Clinical Reasoning

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University of Nottingham
Outline for today

Brainstorming
Introduction to clinical reasoning

Break

Components of clinical reasoning

Lunch

Teaching/learning clinical reasoning
Heuristics and biases

Break

Tri-process theory, deliberate practice
Work-based teaching tips
Why are some Med Regs really good at their job compared with others?

What do the really good ones ‘have’ that others might not have?
What is clinical reasoning?
• There are several definitions of clinical reasoning in the literature

• In a nutshell: clinical reasoning describes the thinking and decision making processes associated with clinical practice
Clinical reasoning can be conceptualised as a process with different components that each require specific knowledge, skills and behaviours:

1. History and physical examination
2. Choosing and interpreting diagnostic tests
3. Problem identification and management
4. Shared decision making

Consensus statement on the content of clinical reasoning curricula un undergraduate medical education. UK Clinical Reasoning in Medical Education group, 2019.
Why does clinical reasoning matter?
• 10-15% of diagnoses are incorrect
• Diagnostic error causes significant harm
• Diagnostic error accounts for 40,000 – 80,000 deaths annually in the US, somewhere between breast cancer and diabetes
• Chances are, we will all experience a diagnostic error in our lifetime

Results -
‘System-related factors contributed to diagnostic error in 65% of the cases and cognitive factors in 74% ... the most common cognitive factors involved faulty synthesis.’
‘The prevailing opinion that diagnostic error is a cognitive processing error … is incorrect. This perspective presupposes that all of the available knowledge is present. … In contrast, a diagnostic error may reflect not a processing error, but an incomplete knowledge base or inadequate experience.’
What do we know about clinical reasoning ability, and how it develops?
Expertise = general problem-solving ability?

‘Two of the most important determinants of competence are information and experience; problem-solving skills without a rich supply of facts are insufficient for diagnostic acumen.’

Expertise = bigger, better memory?

Clinical reasoning as a dual process

<table>
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The ‘lazy system 1’

A bat and ball cost £1.10
The bat costs £1 more than the ball
How much does the ball cost?
Clinical reasoning describes the thinking and decision-making processes associated with clinical practice.

It can be conceptualised as a process with different components that each require specific knowledge, skills and behaviours.

It is situated in context.

Diagnostic error and ‘diagnosis education’ has gained prominence in recent years.

Dual process theory is widely accepted as a model of clinical reasoning.

(That’s not all there is to it – it gets more interesting later!)
Discussion

"Questions?" flickr photo by Marcus Ramberg https://flickr.com/photos/marcusramberg/185508448 shared under a Creative Commons (BY-NC) license
Clinical reasoning can be conceptualised as a process with different components that each require specific knowledge, skills and behaviours:

1. **History and physical examination**
2. Choosing and interpreting diagnostic tests
3. Problem identification and management
4. Shared decision making

Consensus statement on the content of clinical reasoning curricula un undergraduate medical education. UK Clinical Reasoning in Medical Education group, 2019.
In a 30-year-old woman who presents with gradual onset headache and a fever, what features in the history and physical examination would make you think she has meningitis? (and therefore need a lumbar puncture)

Discuss in small groups

List the features you come up with, and then rate them on a scale of 1-10 in terms of how good they are.
‘Acute infection of the meninges presents with a characteristic combination of fever, headache and meningism.

Meningism consists of headache, photophobia and neck stiffness, often accompanied by other signs of meningeal irritation, including Kernig’s and Brudzinski’s sign.’

### Presenting symptoms

<table>
<thead>
<tr>
<th>Patients without meningitis</th>
<th>Patients with meningitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Headache (81%)</td>
<td>• Headache (92%)</td>
</tr>
<tr>
<td>• Fever (67%)</td>
<td>• Fever (71%)</td>
</tr>
<tr>
<td>• n&amp;v (53%)</td>
<td>• n&amp;v (70%)</td>
</tr>
<tr>
<td>• Photophobia (51%)</td>
<td>• Photophobia (57%)</td>
</tr>
<tr>
<td>• Stiff neck (45%)</td>
<td>• Stiff neck (48%)</td>
</tr>
<tr>
<td>• Focal symptoms/seizure (21%)</td>
<td>• Focal symptoms/seizure (18%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Presenting signs</th>
<th>Patients without meningitis</th>
<th>Patients with meningitis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Temperature &gt;38°C (52%)</td>
<td>• Temperature &gt;38°C (43%)</td>
</tr>
<tr>
<td></td>
<td>• Neck stiffness (32%)</td>
<td>• Neck stiffness (30%)</td>
</tr>
<tr>
<td></td>
<td>• Kernig’s sign (5%)</td>
<td>• Kernig’s sign (5%)</td>
</tr>
<tr>
<td></td>
<td>• Brudzinski’s sign (5%)</td>
<td>• Brudzinski’s sign (5%)</td>
</tr>
<tr>
<td></td>
<td>• GCS &lt;13 (7%)</td>
<td>• GCS &lt;13 (10%)</td>
</tr>
<tr>
<td></td>
<td>• Mean wbc in CSF 1</td>
<td>• Mean wbc in CSF 359</td>
</tr>
</tbody>
</table>

Fig. 1.2 Likelihood ratio (LR) of Kernig’s sign, Brudzinski’s sign and nuchal rigidity in the clinical diagnosis of meningitis.

\[
LR = \frac{\text{probability of finding in patients with disease}}{\text{probability of finding in patients without disease}}
\]
How do you think textbooks, and our teaching, influence clinical reasoning ability?

‘Simply teaching medical triads may encourage superficial pattern recognition that results in overconfidence and premature closure’

Elieson and Papa (1994) compared learning lists of features with qualifiers such as ‘usually’ – versus probabilities of features in various diseases. Students who learned probabilities scored higher in diagnostic accuracy (70% vs 58%)

But probabilities are hard to remember, so Woods (2005) used the same materials, with group 1 learning probabilities of features and group 2 learning the basic science explanation of the features. While there was no difference on immediate testing, the group that had learned the basic science mechanisms outperformed the probability group by about 10% on later testing.

The challenge for teachers

In order to teach clinical reasoning, we need to:

• Understand what is meant by ‘clinical reasoning’
• Know how clinical reasoning ability develops and what teaching strategies best facilitate this
  and
• Have sound knowledge of the content we need to teach (appropriate to the level of the learner)
The reason why ‘evidence-based’ history and physical examination is so vital in clinical decision-making is because:

- 76% of diagnosis is history alone
- Physical examination adds another 12%
- These combine to give the **pre-test probability**
- Pre-test probability is essential in using and interpreting diagnostic tests

Clinical reasoning can be conceptualised as a process with different components that each require specific knowledge, skills and behaviours:

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Consensus statement on the content of clinical reasoning curricula un undergraduate medical education. UK Clinical Reasoning in Medical Education group, 2019.
In a 60-year old heavy smoker who presents with persistent breathlessness on exertion and wheeze, what is the probability of him having emphysema with a normal* spirometry result?

*FEV1/FVC ratio >70%: GOLD Guide 2017
Tests lie! – tests give us test probabilities not real probabilities

All test results are affected by the following:

• How ‘normal’ is defined
• Factors other than disease that influence test results
• Operating characteristics
• Sensitivity and specificity
• Prevalence of disease in the population
Sensitivity and specificity

- Sensitivity is the ability to detect true positives
- Specificity is the ability to detect true negatives
- No test has 100% sensitivity and specificity

<table>
<thead>
<tr>
<th></th>
<th>Disease</th>
<th>No disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive test</td>
<td>A (True pos)</td>
<td>B (False pos)</td>
</tr>
<tr>
<td>Negative test</td>
<td>C (False neg)</td>
<td>D (True neg)</td>
</tr>
</tbody>
</table>

Sensitivity = \( \frac{A}{A+C} \times 100 \)

Specificity = \( \frac{D}{D+B} \times 100 \)
An elderly lady is admitted following a fall. She had hurt her left hip and was unable to weight bear.

On examination, the left hip was extremely painful to move.

Her X-ray (shown) is normal.

Is there a fracture?
The most fundamental principle in clinical decision making is that the interpretation of new information depends on what you believed beforehand.

In a 60-year old heavy smoker who presents with persistent breathlessness on exertion and wheeze, what is the probability of him having emphysema with a normal* spirometry result?

*FEV1/FVC ratio >70%: GOLD Guide 2017
Probability of having a disease

http://vassarstats.net/clin2.html
Probability of having a disease

50% chance of having the disease before the test is done

Patient B

13.6% chance of having the disease if test is negative

94.4% chance of having the disease if test is positive

http://vassarstats.net/clin2.html
The probability of a disease depends on the clinical (pre-test) probability plus the sensitivity and specificity of the test.
\[ P(A \mid B) = \frac{P(B \mid A) P(A)}{P(B)} \]
Understanding basic science

Figure 3  Non-proportional Venn diagram: the presence of emphysema on CT (n = 36), a decreased KNO (n = 94) and FEV1/FVC < 70% (n = 95) are partially overlapping entities.

Van der Lee, I et al. (2002). Nitrous oxide diffusing capacity versus spirometry in the early diagnosis of emphysema in smokers. Respiratory Medicine; 103: 1892-1897
If a test to detect a disease whose prevalence is 1:1000 has a false positive rate of 5%, what is the chance that a person found to have a positive result actually has the disease, assuming you know nothing about the person’s symptoms and signs?

(45% of Harvard doctors said 95%)

False positives 50/1000
True positives 1/1000
Means the chance of a positive result with disease = 1 out of 51 or 2%

<table>
<thead>
<tr>
<th></th>
<th>Present</th>
<th>Absent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual disease</td>
<td>1</td>
<td>999</td>
<td>1000</td>
</tr>
<tr>
<td>Test +</td>
<td>1</td>
<td>50</td>
<td>51</td>
</tr>
<tr>
<td>Test -</td>
<td>0</td>
<td>949</td>
<td>949</td>
</tr>
</tbody>
</table>

The importance of understanding prevalence
• Predictive values are the combination of sensitivity, specificity and **prevalence**

• Sensitivity and specificity are characteristics of the test – the population does not change this

• But we are interested in the Q, ‘What are the chances that a person with a positive test result truly has a disease?’ – the positive predictive value of a test

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<td><strong>Negative test</strong></td>
<td>C (False neg)</td>
<td>D (True neg)</td>
</tr>
</tbody>
</table>

Positive PV = \( \frac{A}{A+B} \times 100 \)

Negative PV = \( \frac{D}{D+C} \times 100 \)
A cab was involved in a hit-and-run at night. Two cab companies operate in the city, the Green and the Blue. 85% of the cabs in the city are Green and 15% are Blue. A witness identified the cab as Blue. The Court tested the witness under the circumstances that existed on the night of the accident and concluded that the witness correctly identified the colour 80% of the time.

What is the probability that the cab was actually Blue?

(The most common answer is 80%)

<table>
<thead>
<tr>
<th></th>
<th>Green</th>
<th>Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Witness +</td>
<td>68 (80% of 85)</td>
<td>12 (80% of 15)</td>
</tr>
<tr>
<td>Witness -</td>
<td>17</td>
<td>3</td>
</tr>
</tbody>
</table>

- 12/100 times the witness will correctly identify a Blue cab as Blue
- 17/100 times the witness will incorrectly identify a Green cab as Blue
- There is therefore a 12+17=29% chance the witness will identify the cab as Blue
- This results in a 12/29 or 41% chance that the cab identified as Blue is actually Blue

Base rate neglect (prevalence neglect)
A 30-year old woman complained of a dull left-sided headache

On examination she was tender over her left temple

A junior doctor remembered learning about temporal arteritis and requested an ESR (a test for temporal arteritis) which was raised at 100 mm/hr

The junior doctor diagnosed temporal arteritis

Temporal arteritis does not exist in people aged <50
You see two patients with chest pain and decide to send them both for an imaging stress test to see whether they have ischaemic heart disease (see WORKSHEET).

Stress testing has a sensitivity of 90% and specificity of 85%.

We know the actual prevalence of IHD in the population based on angiography and post-mortem studies.

What is the chance of a positive stress test being correct in each of your two patients?

(The answer is not 90%)
65 year old man with typical angina history: results

<table>
<thead>
<tr>
<th></th>
<th>IHD</th>
<th>No IHD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual</td>
<td>94</td>
<td>6</td>
</tr>
<tr>
<td>Pos ST</td>
<td>84.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Neg ST</td>
<td>9.4</td>
<td>5.1</td>
</tr>
</tbody>
</table>

PPV = true pos/(true pos + false pos) x 100

= 84.6/(84.6 + 0.9) x 100 = 99%

The above are the actual results you would get.
35 year old woman with atypical chest pain history: results

<table>
<thead>
<tr>
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<th>IHD</th>
<th>No IHD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Pos ST</td>
<td>0.9</td>
<td>14.9</td>
</tr>
<tr>
<td>Neg ST</td>
<td>0.1</td>
<td>84.1</td>
</tr>
</tbody>
</table>

The above are the actual results you would get.

$$PPV = \frac{\text{true pos}}{\text{true pos} + \text{false pos}} \times 100$$

$$= \frac{0.9}{0.9 + 14.9} \times 100 = 5.7\%$$
A test result by itself is not the answer

- Tests must be interpreted in the light of CLINICAL PROBABILITY
- You must also know something about the CHARACTERISTICS of the test in question
- And if the PREVALENCE of the disease is very high or very low in the patient’s group – this affects the predictive value of the test
Conclusions: ‘Commonly used measures of test accuracy are poorly understood by health professionals’
It is not necessary to know the true state of the patient before deciding whether to act.

The therapeutic threshold combines factors such as test characteristics, risks of the test, and the risks and benefits of treatment.

The point at which all factors are evenly weighed is the threshold.

If a test or treatment is effective and low risk we would have a lower threshold for going ahead …
Two patients with diabetes have their HbA1c measured and both have a result of 7.0%

120 days later they are re-tested

Patient A’s result is 6.5%

Patient B’s result is 7.5%

Is Patient A more successful in controlling his diabetes?
All lab tests vary due to analytical variation and biological variation

The amount by which they can vary is called the ‘critical difference’ and this value is different for different tests

For HbA1c the critical difference is a change in value of 0.5%

So Patient A and Patient B had the same HbA1c result both times
# Calculated Critical Differences for Some Chemistry Parameters

<table>
<thead>
<tr>
<th>Test</th>
<th>Biological CV</th>
<th>Analytical CV</th>
<th>CD as %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>4.7</td>
<td>1.9</td>
<td>9.9</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>5.8</td>
<td>2.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Uric Acid</td>
<td>8.6</td>
<td>3.0</td>
<td>25.2</td>
</tr>
<tr>
<td>Urea</td>
<td>10.3</td>
<td>1.6</td>
<td>28.9</td>
</tr>
<tr>
<td>Total Protein</td>
<td>2.6</td>
<td>3.1</td>
<td>11.2</td>
</tr>
<tr>
<td>Albumin</td>
<td>2.6</td>
<td>3.1</td>
<td>11.2</td>
</tr>
<tr>
<td>Calcium</td>
<td>1.6</td>
<td>1.5</td>
<td>6.1</td>
</tr>
<tr>
<td>In Phosphorus</td>
<td>4.8</td>
<td>1.3</td>
<td>13.8</td>
</tr>
<tr>
<td>T. Bilirubin</td>
<td>16.5</td>
<td>4.7</td>
<td>47.5</td>
</tr>
<tr>
<td>Alk. Phosphate</td>
<td>6.5</td>
<td>3.6</td>
<td>37.1</td>
</tr>
<tr>
<td>LD</td>
<td>12.9</td>
<td>1.5</td>
<td>35.0</td>
</tr>
<tr>
<td>AST</td>
<td>8.2</td>
<td>5.7</td>
<td>27.7</td>
</tr>
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Let's Recap
Clinical reasoning can be conceptualised as a process with different components that each require specific knowledge, skills and behaviours:

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Consensus statement on the content of clinical reasoning curricula in undergraduate medical education. UK Clinical Reasoning in Medical Education group, 2019.
A 18-year-old man presented to his GP Surgery and was seen by a final year medical student

The student presented the clinical findings to her supervisor

The patient had a 48 hour history of feeling feverish, being off his food, he had vomited once, and complained of central abdominal pain. He had not opened his bowels for 2 days

On examination, he was tender in his right iliac fossa

When asked about her differential diagnosis, the student said ‘constipation’.
• The problem representation is a concise, accurate synthesis of all the information gathered in the history and physical examination (and sometimes initial test results)

• It is a key step in clinical reasoning

• It consists of precise medical terms (a.k.a. ‘semantic qualifiers’)
  - Sudden vs gradual
  - Constant vs intermittent
  - Dull vs stabbing
  - Unilateral vs bilateral

• It comes before differential diagnosis

• Sometimes, a problem list may be required rather than a single representation
• Converting the history and physical examination (and sometimes test results) into a precise medical summary – **encapsulation using semantic qualifiers** – helps to organise and retrieve knowledge from long term memory relevant to the case.

• The main difference between ‘strong’ as opposed to ‘weak’ diagnosticians is in their use of semantic associations to organise their knowledge.

• This elaborated structure is associated with accurate resolution of complex problems (75-80%) as opposed to near zero resolution for dispersed discourses.

Clinical reasoning can be conceptualised as a process with different components that each require specific knowledge, skills and behaviours:

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4. **Shared decision making**
What does ‘shared decision making’ mean to you?
Shared decision making

Decisions are often co-produced with:

• Patients and carers
• Teams
• Guidelines
• Scores and decision aids

‘Optimal decision making behaviours’ lead to better decisions

Consensus statement on the content of clinical reasoning curricula un undergraduate medical education. UK Clinical Reasoning in Medical Education group, 2019.
At the present time, disease-specific training is the only intervention that is both supported by evidence and seems implementable.

Knowledge remains the key determinant of diagnostic accuracy.

Courses aimed at teaching the general thinking processes involved in clinical decision making are largely ineffective, whereas teaching strategies aimed at building knowledge and understanding lead to improvements.

Schmidt & Mamede. (2015). How to improve the teaching of clinical reasoning: a narrative review and a proposal. Medical Education; 49; 961-973
What do we mean by ‘knowledge’?
Teaching clinical reasoning: knowledge dimensions

Arterial Blood Gas:

- pH 7.1
- PaCO₂ 3.5 kPa
- St bicarb 8 mmol/L
- BE – 20
- PaO₂ 12 kPa

- **Factual**
  - Terminology
  - What ‘pH’ means

- **Conceptual**
  - Physiological principles
  - A model for understanding blood gases

- **Procedural**
  - Techniques (when to do a blood gas, how to read a blood gas)

- **Metacognitive**
  - Contextual knowledge (“This is bad”)
  - Strategic/self-knowledge (“I need to read up on that”)

A statement of a **learning objective** contains a **verb** (an action) and an **object** (usually a noun).

- The **verb** generally refers to [actions associated with] the intended **cognitive process**.
- The **object** generally describes the **knowledge** students are expected to acquire or construct. (Anderson and Krathwohl, 2001, pp. 4–5)

In this model, each of the colored blocks shows an example of a learning objective that generally corresponds with each of the various combinations of the cognitive process and knowledge dimensions.

**Remember**: these are **learning objectives**—not learning **activities**. It may be useful to think of preceding each objective with something like: “Students will be able to . . .”


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*Model created by: Rex Heer
Iowa State University
Center for Excellence in Learning and Teaching
Updated January, 2013
Licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License.
For additional resources, see:
www.celt.iastate.edu/teaching/RevisedBloom5.html*
• Cognitive psychology experiments find that learners struggle to apply knowledge gained in one context to solving problems in another

• Therefore practice with as many cases as possible in as many different contexts as possible is required – with feedback

• Structuring knowledge around problem-specific concepts has been shown to promote spontaneous analogical transfer

Organised problem-specific knowledge

DOI 10.1007/s10459-008-9149-8

Qualitative differences in knowledge structure are associated with diagnostic performance in medical students

Sylvain Coderre · Deirdre Jenkins · Kevin McLaughlin

• Factual knowledge is essential but is not enough (procedural, conceptual and metacognitive knowledge is also required)
• Practice with as many cases as possible in as many different contexts as possible is also required – with coaching and feedback
• How knowledge is structured/organised in memory is a key factor for effective clinical reasoning ability

Discussion
Let’s Recap
Clinical reasoning as a dual process

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All roses are flowers
Some flowers fade quickly
Therefore some roses fade quickly

This argument is flawed because it is possible that there are no roses among the flowers that fade quickly

Spot the cognitive biases at play

Case history (see worksheet)
<table>
<thead>
<tr>
<th><strong>Anchoring</strong></th>
<th><strong>Diagnostic momentum</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>When we fix on a particular bit of information, leading us to think in a constrained way</td>
<td>Tendency for a particular diagnosis to stick despite lack of supporting evidence</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Confirmation bias</strong></th>
<th><strong>Search satisficing</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendency to look for confirming evidence to support our initial hypothesis rather than looking for disconfirming evidence to refute it</td>
<td>From the words ‘satisfy’ and ‘sufficient’ - when we stop searching because we have found something that fits or is convenient, instead of systematically looking for the best alternative</td>
</tr>
</tbody>
</table>
• Tendency for a particular diagnosis to stick despite lack of supporting evidence

• ‘Like a boulder rolling down a mountain, the diagnosis gathers momentum, crushing all else in its path’

• Usually involves several intermediaries, including the patient

• Often starts as an opinion, not necessarily medical, and passed with increasing certainty from one person to the next

• Diagnostic labels become particularly ‘sticky’ once a patient has been seen by a consultant
‘Bias should be considered a normal operating characteristic of the human brain – biases are everywhere and have the potential to influence almost every decision we make.’

Croskerry P. Bias: a normal operating characteristic of the diagnosing brain. Diagnosis 2014; 1: 23-7
Heuristics and biases

• Heuristics (pattern recognition) and ‘biases’ are shortcuts
• They are neither good nor bad
• Correct diagnosis is associated with spending less time on a diagnostic task
• The positive effect of reflection during decision making is primarily observed while diagnosing complex cases (relative to the stage of training)

Reflection in diagnostic decision making

• Several studies have been performed looking at the effect of reflection during diagnostic decision making.

• Guided reflection in particular improves diagnostic performance (effect size 0.5).

• Immediate feedback using contrasting examples also improves diagnostic accuracy.

Reflection during case-based learning

For example:

- ‘What’s the evidence for this diagnosis? What else could this be?’

- Structured reflection / contrastive feedback:
  - List the findings that support the diagnosis
  - List the findings that go against the diagnosis
  - List the missing findings you would expect to be present if this is the diagnosis

• Structured reflection while practicing with cases appears to foster the learning of clinical knowledge

• But what about when the teacher is not there?

Human thinking and decision-making relies on two distinct types of processes, known as System 1 and System 2.

Pattern recognition is what experts do.

Humans are cognitive misers.

‘Reflection’ leads to improved diagnostic performance in studies.

Change in performance after being instructed to reflect is not a measure of one’s thinking dispositions (cognitive style).

Deliberate practice is a specific concept that leads to expert performance.
Discussion
You can diagnose an individual learner’s difficulties by conceptualising clinical reasoning as a process with different components that each require specific knowledge, skills and behaviours:

1. History and physical examination
2. Choosing and interpreting diagnostic tests
3. Problem identification and management
4. Shared decision making

Teachers can use a few brief questions or prompts to stimulate reflection-on-action on the part of the learner.
A 70-year-old woman presented to hospital with a 24-hour history of breathlessness on exertion. She had no other symptoms.

Her only past medical history was non-small cell cancer of the lung, for which she was having chemotherapy. She was normally independent and was only taking anti-emetic medication when required.

On examination, her vital signs were: heart rate 90/min, RR 20/min, SpO₂ 96% on air, BP 130/80mmHg, apyrexial.

The physical examination was normal.

Full blood count, urea & electrolytes, glucose and liver tests were normal. Her 12-lead ECG was normal.

CXR: no change to previous
• What is the most likely diagnosis?

• Write down a ‘problem representation’ using semantic qualifiers
Different learners have different difficulties

**Learner 1**
- Takes a good history and performs an accurate physical examination
- Identifies the problem as ‘breathlessness’
- Has not considered PE

Probable skills gap: accurate problem representation

Possible knowledge gap

‘What causes of breathlessness do you know?’

‘What causes breathlessness in a 70-year-old woman with cancer on chemotherapy?’

Minimally guided prompts to simulate reflection focusing on problem representation
Different learners have different difficulties

**Learner 2**

Takes a good history and performs an accurate physical examination

Has considered PE but decides against it because the patient has normal vital signs and has not had any chest pain

Possible knowledge gap

Probable problem with interpretation of history and examination findings

‘What symptoms does PE most commonly present with?’

‘Can you have normal vital signs at rest and have a PE?’

Minimally guided prompts to simulate reflection focusing on pre-test probability and likelihood ratios
Different learners have different difficulties

**Learner 3**

Has correctly identified the problem as: ‘Acute breathlessness in a 70-year-old woman with breast cancer on chemotherapy’ and considered PE.

However, an ABG is normal, so the learner seeks your advice on how to proceed.

**Possible knowledge gap**

Probable problem with interpretation of diagnostic test results

‘What is the clinical (pre-test) probability of PE in this case – low, intermediate or high?’

‘How does this one normal test result shift your thinking?’

Minimally guided prompts to simulate reflection focusing Bayesian reasoning (and knowledge)
# Resources for advanced learners

## ASSESSMENT of REASONING TOOL

<table>
<thead>
<tr>
<th>Did the Learner…</th>
<th>Assessment</th>
<th>Learner</th>
<th>Evaluator</th>
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</thead>
<tbody>
<tr>
<td>Collect/report history and examination data in a hypothesis-directed manner?</td>
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<tr>
<td>- Non-directed in questioning and exam</td>
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<td>- Asked questions without clear focus on potential diagnoses</td>
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<td></td>
<td>Partial</td>
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<tr>
<td>Articulate a complete problem representation using descriptive medical terminology?</td>
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<td>- Included extraneous information</td>
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<tr>
<td>- Missed key findings</td>
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<td>- Did not translate findings into medical terminology</td>
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<tr>
<td>Articulate a prioritized differential diagnosis of most likely, less likely, unlikely, and 'can't miss' diagnoses based on the problem representation?</td>
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<tr>
<td>- Missed key elements of differential diagnosis, including likely diagnoses or 'can't miss' diagnoses</td>
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<td>Direct evaluation/treatment towards high priority diagnoses?</td>
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<td>- Directed evaluation and treatment toward unlikely/unimportant diagnoses</td>
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<tr>
<td>- Did not evaluate or treat for most likely 'can't miss' diagnoses</td>
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<tr>
<td>Demonstrate the ability to think about their own thinking (metacognition)? Consider asking: Is there anything about the way you are thinking or feeling about this case that may lead to error?</td>
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<td>- Not able to describe influence of cognitive tendencies or emotional/situational factors that may have influenced decision-making</td>
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## Overall Assessment

<table>
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<tr>
<th>Needs Improvement</th>
<th>Meets Competency</th>
<th>Excellence</th>
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**Comments:**

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https://www.improvediagnosis.org/art/
• When teaching in clinical settings or with practice cases, teachers can use brief ‘teachable moments’

• You can diagnose a learner’s difficulties by conceptualising clinical reasoning as a process with different components that each require specific knowledge, skills and behaviours

• Teachers can use a few brief questions or prompts to stimulate reflection-on-action on the part of the learner
Further resources