.nhs.uk/tourniquets).

What can we do?

In the absence of evidence, the NPSA and the Royal College of Surgeons consulted clinical experts to identify key actions to make practice safer:

- Use only tourniquets with the CE marking (which indicates conformity with the European Union's safety standards), which are labelled and/or brightly coloured to maximise visibility. Do not use gloves as tourniquets
- Reconcile the number of tourniquets through swab counting procedures, and record the on/off time of tourniquets
- Consider including tourniquets as part of the surgical safety checklist (tourniquet removal at "sign out" stage)
- Once the tourniquet has been removed, check for adequate perfusion of finger or toe
- Ensure that staff and patients know to look for later signs of tissue ischaemia, necrosis, and gangrene (skin discoloration or a pulseless, painful, paralysed, paraesthetic, and cold digit).

What else do we need to know?

Responses from clinicians while the NPSA report was being compiled highlighted many items used as tourniquets, including catheters, elastic bands, and surgical gloves (either whole or finger only, sometime with additions—for example, artery clips or the red string used for bundling up gauze swabs). Some of these techniques may be safer than others, but little high quality evidence exists. However, the wide range of practice is in itself of interest and suggests the need for evidence based guidelines.

How will we know when practice has become safer?

Early information from the manufacturers currently producing tourniquets with the CE marking shows a 140% increase in purchasing in the three months after the issue

of the RRR compared with a similar period before issue. The NPSA will continue to monitor purchasing. To date, no further incidents of harm from tourniquets left on after finger or toe surgery have been reported to the NPSA.

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1 De Boer HL, Houpt P. Rubber glove tourniquet: perhaps not so simple or safe? *Eur J Plastic Surg* 2007;30:91-2.
2 Haas F, Moshammer H, Schwarzl F. Iatrogenic necrosis of the large toe after tourniquet placement—clinical course and reconstruction. *Chirurg* 1999;70:608-10.
3 King C, Henretig FM. Textbook of pediatric emergency medicine. 2nd ed. Wolters Kluwer Health, 2008. http://books.google.co.uk/books?id=qfcKjyZ6xP4C&pg=PA947&lpg=PA947&dq=textbook±tourniquet±glove&source=bl&ots=yr-wjLc9nv&sig=ckLoau5l1p4qX4Z-VVv8tkAxerE&hl=en&ei=_9-gS6iFE9iPjAf30_yjBA&sa=X&oi=book_result&ct=result&resnum=2&ved=0CA4Q6AEwAQ#v=onepage&q=textbook%20tourniquet%20glove&f=false
4 Tucker S, Harris PC. The unforgettable finger tourniquet. *Injury* 2002;33(1):76-3.
5 Smith IM, Austin OM, Knight SL. A simple and fail safe method for digital tourniquet. *J Hand Surg* 2002;27:363-4.
6 Medicines and Healthcare Products Regulatory Agency. Medical devices alert MDA/2010/001: medical devices in general and non-medical products. 2010. www.mhra.gov.uk/Publications/Safetywarnings/MedicalDeviceAlerts/CON065771.

EASILY MISSED?

Pulmonary embolism

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This is a series of occasional articles highlighting conditions that may be more common than many doctors realise or may be missed at first presentation. The series advisers are Anthony Harnden, university lecturer in general practice, Department of Primary Health Care, University of Oxford, and Richard Lehman, general practitioner, Banbury. If you would like to suggest a topic for this series please email us (easilymissed.bmj@bmjgroup.com).

Complete occlusion of a peripheral pulmonary artery usually results in a pulmonary infarction with pleuritic chest pain and haemoptysis. When the blood clot is lodged in more proximal pulmonary arteries and is not occlusive, pulmonary infarction does not occur and pulmonary embolism might present as isolated dyspnoea. Massive pulmonary embolism is caused by large bilateral proximal clots resulting in haemodynamic collapse.[1]

Why is it missed?

The classic triad of pleuritic chest pain, dyspnoea, and haemoptysis occurs in less than 10% of patients, but the most common symptoms (dyspnoea, chest pain) are non-specific. In 40% of cases, major thromboembolic risk factors are absent. Clinical signs of deep vein thrombosis are observed in only 15% of patients and haemoptysis in only 4.5-11% of cases.[1 5] Pulmonary infarction with fever may mimic pneumonia. Chest pain reproducible on palpation also does not rule out pulmonary embolism.[6] In addition, abnormalities in chest radiographs or electrocardiograms are non-specific; sinus tachycardia is the most common electrocardiogram abnormality whereas right heart strain is observed only in severe cases. Arterial partial pressure of oxygen and the alveolar-arterial oxygen gradient are normal in 20% of patients; hypoxaemia with hypocapnia is the most common abnormality in blood gas pressures, but is non-specific.[1] Symptoms and initial test findings can also be ascribed to underlying disease such as heart failure or chronic lung disease.[7]

KEY POINTS

Suspect pulmonary embolism in cases of unexplained dyspnoea or chest pain, or both, even in the absence of obvious risk or triggering factors

Clinical probability assessment is the cornerstone of all validated diagnostic strategies

Always conduct objective tests to confirm or exclude suspected pulmonary embolism. Most patients diagnosed and treated according to guidelines have an uneventful outcome. On the other hand, unrecognised and untreated pulmonary embolism carries a 50% risk of recurrence and a 25% risk of death

Why does it matter?

Without adequate treatment, pulmonary embolism recurs in 30-50% of cases, with a case fatality rate of between 10-45%.[8] Non-diagnosed cases therefore have a high risk of recurrence and death.

How is it diagnosed?

Consider a diagnosis of pulmonary embolism in patients with:

- Dyspnoea, pleuritic chest pain, and haemoptysis
- Any chest symptoms and clinical features suggesting deep vein thrombosis
- Dyspnoea or chest pain, and a major risk factor for pulmonary embolism (table)
- Unexplained dyspnoea, chest pain, or mild haemoptysis, whether or not they have minor risk factors for pulmonary embolism.

Once the diagnosis is suspected, conduct a clinical or pre-test probability assessment based on risk factors and clinical features, as post-test probability depends on test characteristics and pre-test probability. The assessment can be done either by implicit clinical judgment or by using a validated prediction rule such as the Geneva or Wells scores (table). These rules have a fair accuracy in large prospective series of patients with suspected pulmonary embolism: prevalence of pulmonary embolism is about 10% in patients with a low clinical probability, 30% in those with a moderate clinical probability, and 65% in those with a high clinical probability.[9 10]

Revised Geneva rule and Wells rule for estimation of the clinical probability of pulmonary embolism

Geneva revised score		Wells score	
Variables	Points	Variables	Points
Predisposing factors			
Age >65 years	1	–	–
Previous venous thromboembolism	3	Previous DVT or PE	1.5
Surgery or fracture <1 month	2	Recent surgery or immobilisation	1.5
Active malignancy	2	Cancer	1
Symptoms			
Unilateral lower limb pain	3	–	–
Haemoptysis	2	Haemoptysis	1
Clinical signs			
Heart rate 75-94 bpm	3	–	–
Heart rate ≥95 bpm	5	Heart rate >100 beats/min	1.5
Unilateral lower limb oedema and pain	4	Clinical signs of DVT	3
–	–	Alternative diagnosis less likely than PE	3
Clinical probability			
Low	0-3	Low	0-1
Intermediate	4-10	Intermediate	2-6
High	≥11	High	≥7

DVT=deep vein thrombosis, PE=pulmonary embolism.

Investigations

- Plasma D-dimer measurement is the next step for most outpatients. D-dimer levels are raised in many situations and a positive test result is non-specific. However, based on a negative likelihood ratio of 0.08, a negative result for a quantitative, enzyme linked immunosorbent assay (ELISA) D-dimer test excludes pulmonary embolism and the need for further testing in about 30% of patients, provided that the clinical probability is low or moderate.[11] Quantitative latex based and whole blood qualitative D-dimer assays have a negative likelihood ratio of 0.20 to 0.30 and allow exclusion of pulmonary embolism only in patients with a low clinical probability.[11] In patients with a high clinical probability, no D-dimer test is sensitive enough to rule out pulmonary embolism.
- Refer patients with a positive D-dimer test for multidetector spiral computed tomography. This procedure confirms pulmonary embolism when an intraluminal defect is seen in several subsegmental arteries or in a more proximal pulmonary artery (figure).[12] A ventilation and perfusion lung scan may be selected when multidetector spiral computed tomography is contraindicated (renal failure, allergy to contrast medium) but yields a high rate of inconclusive results. Finally, compression ultrasonography of the leg veins showing a proximal deep vein thrombosis in a patient with thoracic symptoms allows confirmation of pulmonary embolism without further testing, but has a low diagnostic yield, except in patients with clinical symptoms of deep vein thrombosis.[9 11]
- Excluding pulmonary embolism on inappropriate criteria, for example, low D-dimer reading in a patient with a high clinical probability or a low probability lung scan in a patient with a high clinical probability, exposes patients to an increase risk of it recurring and death.[7]

How is it managed?

In patients with a high clinical probability, start anticoagulant treatment before objective confirmation of the disease. Low molecular weight heparin and fondaparinux are the first line options but are contraindicated in patients with severe

CASE SCENARIO

A non-smoking, previously well woman in her 70s complained of recent onset of dyspnoea. She had no cardiovascular or thromboembolic risk factors and clinical examination was normal apart from a heart rate of 96 beats per minute. With no clear explanation for the symptoms, her general practitioner applied a decision rule (table) to evaluate the clinical probability of pulmonary embolism. The result was intermediate, prompting him to request a D-dimer level, which was raised. He referred the patient to hospital, where pulmonary embolism was confirmed on computed tomography.

HOW COMMON IS IT?

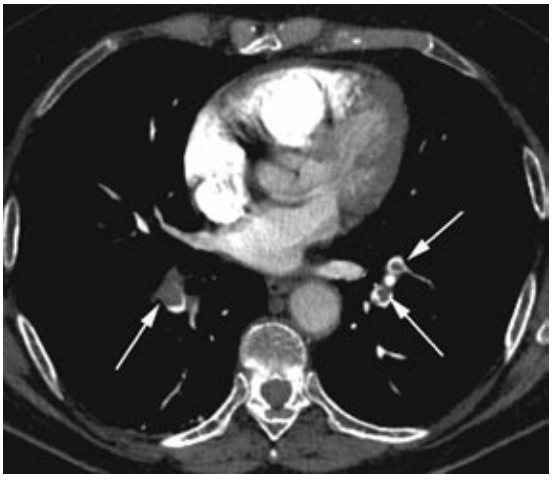
The incidence of diagnosed pulmonary embolism increases with age

The annual rate is about 1 in 10 000 in individuals below 40 years of age and can reach 1 in 100 in patients over 80 years[2 3]

According to autopsy studies, the disease is clinically suspected in less than half of fatal cases, so the real incidence is probably underestimated[4]

However, most episodes of pulmonary embolism carry a low mortality risk (about 1%) when properly diagnosed and treated

Massive pulmonary embolism represents only 5% of all cases of pulmonary embolism and is fatal in about 40% of patients[1]



Multidetector spiral computed tomogram showing bilateral filling defects [arrowed] in the pulmonary artery

renal insufficiency. In these patients, unfractionated heparin is still used for initial treatment.[13] Start vitamin K antagonists on the first day and give for at least three months.[13]

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1 Torbicki A, Perrier A, Konstantinides S, Agnelli G, Galiè N, Pruszczyk P, et al. Guidelines on the diagnosis and management of acute pulmonary embolism: the Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC). *Eur Heart J* 2008;29:2276-315.
2 Oger E. Incidence of venous thromboembolism: a community-based study in western France. EPI-GETBP Study Group. Groupe d'Etude de la Thrombose de Bretagne Occidentale. *Thromb Haemost* 2000;83:657-60.
3 Nordström M, Lindblad B. Autopsy-verified venous thromboembolism within a defined urban population-the city of Malmo, Sweden. *APMIS* 1998;106:378-84.
4 Pineda LA, Hathwar VS, Grant BJ. Clinical suspicion of fatal pulmonary embolism. *Chest* 2001;120:791-5.
5 Le Gal G, Righini M, Roy PM, Sanchez O, Aujesky D, Bounameaux H, et al. Prediction of pulmonary embolism in the emergency department: the revised Geneva score. *Ann Intern Med* 2006;144:165-71.
6 Le Gal G, Testuz A, Righini M, Bounameaux H, Perrier A. Reproduction of chest pain by palpation: diagnostic accuracy in suspected pulmonary embolism. *BMJ* 2005;330:452-3.
7 Roy PM, Meyer G, Vielle B, Le Gall C, Verschuren F, Carpentier F, et al. Appropriateness of diagnostic management and outcomes of suspected pulmonary embolism. *Ann Intern Med* 2006;144:157-64.
8 Meyer G, Planquette B, Sanchez O. Long-term outcome of pulmonary embolism. *Curr Opin Hematol* 2008;15:499-503.
9 Righini M, Le Gal G, Aujesky D, Roy PM, Sanchez O, Verschuren F, et al. Diagnosis of pulmonary embolism by multidetector CT alone or combined with venous ultrasonography of the leg: a randomised non-inferiority trial. *Lancet* 2008;371:1343-52.
10 Van Belle A, Büller HR, Huisman MV, Huisman PM, Kaasjager K, Kamphuisen PW, et al. Effectiveness of managing suspected pulmonary embolism using an algorithm combining clinical probability, D-dimer testing, and computed tomography. *JAMA* 2006;295:172-9.
11 Roy PM, Colombet I, Durieux P, Chatellier G, Sors H, Meyer G. Systematic review and meta-analysis of strategies for the diagnosis of suspected pulmonary embolism. *BMJ* 2005;331:259.
12 Stein PD, Fowler SE, Goodman LR, Gottschalk A, Hales CA, Hull RD, et al. Multidetector computed tomography for acute pulmonary embolism. *N Engl J Med* 2006;354:2317-27.
13 Kearon C, Kahn SR, Agnelli G, Goldhaber S, Raskob GE, Comerota AJ. Antithrombotic therapy for venous thromboembolic disease: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). *Chest* 2008;133:454S-5S.

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PRACTICE SECTION — CALL FOR ARTICLE PROPOSALS

The Practice section is the "How to" section of the journal, with practical articles to assist clinicians in their daily tasks.
We welcome proposals of articles for various Practice series, especially:
Change page—alerting clinicians on the immediate need for a change in practice, with compelling evidence that the change is beneficial and feasible;
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Please email your proposals to practice.bmj@bmjgroup.com.

A memorable patient

It was a relaxed weekday evening. The day's emergency surgical take had been light, and I sat down for dinner with my colleagues in the hospital canteen. The evening's on-call consultant joined us. He was a vascular surgeon, staying late to deal with an overdue amputation. The conversation was carefree, and we headed our separate ways. The patients waiting for theatre were prioritised. First on the list tomorrow would be the man seen earlier with back pain and a large abdominal aortic aneurysm. Computed tomography had reassured us that all was well—no leak. I reclined in the theatre coffee room in the company of the night's anaesthetist.

Then the calm of the evening was shattered by the sound of his pager: someone had "arrested" in the emergency department. Shortly after, a telephone call sent the theatre team into frantic activity—the collapsed patient was our man with the aneurysm.

I ran towards the emergency department and and met the lifeless patient hurtling towards the operating department with a mass of nurses and doctors over and around the bed, cardiopulmonary resuscitation ongoing. Visitors in the corridor were shouted to one side and stared with wide eyes.

We reached the emergency theatre, and my consultant appeared within the melee. For seconds that seemed like an eternity he chewed furiously at his gum, silently considering the already 15 minute long resuscitative effort, and then made his decision. He rushed to the changing rooms as chest compressions continued and then reappeared to pull on a gown and a pair of gloves, dispensing with the luxury of sterilisation. The abdomen was opened with bold and rapid strokes and the peritoneum was spilling over with fresh blood. Somehow, among the confusion and the mangled artery, he found the aneurysm's neck and swiftly applied a clamp. Within a minute, the team began to relax as cardiac output was re-established—we had switched off the gushing tap.

This had undoubtedly been the most dramatic clinical experience in my short surgical career. But as my thoughts turned from elation to reflection, I realised what an extraordinary combination of circumstances had made initial surgical success possible. First, we were able to make an immediate, accurate diagnosis of a ruptured aneurysm that had occurred under direct observation in the emergency department's resuscitation room. Secondly, even though this occurred out of working hours, the theatre staff, anaesthetist, and entire surgical team—including a consultant vascular surgeon—were instantly available to perform the lifesaving surgery. Thirdly, our patient was relatively young with minimal comorbidities.

What did I learn? Certainly, I gained a healthy respect for symptomatic aortic aneurysms. I realised the necessity of intelligent decisiveness in a "crash" situation and the need to modify normal conventions in order to grab control of a fast deteriorating situation. I was encouraged that sometimes our long years of training really do pay off in terms of saving life, and my heart was warmed again by the incomparable satisfaction of surgical practice.

What of our patient? Remarkably, he was walking around the general ward within a week and was mentally unharmed by his close call with death.

This incident spoke to me of the extraordinary capabilities of modern medicine, yet also hinted at the powerful influence of factors entirely beyond our control. Although we were justly proud of our success, there were many reasons to remain humble. One of the greatest of surgeons, Ambroise Paré, simply said of his successes: "I dressed him. God healed him."

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