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What strategies to review diagnoses are feasible and sustainable in Emergency Departments?

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Executive summary

Diagnosing illness and injury is a core task in the practice of medicine, and involves a complex process of gathering and synthesising information from patients, imaging and other tests. Diagnostic error - defined as "the failure to (a) establish an accurate and timely explanation of the patient's health problem(s) or (b) communicate that explanation to the patient" – can create considerable harm to patients and are a major contributor to malpractice claims. The challenge of diagnosis is magnified in the Emergency Department (ED) due to time pressures, distractions and unfamiliarity with patient history and information.

Concerted efforts to measure, understand and reduce diagnostic error, including in EDs, have increased in recent years. In addition to gaining a better understanding of system-related factors, this has also led to an emerging understanding of the significant role of cognitive bias due to use of mental heuristics or 'short cuts'. Clinician over-confidence, problems relating to diagnostic testing, and breakdowns in doctor-patient communication are other prominent factors contributing to misdiagnosis.

This project focuses on the development of a feasible, scalable and sustainable strategy to minimize diagnostic error in Victorian EDs. A rapid review of literature identified six relevant systematic reviews, including two of high methodological quality, and two narrative reviews. Collectively, these reviews identified categories of intervention that could be applied to ED settings:

1. Additional Review / Second Opinion
2. Decision Aids, for example checklists
3. Guided reflection to examine possible sources of cognitive bias
4. Education regarding diagnosis of specific conditions
5. Improving teamwork in the ED setting
6. Engaging the patient as a partner in the diagnostic process
7. Improving feedback; finding diagnostic errors and learning from them

We consulted with a panel of 11 Victorian community members to better understand their perspectives on diagnosis in the ED. This underlined that citizens value honesty and are comfortable with uncertainty as they recognise that diagnosis in the ED setting is challenging. Citizens also emphasised the value of communication in creating the space for patients to fully describe their symptoms and other relevant information, and expressed the need for better and more consistent training in this area. Frustration with inaccessibility of e-health records to reduce 'telling the same story again' was also expressed, as well as the need for patients and families to better understand the role of ED and provide feedback on ED processes. Practice interviews with ED clinicians, researchers and medico-legal specialists reiterated the complexity and challenges of optimising ED diagnosis and the need to optimise communication with patients. Other important insights were the importance of teamwork, especially in chaotic environments; the need for critical thinking skills training; the effectiveness of second opinions and time-outs to review working diagnoses; and the importance of following up on tests. Collectively, the review and consultation activities have highlighted a range of strategies and insights that can shape intervention development. The key challenge in developing and testing an intervention to optimise diagnosis in the ED will be to ensure that it is evidence-based, feasible, acceptable and therefore sustainable in the long term.

Aims

This research project is one of six to be conducted within a three-year Research and Innovation Program funded by the Victorian Managed Insurance Authority (VMIA) and being delivered by Monash University's BehaviourWorks Australia (see Appendix 1 for more details). The research projects are developed using a structured approach known as the Forum method (Bragge et al., 2015a; Bragge et al., 2015b; Lavis, Boyko, & Gauvin, 2014; Middleton et al., 2015). The aim of this research project and the associated activities are presented below.

Table 1: *Research Project Overview*

Aims	Status
Conduct a rapid review of evidence into the effectiveness of strategies to review diagnoses that are feasible and sustainable in emergency departments	Findings are presented in this Briefing Document, which has been prepared to inform a structured stakeholder dialogue at which research evidence is one of many considerations. The Briefing Document is directed towards stakeholder groups with expertise in or experience in Victorian health service emergency departments. These include Emergency Medicine clinicians representing metropolitan and rural health services, consumers and consumer representatives, researchers with expertise relevant to this topic, the Victorian Department of Health and Human Services (DHHS) and the Victorian Managed Insurance Authority (VMIA).
Examine current practice and key issues in health service emergency departments in Victoria through one-on-one interviews with clinicians and other experts in the field and a citizens panel	
Convene a representative stakeholder group to: - Gain a shared understanding of key issues in diagnosis in the emergency department (ED) setting, including specific conditions that present diagnostic challenges; - Identify an intervention to optimize ED diagnosis for a high-priority condition that could be trialed and scaled across Victoria; - Determine broad trial characteristics for further development following the dialogue.	A day-long structured stakeholder dialogue will be held on **December 11, 2017.** The dialogue aims to connect the information from this briefing document with the people who can make change happen, and deliberate upon this shared challenge. Collective problem solving through multi-stakeholder dialogue has been used around the world to address healthcare policy and practice challenges and participants consistently demonstrate high satisfaction and high intention to act upon evidence presented in this dialogue. Specific questions for deliberation at this stakeholder dialogue are presented at the end of this briefing document.
Design, develop, implement and evaluate a pilot trial of the identified intervention to review diagnoses in Victorian Emergency Departments.	The pilot trial is anticipated to be designed and implemented in the first half of 2018.

Introduction

The Diagnostic Process

The diagnostic process involves a continuous process of information gathering, interpretation and revision of diagnostic hypotheses. The diagnostician must decide what evidence they require to exclude to some possibilities while increasing the likelihood of the final diagnosis. Relevant evidence may come in a variety of forms, such as a patient's responses to questioning about symptoms and medical history, physical examination or laboratory test results. When one or several initial diagnoses are being considered, tests are typically ordered to refine the differential diagnosis by improving the estimated probability of the working diagnosis relative to other potential diagnoses (Bornstein & Emler, 2001). Diagnoses emerge and sometimes evolve over time. Insights are taken from history and presenting symptoms but new symptoms may develop and information becomes available from tests and further investigations. Figure 1 is a representation of this process patient presentation to patient and system outcomes.
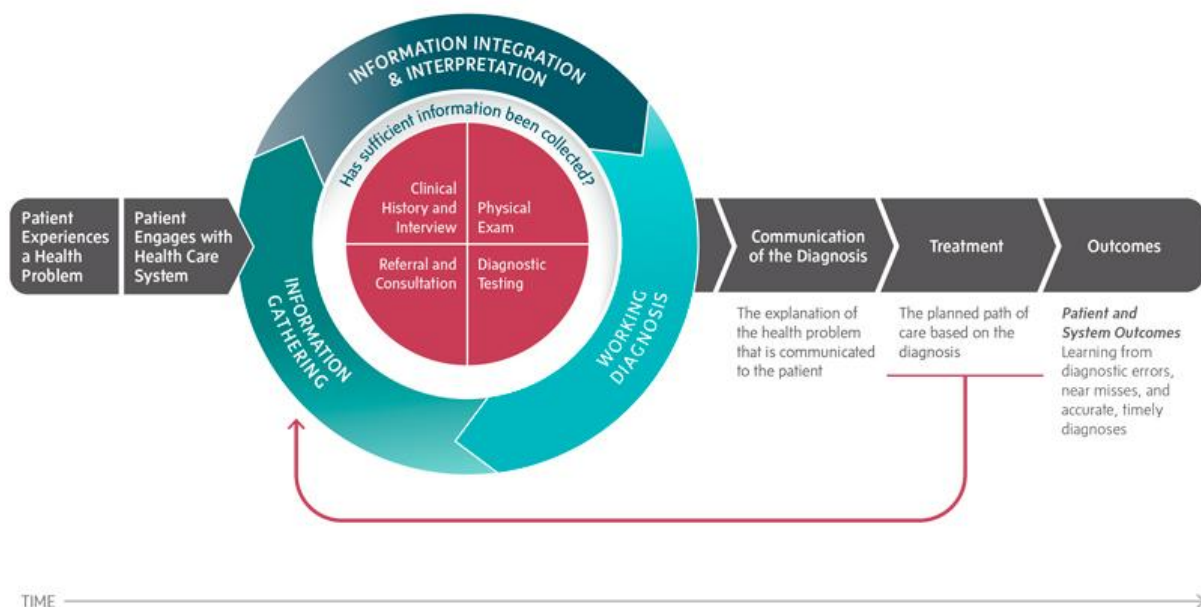
Figure 1: The Diagnostic Process (National Academy of Medicine, 2015)

Diagnostic error

Diagnostic error is defined as "the failure to (a) establish an **accurate and timely explanation** of the patient's health problem(s) or (b) **communicate that explanation** to the patient" (National Academy of Medicine (NAM), 2015).

The Australian Patient Safety Foundation further specifies three types of diagnostic error (Australian Patient Safety Foundation, 2017):

- Misdiagnosis: the diagnosis was incorrect (another diagnosis was made before the correct one)
- Missed diagnosis: no diagnosis was ever made
- Delayed diagnosis: diagnosis was unintentionally delayed (sufficient information was available earlier).

Breakdowns in the diagnostic process reflect 'missed opportunities' to have made the diagnosis more accurately or more efficiently (Bornstein & Emler, 2001; Singh, Graber, Kissam, & et al, 2012). Due to the complexity of the diagnostic process, there are many definitions of 'diagnosis' and 'diagnostic error' in research literature other than those presented above, which variably focus on the diagnostic process itself, system vs. cognitive errors, and conceptual models of how diagnosis evolves over time. (National Academy of Medicine, 2015). The definition above, contained within a recent major report on diagnostic error by the National Academy of Medicine (National Academy of Medicine, 2015), was developed to highlight key characteristics of diagnosis – accuracy, timeliness and communication to the patient.

Diagnostic error can either delay timely treatment of a condition, or create unnecessary harm by treating a condition not actually present. This can result in inappropriate or extended hospital admission and in extreme cases, permanent disability or death. In recent years there has been increasing awareness of the need to address diagnostic error, as reflected by the NAM report and the establishment in 2011 of the US-based Society to Improve Diagnosis in Medicine (http://www.improvediagnosis.org/).

Diagnostic error epidemiology

Observational data on diagnostic error statistics is sparse due to the lack of reliable measures and the often-retrospective nature of diagnostic error identification. Both the National Academy of Medicine report and an Australian report by the NSW Clinical Excellence Commission state that one in every 10 diagnoses involves error (Clinical Excellence Commission, 2015). Although many diagnostic errors do not result in adverse patient events, diagnostic error is in the top ten causes of death in first-world health systems. Additional evidence on the incidence of diagnostic errors derives from surveys of patients and providers, chart reviews of specific conditions, using 'standardized patients' (secret shoppers) sent out into private practice settings, and autopsies (M. Graber, 2013). Autopsy data is considered the gold standard for identifying diagnostic errors, and identifies major diagnostic discrepancies in 10-30% of cases (Marshall & Milikowski, 2017).

An important source of diagnostic error data is medical liability claims. A review of over 350,000 malpractice claims from 1986 – 2010 in the USA found that diagnostic errors represented the biggest single category of claims, representing 28.6% (100, 249) of all claims – in excess of surgical (24.2%) and medication errors (5.3%). This review also found that diagnostic errors resulted in death more often than other claim groups, also led to significant, major and minor permanent injury and cost a total of US$38.8 billion when adjusted for inflation (Tehrani et al., 2013). Data from the Victorian Managed Insurance Authority (VMIA) into Medical Indemnity claims that closed between 2012 – 2017 (relating to incidents between 1963 – 2016) reveals similar insights into diagnostic error in Victoria, Australia. Diagnosis-related claims were the second highest claims in all Medical Indemnity claims.

Although liability claims are generally a reliable source of data, the above statistics should be interpreted in the context that claims represent the severe end of diagnostic error consequences, and do not capture all cases of diagnostic error. Furthermore, claims data cannot quantify 'near misses' – events that could have had adverse consequences but did not (Barach & Small, 2000).

What are the causes of diagnostic error?

Even when it goes well, as it most often does, diagnosis is complex: There are over 10,000 diseases, 5000 diagnostic tests, and uncertainty is inherent at every step of the diagnostic process. This section

will focus on the factors that detract from successful diagnosis, emphasizing the major cognitive- and system-related issues that are commonly identified. In particular, we highlight those issues that seem preventable through appropriate interventions.

Breakdowns in accuracy and timeliness

The first part of the definition of diagnostic error used in the NAM report relates to the failure to establish an accurate and timely diagnosis. Most cases involve several different root causes, and some combination of cognitive- and system-related breakdowns. Cognitive factors are thought to be at play in an estimated 75 – 96% of misdiagnosis cases (Hendrie et al., 2017; Kachalia et al., 2007). Although inadequate medical knowledge or problems acquiring the relevant medical data sometimes contribute to cognitive errors, most cognitive breakdowns involve the clinical reasoning step, where the physician establishes the diagnostic possibilities based on the available information and their store of knowledge (Lambe, O'Reilly, Kelly, & Curristan, 2016). Reflecting this, VMIA data shows that failure to establish or act upon differential diagnosis at initial assessment is a major contributor to claims.

Cognitive bias

Many diagnoses are made intuitively – the clinician simply recognizes the diagnosis, or believes that they do. Cognitive scientists describe this process as using mental 'short cuts', often referred to as 'heuristics' or 'rules of thumb'. These are the same processes used outside of medicine in every-day decision making, and in both settings the vast majority of our actions and decisions are appropriate and correct, thanks to this subconscious cognitive processing.

Unfortunately, each of these heuristics is also inherently fallible, and can lead to diagnostic error. In this case, they represent cognitive bias, defined as "systematic and predictable errors in judgement that result from reliance on heuristics." (Blumenthal-Barby & Krieger, 2014) Over 150 cognitive biases have now been described, and biases that are commonly encountered in clinical reasoning are listed in Table 1 below.

In cases of actual diagnostic error, two of these biases were found to be especially common: Context errors and premature closure (Croskerry, 2009; M. L. Graber, Franklin, & Gordon, 2005):

- Context errors are situations where the clinician, in trying to make sense of the patient's findings, fails to construct an accurate mental model. As examples, a chronic problem is misjudged to be acute; or abdominal pain is assumed to reflect a GI problem, when in fact it could be due to a cardiac, neurological, or vascular condition; or fever due to inflammation is misjudged as being an infection. A common factor predisposing to context errors involve how a problem is framed. For example, the ED physician may be misled by a patient who presents with their own ideas of what the diagnosis is, or by a diagnosis assigned by another physician who has seen the patient earlier.
- Premature closure is the tendency to accept the first diagnostic hypothesis that explains all the findings in a case, without considering other possibilities. This again is human nature, and the economist Herbert Simon received a Nobel prize for describing this tendency as 'satisficing'. Consistent with this concept of satisficing, Singh et al found that in cases of diagnostic error there was no differential diagnosis listed 80% of the time (Singh et al., 2013).

Bias has also been consistently demonstrated in experimental studies where clinicians attempt to determine the diagnosis from case scenarios. A recent review found that the presence of cognitive

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biases was associated with diagnostic inaccuracies in 36.5 - 77% of case-scenarios (Saposnik, Redelmeier, Ruff, & Tobler, 2016). Another review of 145 studies examining cognitive biases and heuristics in medical decision-making found evidence of a bias or use of a heuristic in 68% of studies (populations including both doctors and patients) and bias or heuristic in a subpopulation in a further 22% (N=46). Only 22 (10%) of studies disconfirmed the presence of a bias in the study population. Of the studies examining biases in medical personnel, 80% (n = 51) confirmed their presence, compared with 61% (n = 86) in patients. (Blumenthal-Barby & Krieger, 2014). It is important to bear in mind when examining bias that real-world clinical decision-making is also mediated by technology and teamwork (Blumenthal-Barby & Krieger, 2014).

Reviews have found strong support for specific biases in medical decision-making. For example, 25 out of 29 studies (86%) confirmed the presence of relative risk bias (Blumenthal-Barby & Krieger, 102014). The omission bias was also strongly supported, with 14 of 18 studies (78%) confirming it. Availability bias is the bias that has been studied the most in actual decision scenarios (10 of 22 studies, with all of them confirming the presence of the bias). However, three out of four studies disconfirmed the presence of the sunk-cost effect. Investigations have also considered confirmation bias (the tendency to seek and pay greater attention to confirmatory evidence). One review found that internists' evaluation of symptoms relating to pneumonia were more sensitive to confirmatory symptoms (e.g. the presence of chills), they were less sensitive to the absence of equally valuable symptoms (Bornstein & Emler, 2001).

Overconfidence
Another human tendency thought to contribute to diagnostic error is over-confidence on the part of clinicians (Berner & Graber, 2008). Diagnostic calibration has been defined as the relationship between diagnostic accuracy and doctor confidence in that accuracy. A well-calibrated physician would have a good sense of knowing what they know and what they don't, and when they need to 'slow down' and think more deeply about a problem, or consult the medical literature, or request consultation from a specialist. The VMIA claims data shows that failure / delay in referral to specialists is a frequent contributor to diagnostic error and delay.

It makes sense that diagnostic accuracy decreases when doctors are faced with more difficult cases. The surprising finding in a report that studied the issue is that as their accuracy falls off, physician confidence in the diagnosis stays high (Meyer, Payne, Meeks, Rao, & Singh, 2013).   These findings are in agreement with other studies demonstrating that physicians' confidence in their diagnosis is not a good indicator that the diagnosis is correct (Podbregar et al., 2001). Furthermore, individuals with the least-experience are the most overconfident of their abilities and decisions, the so-called Kruger-Dunning effect, (Kruger & Dunning, 1999) which may be relevant to situations where junior staff or trainees are working in ED settings.

The most effective intervention to improve calibration is providing feedback on performance. Physicians in the ED receive occasional feedback, but the vast majority of patient encounters are one-time events with no follow-up, and the physician never learns whether their triage or diagnostic decisions were correct or not. One more human tendency that comes into play here is that, in the absence of feedback, we assume all our assessments and decisions are correct, (Schulz, 2010) perpetuating the overconfidence we have in our abilities.

Table 1: Cognitive Biases involved in medical decision-making

Bias	Definition
Anchoring	The tendency to perceptually lock on to salient features of the patient's presentation too early in the diagnostic process and failing to adjust this impression in light of later information
Availability	Overestimating probability of a diagnosis when instances are relatively easy to recall
Confirmation	Selectively gathering and interpreting evidence that confirms a diagnosis and ignoring evidence that might disconfirm it
Context Errors Framing Bias	Related biases that result from the way information is presented. Examples: Ed physicians may fail to consider other possibilities in a patient sent from clinic with a preliminary diagnosis of heart failure. Or a patient with abdominal pain is immediately assumed to have a GI problem, when in fact it could be vascular, neurogenic, or have some other origin.
Gambler's Fallacy	The pre-test probability that a patient will have a particular diagnosis might be influenced by preceding but independent events i.e. The belief that if a coin is tossed ten times and is heads each time, the 11th toss has a greater chance of being tails
Hindsight	Overestimating probability of a diagnosis when the correct diagnosis is already known
Omission	The judgement that harmful commissions are worse than the corresponding omissions
Order Effects	Information presented at the beginning or end of a series is remembered and chosen more often than information presented in the middle of the series (U-function)
Outcome	The tendency to opt for diagnostic decisions that will lead to good outcomes, rather than those associated with bad outcomes. It is a form of value bias in that doctors may express a stronger likelihood in their decision-making for what they hope will happen rather than what they believe might happen.
Overconfidence	A universal tendency to believe we know more than we do, and that our decisions are correct. Overconfidence reflects a tendency to act on incomplete information, intuitions or hunches.
Premature Closure Search Satisficing	The decision-making process ends too soon, the diagnosis is accepted before it has been fully verified, and without considering alternatives
Regret	Overestimating probability of a diagnosis with severe possible outcome because of anticipated regret if diagnosis were missed
Representativeness	Over-emphasising evidence that strongly resembles a class of events. Can lead to undervaluing of relevant base rates, ignoring regression to the mean and gambler's fallacy
Risk tolerance / aversion	A measure of the degree of uncertainty that someone is willing to accept in respect of negative outcome
Triage cueing	In EDs, triage is a formal process that results in patients being sent in particular directions, which cues their subsequent management
Sunk Cost	The more clinicians invest in a particular diagnosis, the less likely they may be to release it and consider alternatives.

(Bornstein & Emler, 2001; Croskerry, 2003; Saposnik et al., 2016)

Errors related to laboratory testing

Errors related to laboratory testing are common. Only a small fraction reflect errors in the analytical phase of testing; the majority involve errors by the ordering physician. These can be 'pre-analytical' errors, for example choosing the wrong test or test strategy (pre-analytical errors) or, retrieving the test results and, as the VMIA claims data also shows, delays in ordering tests in the first place.

'Post-analytical' errors relate to interpreting test correctly, and choosing the next appropriate course of action based on those results (Plebani, 2009). More specifically, these errors include failure to appreciate false positive and false negative results in the context of their relationship to the test's *sensitivity* (the proportion of patients who test positive who actually have the condition) and *specificity* (proportion who test negative and don't have the condition). A systematic review of how health professionals use diagnostic information found that although 82% of doctors reported being familiar with sensitivity and specificity, only 58% actually used this information when interpreting test results. This review also found that health professionals were generally poor at combining information on prevalence with data on sensitivity and specificity to calculate the post-test probability of disease; and that presenting natural frequencies (e.g. 10 out of every 1000 women have breast cancer) improved post-test probability estimation compared with presenting probabilities (e.g. the probability of a women having breast cancer is 1%) (Whiting et al., 2015).

Breakdowns in *communication*

The second part of the definition of diagnostic error used in the NAM report relates to the failure to clearly communicate the explanation to the patient. Communication breakdowns were the leading system-related contribution to diagnostic errors involving internal medicine patients (M. L. Graber et al., 2005). A critical issue that limits communication is the time allocated for interacting with the patient. A recent review found that internationally, the average primary care visit averaged just 5 minutes (Irving et al., 2017). ED interactions are also typically short, constrained by patient load and pressures that can be introduced by the '4 hour rule'. Besides time, several other factors detract from effective communication (Graham & Smith, 2016). The use of jargon, specialist terms and abbreviations when communicating with patients often impedes the patient's ability to understand the diagnosis or the associated instructions. For example, one study found that patients who presented with chest pain in the ED were often unable to remember diagnoses or advice post-discharge and were given very limited chances to discuss the diagnoses or concerns or ask questions (Ackermann et al., 2016). Patients' communication preferences in the ED include the use of plain language, providing the rationale for tests ordered, explanation of results and clear discharge instructions. The health literacy of individual patients needs to be considered in how teams talk to their patient.

Using a more dialogue-based discussion style has been found to be an effective method for improving communication. This allows for patients to feel like they are being heard, causing less anxiety and giving better information recall (Sloan & Knowles, 2017).

The American College of Physicians outlined a number of recommendations revolving around the concept of altering the perception that consultation time is inadequate. These included effective communication (active listening, information provision), striking a balance between time spent with patients vs. other tasks associated with patient care and minimisation of barriers to appropriate care by health institutions and systems (Braddock & Snyder, 2005).

Why focus on Diagnostic Error in the Emergency Department?

"The Emergency Department is the natural laboratory for studying diagnostic error, given the many factors that detract from optimal diagnostic conditions in this setting, including time pressure, distractions, incomplete access to information, and the fact that the physician typically has never seen the patient before." (Clinical Excellence Commission, 2015) p. 10

Patients often present to the ED with undifferentiated and complicated disease states that need to be managed expeditiously yet competently (Hendrie et al., 2017). The ED is often the gateway into the hospital for patients; however, due to the high-stress environment, as well as resource and time constraints, it is an area at potentially increased risk of diagnostic error relative to other health contexts. In the management of the undifferentiated critically ill patient, emergency doctors are constantly challenged to narrow the diagnostic conundrum rapidly and effectively at the bedside. In Australia, EDs are further constrained by the National Emergency Access Target (NEAT), also known as the '4-hour rule' which means that EDs are under pressure to make sure that 98% of patients arriving at the ED are to be seen and either admitted, discharged or transferred within four-hours from the time of triage. There is evidence from a range of studies quantifying diagnostic error in the ED setting:

- A study of 122 ED malpractice claims from hospital insurers found that leading breakdowns in the diagnostic process were: failure to order an appropriate test; failure to perform an adequate medical history or physical examination; incorrect interpretation of a diagnostic test; and, failure to order an appropriate consultation. The leading factors contributing to misdiagnosis were: cognitive factors; patient related factors; lack of appropriate supervision; inadequate handoffs; and, excessive workload. Most cases had two process breakdowns and three contributing factors (Kachalia et al., 2007);
- An Emergency Medicine Event Register found an overall diagnostic error rate of 18.2% (Abimajyi-Ochom, Mudiyanselage, Catchpool, Firipis, & Watts, 2017);
- A four-year review of diagnostic error in a US accident and emergency department found that the most common diagnostic error was missed fractures (79.7%). The most common reasons for error were misreading radiographs (77.8%) and failure to perform radiography (13.4%) (Guly, 2001)
- A case-control study in the US of EDs found a diagnostic error rate of 3.7% across multiple conditions (CI 2.9 - 4.5). Of the 79 cases with diagnostic error, the diagnosis was missed in 44. In 39% of cases, the correct diagnosis was considered, but an alternative was preferred. In 70.0% of cases, the diagnostic error was attributed to cognitive error alone, 25.3% had both a cognitive and system component and system error alone was responsible for 3.8% of cases. (Hendrie et al., 2017).
- In a retrospective chart review of ED patients aged over 18 presenting with abdominal pain, 35% of cases were determined to include a diagnostic error. In cases where there was a diagnostic error, the final diagnosis was less likely to have been included in differential diagnoses. Factors associated with diagnostic error included problems with the patient–provider encounter (68.6%, n=24), most frequently related to failure to order sufficient diagnostic tests for work-up (48.6%, n=17); problems collecting the patient history (40.0%, n=14); problems with follow-up and tracking of diagnostic information (74.3%, n=26), most frequently related to follow-up of abnormal diagnostic test results (65.7%, n=23); issues related to diagnostic test

performance/interpretation; problems with the consultation process (11.4%, n=4) and patient-related issues (14.3%, n=5) such as failure to mention key symptoms (Medford-Davis et al., 2016).

Ethnographic research reinforces the extent of the diagnostic challenge in the ED setting. A study of two metropolitan EDs in NSW highlighted a range of unique negotiation and persuasion tactics that are required to address the challenges described above. This study also identified important factors that collectively optimise the smooth transition of patients through the ED setting – hierarchy, formally imposed organizational boundaries, roles power and education (Nugus et al., 2017). Similarly, a separate study of five NSW EDs, the Emergency Communication Project, examined communication encounters through a linguistics lens, making a range of recommendations for best practice. These included achieving a balance between medical and interpersonal communication with patients; provision of explicit instructions to patients regarding ED processes and procedures; effective interdisciplinary teamwork; cross-cultural communication awareness and strategies; more effective and durable forms of patient records; and examining communication in clinical handovers (Slade et al., 2015).

What does research tell us about effective strategies to review diagnoses in Emergency Departments?

A rapid literature review was undertaken to identify, evaluate and synthesise published literature investigating interventions to reduce diagnostic errors in Emergency Departments via forms of diagnostic review. Whilst a focus on Emergency Departments was prioritised, evidence from other areas of hospitals was also considered.

Rapid reviews are an emerging method of efficiently synthesising research evidence in health policy and other settings where a broad overview of research evidence is required in a short timeframe. Unlike traditional systematic literature reviews (which take 12- 18 months), rapid reviews focus on synthesised research evidence and / or high-quality or recent primary studies. Caution needs to be applied interpreting rapid review findings, as more comprehensive review approaches may elucidate further information and insights, which would influence review interpretation and conclusions (Khangura, Polisena, Clifford, Farrah, & Kamel, 2014). Therefore, systematic reviews remain the definitive method of literature review, and we recommend systematic reviews be undertaken whenever possible. Further details of the review and other methods employed in producing this briefing document can be found in Appendix 2.

The literature search yielded a total of 4826 citations. Following screening, six systematic reviews (Abimajyi-Ochom et al., 2017; Bell, Strand, & Inder, 2014; Blumenthal-Barby & Krieger, 2014; Lambe et al., 2016; Riches et al., 2016) and two narrative reviews (Graber et al., 2012; Singh et al., 2012) were identified. Of the six systematic reviews appraised using a recognised quality appraisal tool, two were of relatively high quality (Lambe et al., 2016; Riches et al., 2016).

Interventions identified in the reviews typically related to efforts to improve clinical reasoning through reflective practice or metacognition, providing cognitive support through review or teamwork, and education or training interventions. The major interventions are summarised below, first in relation to EDs specifically, followed by evidence from other areas.

Additional Review / Second Opinion

Emergency Departments

A study within a recent literature review by Deakin University aimed to reduce errors in interpreting radiographs through use of a second opinion provided by a radiologist. When there was a clinically significant misinterpretation, the patient was contacted and asked to return. The study concluded that the intervention improved radiograph reading skills of ED clinicians and reduced error (e.g. missed fractures or foreign bodies) (Abimajyi-Ochom et al., 2017). Furthermore, common errors would be discussed in monthly meetings and a file of the clinically significant errors was created. The file was then used in ongoing training and its review was made mandatory for all new staff. A significant reduction in errors rates were seen following the implementation of the mandatory review (Abimajyi-Ochom et al., 2017).

Other Medical Areas

Use of second examination by members of a specialist team (composed of paediatric ED attending, a surgical attending and/or resident, a neuro-surgical fellow and/or resident, trauma nurses and ancillary staff) resulted in a significant reduction in delayed diagnosis of injury in a paediatric trauma

service (Abimajyi-Ochom et al., 2017). Similarly, ongoing patient examinations (including review of initial x-rays, continued serial examination of each patient for the entire clinical course, and objective and thoughtful discussion of missed injuries on a routine basis) have been found to reduce delayed diagnosis (Abimajyi-Ochom et al., 2017). A systematic review found that introducing redundancy in interpreting test results overall had positive effects on diagnosis (McDonald, Matesic, et al., 2013). Another systematic review focusing on low trauma patients in an outpatient setting found that the presence of an osteoporosis professional improved investigations, increased initiation of treatment, reduced future fractures and improved referral to specialist bone clinics (Bell et al., 2014). Several studies have demonstrated that second reviews of surgical pathology or cytology specimens find a small but important group of errors, and a growing number of healthcare systems now require second readings in case types known to have substantial rates of inter-observer variability. However, the narrative review of Graber et al. found that most of these studies do not include data on patient outcomes (Graber et al., 2012). The Graber review also identified two studies on feedback (on cancer detection rates) to improve diagnostic performance. Both studies showed benefits of feedback on later diagnostic accuracy. However, the positive impact noted could possibly be explained by the provision of detailed feedback to trainees on the reasons their initial diagnoses were correct or not (Graber et al., 2012).

Decision Aids including Checklists

Emergency Departments

Decision aids can improve doctors' decision-making performance by encouraging them to attend to the most relevant information and to assign that information its proper weight (Blumenthal-Barby & Krieger, 2014); decision aids can take the form of checklists, a set of questions, flowcharts or visual aids. Checklists are often used to ensure that proper steps are followed or that consideration has been given to a range of items. Checklists can provide clinicians with an additional method of review when diagnosing patients, checklists have the potential to improve the diagnostic process through the consideration of additional diagnostic possibilities. Whilst decision-aids are often used in the initial formulation of a diagnosis, checklists can also be used to check or review diagnoses.

Decision-aids and checklists have been found to assist in the diagnostic process, improve accuracy and reduce error. One study that implemented checklists in the ED setting prompted various differential diagnosis and changed the working diagnosis in approximately 10% of cases. Doctors found the symptom specific checklist more useful and therefore used more often than the general checklist. (Abimajyi-Ochom et al., 2017). A further ED study found that the introduction of a visual-based diagnostic decision support system improved diagnostic accuracy of skin infections more accurately by non-dermatologists (Abimajyi-Ochom et al., 2017).

Furthermore, a 'SEARCH 8Es' decision aid for bedside ultrasound was found to be an effective tool to help emergency doctors to narrow the differential diagnosis, to increase diagnostic confidence and was found to be accurate in the evaluation of patients with dyspnea, chest pain, or symptomatic hypotension (Ahn et al., 2017).

Another study explored how a computer-based decision aid could improve diagnosis and management of acute abdominal pain in ED settings. The study found that the system was accurate and noted that other system benefits may occur.

Utilising technology to improve the diagnostic process may also be effective. For example, an electronic trigger on unscheduled return visits in tertiary hospitals followed by the retrospective

patient record review identified cases of abdominal pain at high risk for diagnostic error. Although the aim of the study was to evaluate possible diagnostic error, the trigger system also identified opportunities for process improvement (Abimajyi-Ochom et al., 2017).

The implementation of a Picture Archiving and Communications System (PACS) in EDs electronically acquired, transferred, and stored radiographic images. This system also allowed for a review of the imaging to occur. This intervention improved diagnostic performance by reducing the overall misdiagnosis rate (particularly reducing false negative image readings), although the rate of serious misdiagnosis did not change (Singh et al., 2012).

Lastly, a patient-administered computerised questionnaire that patients filled in while waiting to be seen in the ED helped identify patients with mental illness, which doctors rarely diagnose in ED settings (Abimajyi-Ochom et al., 2017).

Other Medical Areas
The high-quality systematic review by Lambe et al. found that checklist interventions (both general and specific) were associated with fewer overall errors, more correction of errors on verification, and more extensive differential diagnosis (Lambe et al., 2016). Within this review, one study reported that checklists were only beneficial where doctors could review the content of the case (Lambe et al., 2016). A further high-quality review by Riches et al. found that differential diagnosis generators (DDX) tools with a comparator (clinical diagnoses by doctors or students), indicated that the use of DDX tools were associated with small, non-significant increases in accurate diagnosis retrieval and were just as likely to include the correct diagnosis as doctor generated lists (Riches et al., 2016). A further study trialled checklist as an additional review method, rather than in the initial interpretation stage. They found that their use during the verification stage of diagnostic decisions did not increase cognitive load and resulted in a reduction in diagnostic errors (Newman-Toker, 2013). Furthermore, two Canadian studies showed evidence of improvement in accuracy of diagnosis with use of checklists in cardiology; using a checklist in verification of diagnosis by experts and re-examining a cardiac exam using a checklist (Abimajyi-Ochom et al., 2017).

Studies on computer decision support systems have also found them to be useful in improving time to diagnosis (Abimajyi-Ochom et al., 2017). One study improved screening for major depressive disorder using a computer program which showed benefits compared to a manual reminder resulting in decreased time to diagnosis (Abimajyi-Ochom et al., 2017). Specifically, one web-based decision support program, 'ISABEL', was associated with the highest accurate diagnosis retrieval rates compared to all other DDX generators.

A review of system changes including protocols, feedback steps and quality improvement processes (many of these interventions involved a checklist or a form e.g. to guide and standardize physical examination of a patient) found some positive results however results of randomised control trials were mixed (McDonald, Matesic, et al., 2013).

Guided Reflection / Cognitive Forcing Strategies
Other Medical Areas
A high-quality review of five studies found that all interventions involving guided reflection (the use of a guided, structured reflective process rather than instructions to diagnose cases quickly) improved diagnostic accuracy. Within this review, two studies highlighted the utility of guided reflection in overcoming cognitive biases. However, one study reported an effect only in complex cases and results

for medical students were mixed and inconclusive (Lambe et al., 2016). Within this review, there were mixed results relating to the provision of meta-cognitive feedback (the provision of feedback on diagnostic reasoning strategies following final diagnosis), with one study finding no effect, a second study finding that cued or modelled reflection increased diagnostic accuracy and a third finding that experts benefited from supported reflection in complex cases, but novices only benefited in simple cases (Lambe et al., 2016).

Explicitly instructing medical professionals to consider alternative diagnoses was also found to improve diagnostic accuracy, compared with instructions to diagnose based on first impressions or without specific instruction. These instructions also reportedly improved confidence judgements (Lambe et al., 2016).

Guided reflection has also been found to decrease the tendency towards availability bias, and has also demonstrated that reflection on an initial diagnosis was helpful if the initial diagnosis was wrong, and did not lead to new errors if the initial diagnosis was correct (Graber et al., 2012). However, a limitation of these studies is that the additional time spent on problem solving may be what is driving the result, not conscious reflection *per se*.

Cognitive forcing strategies are a specific debiasing technique that introduces self-monitoring of decision-making. One intervention aimed to improve clinical reasoning of trainees by teaching them cognitive forcing strategies to counteract biases. The study lacked baseline data or a control group, and the results were generally negative. In addition, the retention of the cognitive forcing strategies that were the subject of the intervention was short-lived (Graber et al., 2012).

Education / Training

Other Medical Areas

In one hospital, a teaching program was established to identify signs and symptoms of a particular condition (subarachnoid haemorrhage) and to refer immediately to the relevant specialist. During the intervention, hospital seminars were presented on the condition and individual follow-up of all referred cases took place. The teaching program resulted in a 77% decrease in diagnostic errors relating to this condition (Abimajyi-Ochom et al., 2017). In another study, use of combined strategies (pattern recognition plus deliberate consideration) in teaching students to read electrocardiograms improved their diagnostic performance, in part by avoiding biases (Graber et al., 2012).

Educational strategies (e.g. residency training curricula, or maintenance of certification) targeted at professionals produced improvements (McDonald, Matesic, et al., 2013). Further, parent education improved discrimination of serious symptoms necessitating doctor diagnosis (McDonald, Matesic, et al., 2013). Lastly, informing doctors about a specific bias (the tendency to be influenced by a treatment's outcome valence in evaluating treatment decisions) reduced its deleterious effect on decision-making (Bornstein & Emler, 2001).

Additional Intervention options

The following 4 interventions are well justified from the literature and expert opinion, but lack strong experimental validation to date:

Teamwork

The foremost recommendation in the NAM report on Improving Diagnosis in Health Care was to promote teamwork, and more explicitly to engage nursing staff more effectively in the diagnostic process (National Academy of Medicine, 2015). The ED is a fortuitous setting to exploit this strategy, insofar as the staff are relatively fixed. For example, engaging nurses in diagnosis brings a second set of eyes to help understand the patient's condition, and provides a built-in way to enhance communication between the patient and the physician. Recent publications emphasize the potential value of nursing involvement (Considine, 2017; Gleason et al., 2017; M. Graber et al., 2017) as a potentially effective intervention to improve diagnostic quality and safety. One primary study examined a teamwork training curriculum based on crew resource management in aviation, based on five dimensions; maintain team structure and climate, apply problem-solving strategies, communicate with the team, execute plans and manage workload and improve team skills. The number of observed clinical errors (no diagnostic errors were observed during the trial phase) was significantly reduced in teamwork-trained EDs. The intervention was effective at influencing team behaviour, ED performance and attitudes and opinions. The positive impact of the intervention was in large part maintained over the eight months of post-training observation (Morey et al., 2002).

Patient Engagement

Engaged patients have better outcomes in many settings, and it is reasonable to expect that similar benefits would accrue to ED patients by inviting and encouraging the patient to be an active partner in the diagnostic process. In particular, patients should be instructed on when and how to re-engage with the healthcare system if their symptoms persist, change, or worsen, or if they aren't responding to treatment in the expected fashion. This creates a safety net, so that the diagnosis can be reconsidered if the patient returns, potentially preventing diagnostic error. Although largely unconfirmed in experimental studies, the potential benefits of patient engagement and the low-cost of such interventions mean they could be easily replicated and disseminated (McDonald, Bryce, & Graber, 2013).

Finding and learning from diagnostic errors

All of the interventions mentioned to this point are proactive, and meant to prevent diagnostic error, or identify errors in time to prevent harm. An alternative strategy is to find diagnostic errors that have already occurred, and learn from them (M. Graber et al., 2014). EDs are already following up with patients shortly after their visit; placing a second call several weeks later would provide an opportunity to learn whether the diagnosis was correct, based on the patient's condition in follow-up. A second strategy would be to elicit feedback from hospital staff in case the diagnosis changed after admission. Identifying errors in an ED patient population would provide the opportunity to consider the root causes in these cases, and a strong motivation to address these.

Using scribes

A scribe is a trained assistant who accompanies Emergency Physicians and documents the consultation, plans, assessment and other activities; aids in obtaining investigations and conducts other administrative duties such as delivering charts and pathology requests. The physician then reviews and edits the notes and completes writes up investigation request and undertakes all other tasks requiring a medical professional (Walker, Ben‐Meir, O'mullane, Phillips, & Staples, 2014). Research the ED setting and found that training scribes in the Australian setting is feasible; can result in an increase in consultations; and is economically viable once start-up and training costs are recouped (that is, if the scribe remains in the role for a sustained period). Although not an intervention aimed at improving diagnosis, use of scribes in EDs could create time savings that facilitate strategies to improve diagnosis (e.g. guided reflection, obtaining a second opinion, using a decision aid) by 'buying time' to enable these.

What do citizens think?

During a citizen panel convened on 26 October 2017, 11 socio-demographically diverse Victorian community members were provided a plain language version of this briefing document. During the deliberation about the problem, citizens were asked to share what they view as the key challenges in diagnosis, specifically in EDs and what they view as being needed to help support patients. Citizens were asked to reflect on their own experiences and those of friends and family to consider the underlying challenges and inform the types of interventions which may be appropriate. The key themes of the discussion are summarised below in Table 2.

Table 2: Summary of Citizen Panel Themes

Theme	Details
Uncertainty / Honesty	People put a lot of trust in health professionals, but they can still make mistakes; "We expect that medical knowledge is more complete than it is". Human error occurs in all fields and it could happen to anyone (relevant to both doctors and patients).
	Citizens valued honesty and want to know what is going on even if the answer is "we don't know yet". Not knowing what is happening is the worst part, for patients it can be a very over-whelming experience.
	Citizens were comfortable with uncertainty to a point, depending on the severity/intensity of the symptoms and the impact on the person's life.
	Challenge of 'shifting goal post' – okay with initial uncertainty but if doctors keep 'passing the buck' they worry they are not receiving adequate care.
	Citizens want to feel comfortable getting second opinions when not sure.
	The importance of getting second opinions when not sure.
Communication	Citizens felt they are often not being listened to. Ideally, medical professionals would place greater emphasis on the 'authority of the patient's experience' rather than an 'upper hand' approach.
	ED staff need to be more proactive in seeking information.
	Citizens experience many difficulties in speaking-up and may experience challenges in expressing their symptoms/experience with clarity. Therefore, help may be needed to assist patients in explaining their experience.
	To reduce the anxiety of uncertainty, having someone checking in with the patient.
	Provide patients with opportunities to update history or add/describe new symptoms as they emerge "Are there any new symptoms or anything you want to add?"
State-wide Standards	Skills and standards should be consistent across the state, citizens perceive great variability. Better consistency of care across doctors.
	A process to maintain skills across doctors and areas, making sure that collaboration between and across hospitals and networks is possible and adequate resources are available. Providing opportunities to learn from good hospitals and improving teamwork in hospitals.
	How is communication taught, are there common standards?
	How well is communication taught?
	Rural/Regional EDs are under a lot of pressure and don't have adequate resources

Consistency of available information	Systems like E-health make processes easier for patients, patient history needs to be more accessible between doctors and services providing consistent access and reducing repetition, which is especially frustrating in the context of repeated visits to EDs (e.g. when accompanying an elderly parent with multiple condition and medications). Citizens would like more access to their health information - 'I would love to have a snapshot of my general health' – but have concerns about how the information is used.
Patient's role	Patients and their families have a role to play in gathering more information for themselves and arming themselves with more tools and information. How can people ascertain if they should be in the ED? Reflections on the right to be there…patients are grateful for the doctor even seeing them, which then reduces the likelihood of them asking questions of / challenging the doctor Could there be a system that helps patients challenge doctors (e.g. a system for patients to give timely feedback)? Or a feedback sheet that encouraged people to speak up (needs to be carefully designed)? However, there is that danger that it may be abused.
Reflections on interventions	Reviews – hard to admit mistakes in punitive system Checklist - would this be mandatory? Reflection – Allows mental time-out for doctors, reduces cognitive/mental load, would work well with a checklist Teamwork – isn't this something people should be doing anyway. No two teams are the same. Could more nurse practitioners and skilled nurses relieve some of the pressure? More consequences for doctors getting it wrong; enough mistakes should lead to penalties. Must be doable and realistic for all hospitals (big, small, metro, rural), with clear ways to measure improvement.

If they could change one thing…	Communication
	   – More communication, develop communication skills
	   – Liaison person to act as go-between for patient and healthcare team
	   – Make the decision process more collaborative
	   – Provide reassurance to patients
	   – Focus on communication between staff
	   – Something for patients to help explain their symptoms
	Hospital Context
	   – Appropriate rostering of staff
	   – A more calm and collaborative work environment
	   – Workplace culture
	Standards
	   – Consistent education and standards across Victoria
	   – More time for doctors to upskill and maintain skills
	   – Networking between hospitals
	   – Prioritising safety

What can we learn from the experiences of Emergency Departments?

Practice interviews were conducted with two ED Directors, a specialist ED clinician who also provides advisory services, a Professor of Nursing, a postdoctoral research fellow at the Australian Institute of Health Innovation, an ethnographer who specialises in EDs.

Diagnostic challenges in Emergency Departments
"Diagnosis is genuinely difficult."
All interviewees recognised that there are a number of challenges with diagnosis because it is a difficult process, particularly in EDs. There are many features of the process and the environment that contribute to making diagnosis difficult. Common features mentioned included aspects of the illness, the patient, the ED environment and working in teams.

As highlighted by the Citizen Panel findings, being able to more openly talk about difficulties with diagnosis and the challenges faced may help create an environment where doctors are more comfortable going back to the patient and asking more questions. Furthermore, patients may be more engaged and more vocal with relevant information.

> "Which is that, if patients were aware that there's a particular error rate, whatever you want to call it, 10%, 15%, and that it's their duty to shake us and come back and yell louder and tell us if things change."

Furthermore, there was the challenging concept that diagnosis is not purely a biological issue, but is influenced by the culture and context of the hospital environment.

> "the biggest pull around diagnosis is the medical culture and medical training around the fact that diagnosis is a biological phenomenon, which of course it isn't, and you know, and not exclusively at least, and having to reconcile that with organisational pressures."

Patient Factors
Interacting with patients in the ED can include additional challenges as doctors don't have a past relationship with the patients, so there is little contextual information.

> "So I think one of the things is the fast paced nature of the work. Another is the fact that patients come in to us undifferentiated and undiagnosed, and we have a short period, and we're right at the start of the whole process. So, just by the nature of our work, and where we're placed in the patient journey, our place is at a point were often we don't have all the information or our testing is yet to be completed "

> "Emergency department you don't know the patient, so if the patient goes to their GP and has seen them 10 times before…When a patient comes to emergency we don't really have that background, so we have to assume that it might be something serious."

There is also uncertainty about whether the patient has fully described all their symptoms and any other important features. With patients that you don't know, you must consider everything they have said but also be mindful of things that they haven't said or may have missed.

"Anything that a patient says, we consider that and then we consider the opposite and we consider all possibilities."

Communication

Ensuring open communication with the patient is key to ensuring that a full picture is taken.

"You try to not interrupt, you try to let them say their history, but in the emergency department you're consciously aware, constantly aware that there's another five or 10 or 15 patients waiting, so you often do start interrupting, although the literature says it would probably be quicker if you didn't."

There are also communication challenges with patients, especially when they have limited ability to communicate in English.

"There's the patient communication, not communicating the information well and there's the patient not being able to speak or understand English."

Many interviewees also mentioned that ensuring that an accurate and complete history is taken is fundamental to ensuring the diagnostic process starts off well and on the right track.

"A good history is absolutely where the money is."

"80 to 90% of diagnoses are in the history taking, and I think that the better stories and the better questions we ask are more reliable to the diagnosis."

Patients are an important part of the diagnostic process, they need to be able to update their doctors and have input into the decisions to ensure that the information and subsequent options are correct.

"The lack of interaction with patients or poor patient engagement, or patients are unable to engage. So, for whatever reason if we don't include the patient in the loop, we get to a wrong outcome."

"So the empowering patients with information is really important, particularly for the evolving diagnosis- the one where the condition is evolving in its early stages. I think it's really important and similarly saying to patients and asking patients if they're happy with the plan or if they have outstanding concerns before discharge."

As highlighted in the literature, there is also concern that a lot of patients leave EDs without a clear understanding of their diagnosis that therefore, clearer and more consistent communication is needed.

Chaotic Environment

The chaotic and pressured environment of the ED was frequently mentioned as a source of stress and a contributing factor to errors.

"We've got a high-volume, high-pressure environment, where there are repeated interruptions, often more than one patient under the care of a doctor at a time, the time pressure to get people to out within four hours, and people of different seniority working in an environment where supervision can not be provided at very high levels."

In EDs, not only are there many activities going on at once, but doctors must attend to multiple patients, aware that there is often a room full of patients waiting to be seen. The NEAT legislation means that there is constant pressure to get patients through as fast as possible. Furthermore, it was mentioned that there are constant interruptions, especially for senior clinicians.

"I mean, one of the things I should mention, if only briefly, is the rate of interruptions that senior doctors get and the potential for those interruptions to contribute to error. So, I can have an interruption every minute of a shift, so I'm in the middle of writing my notes about a patient and therefore doing my hypothesis testing, but a nurse comes up to say, "Oh, what dose of drug do you want?" Or somebody else has written up a drug and they don't know whether that's a good dose. And it's quite possible to lose one's train of thought, so I think the density of interruptions, particularly if it's a new doctor, is a contributor."

Another feature of the environment is the role that technology plays, although technology can provide fantastic assistance, it can also get in the way of interacting with the patient.

"We often have real challenges with IT systems that can be clunky or slow, and you find that your attention keeps getting drawn back to the computer and it's away from just that pure listening to the patient and observing of the patient."

Patients present to the ED with no contextual relationship to help doctors understand patterns or context of the presenting symptoms. They mostly arrive undifferentiated, with an unclear picture of how symptoms have developed or will continue to develop.

"So, with respect to an illness, an illness develops over time. So the illness may not have classical features at the point in time that the doctor see the patient in the emergency department. So in other words, it may be in the very early stages and quite non-specific, and illnesses do this."

There is also pressure in the ED to make sure that serious diagnoses are ruled out first and that there isn't something with severe consequences that has been missed.

"That's one of the characteristics of E.D. thinking is rule out the worst-case scenario"

Diagnosis in EDs is also challenging due to the restrictions and pressure regarding how long people can stay in the ED.

"So what's the longest time you can realistically observe someone in an emergency department? Is it 12 hours?... I mean, sometimes it's better to keep them there if there are two more hours and there's a lot of games that are played [in order to do that]...They also put them on trolleys, you know, put them in corridors, do all sorts of weird things that are not defined as a bed."

Lastly, each EDs physical environment will be unique and can influence how the ED operates. For example, if there are break-out collaborative spaces where clinicians can talk about cases this encourages discussion. However, some EDs are cramped and there is limited space for discussion to occur or for the whole team to interact.

Working in Teams

Similar to the ED environment, there are also many different teams interacting in the ED. Sometimes key perspectives (e.g. radiology) are not well integrated into the ED team.

"We don't include all the people who can get us to the answer in our patient team. I'm thinking it's the laboratory staff and of imaging staff."

The role of nursing staff and their insights into the patient's condition are also not well recognised.

"Nurses are experts at diagnosing deterioration. We spend more time with patients than anyone else and we know when things are not going the way they should."

Furthermore, proper communication between team members is crucial to ensuring that key pieces of information are available to all members.

> *"Sometimes there's members of the team who've got a piece of information that's just not well communicated."*

This may be junior doctors not feeling confident in communicating (and potentially having to interrupt) senior clinicians.

> *"Obviously the junior doctor in the small hospital has to ring a physician or surgeon in their rooms. And they may be reluctant to interrupt them, even if the person says, "Ring me anytime.", they may be reluctant to interrupt them then, seen to be needy or not crazy."*

And all doctors may feel more comfortable speaking to some colleagues rather than others.

> *"How comfortable people speaking were, you know, how comfortable people are speaking to people in different roles and of course, you know, the research shows that with doctors, it's a bit more idiosyncratic to the personality of a doctor, like a doctor is defined, that's a friendly doctor, that's an unfriendly doctor."*

These issues can also extend beyond the ED, with negotiations with different hospital departments and wards sometimes required.

> *"The classic problem is the category 3 90-year-old who's under five different doctors and all different types of medications, just doesn't feel very well at the moment and you don't know what is wrong with this person but is unwell enough to need admission, [but needing to] match it up with okay, what do we know?"*

This may require needing to match an admission with who is working and how much capacity particular wards have, then the diagnosis words backwards from that availability.

Interventions to address diagnostic challenges in the ED
Critical reasoning
A general reflection was that greater attention and emphasis should be placed on teaching critical thinking skills.

> *"I think that we need to bring back greater emphasis on teaching junior staff how to think of reason better rather than just ordering lists of tests and hope that you get it right."*

Better critical reasoning may help doctors, especially less experienced doctors, to avoid cognitive biases when they're deciding on diagnoses.

> *"Someone starts the ball rolling in one direction, you can very easily anchor a diagnosis that's been made at triage or suggestion at triage, and no one thinks further so they prematurely close it all off."*

Furthermore, having a more open approach to uncertainty and ensuring that doctors do not feel pressured to decide on a diagnosis before they have enough information to be sure.

> *"We need to have a new way of thinking about clinical uncertainty. If you're not comfortable with it you're more likely to land on a diagnosis no matter what that diagnosis is"*

Discomfort with uncertainty may lead some doctors to decide on a diagnosis too early.

"I think that there's a bit of a tendency to early closure and not thinking broadly enough about the differential diagnosis and ruling out the serious quirk"

Reviews and Second Opinions

In one ED, every patient's case was reviewed by a senior clinician.

"we'll see every patient that the intern sees and we'll hear and see many of the ones that the HMO see, so as they get more senior we tend to give them more autonomy, but at the start they're very heavily supervised. That's the first step in trying to prevent it. A senior person will be reviewing their case and hearing the story."

There are also interventions that have provided time for teams to take time-out and review diagnoses.

"We had variable success with our team timeout, and I think it's a tricky one in the E.D. It's easy to say just put it in and you have to do it before every case, and that's it, whereas when most of our patients don't have a procedure that needs this. It's hard to implement that, but we've had some success... so I won't say that didn't work, but it was a struggle because it wasn't part of our normal daily work."

"Team timeout has certainly captured a few near misses that would've had a miss if it hadn't been done"

Establishing the norm that all cases are reviewed also helps to normalise getting second opinions and constantly seeking out other perspectives.

"You can all, we're all going to ask each other's opinions all the time, we're all going to get used to that. It's no longer going to be a scary thing, they might see that I've missed something. It's actually a team effort, it's team diagnosis."

Therefore, this practice also focused on the team nature of diagnosis. Furthermore, seeking out more opinions also helps to protect both the doctors and the patients.

"protected diagnosis, and it's ... If we know that it takes years to develop expertise, why would we put people who are really junior, making diagnoses by themselves, when they're not experts?"

In some EDs it may not be possible to have another opinion available all the time, especially in rural and regional or smaller hospitals. However, with some areas, such as radiography, it may be possible to organise reviews with clinicians off-site, even overseas.

"I mean, obviously one of the things that they talk about with injury is reporting of x-rays and checking of reports. Now, it's not a zero-cost exercise but it's very feasible to have real-time reporting of x-rays 24 hours a day, seven days a week, particularly with the internet these days. So there are places in the world where, let's just say my hospital, where overnight a doctor in England is reporting the x-rays. So they're getting real-time x-ray reports before the patient goes home."

Finding ways to engage with colleagues and ask questions without causing unnecessary interruptions can also be helpful.

"I think there are strategies that could be employed, in particular, educating nurses and junior doctors about how to seek advice without interrupting, how they can help minimise the risk of interrupting. And I think senior doctors need at some stages to say, "Now is not a good time." And I do have a

strategy for saying now, "Is something life-threatening happening or can this wait for five minutes?"
'Cause obviously you need to be interrupted if something life-threatening is happening."

There were also examples mentioned from a recent conference in the US

"as trying to make imaging part of the E.D. So to have a radiologist sitting in the E.D. doing their reporting there, so they were very much part of the team, and help select investigations that would be done. The other one was the concept of a diagnostic management team. These have some doctors like the junior medical staff, this is throughout the whole floor up to the E.D., would see the patient and decide what was going or what might be going on, and then they would involve a diagnostic management team that sat separately and involved the pathologist there. And the pathologist and a senior doctor, they would decide, based on the information that was presented, what the likely diagnosis was and what tests should be done. And this prevented quite a lot of unnecessary tests and interventions from happening. It prevented quite a lot of unnecessary blood transfusions and things like that."

Rostered test-follow-up

Another intervention was rostering people to specifically follow-up test results to ensure that nothing was missed and any follow-up actions were taking place. They found that this was very powerful for an emergency department, not only ensuring that nothing was missed but also making clinicians more aware of its importance.

"Two doctors rostered for pathology follow-up, and that has multiple ... Again everything's got unintended good consequences normally, because it means that ... You should always follow-up your own test results, but we don't always do that. It reminds doctors that they should be doing it themselves, because they're now following up other people's results as well."

Checklists, Checks and Processes

Some EDs had trialled checklists highlighting pertinent information.

"There are some clinical decision rules that are useful around pulmonary embolism and to a lesser extent a heart attack, which are sort of "checklist-y" but that really concern that the probability of this condition is very low."

"We've done things with the observation chart in our EMR that highlights and makes goals, abnormal vital signs or it just stares you in the face so that you're less likely to send someone home with a high sugar or a low blood pressure or something like that."

Putting checks in place that automatically flag patients that re-present within 24-72 hours of first admission. It was also mentioned that there is a need for better flow of information.

"Scanning of ambo notes and GP referral letters by triage clerks into the appropriate part of the scanned medical record (this is currently done a few days after in medical records), preferably with a link in the electronic medical record right where the doctor would click to write his notes saying 'referral letter' or ambulance notes'.

Further to this, standardising handover mnemonics which ambulance, triage, nurses and doctors, so that all information is in the same order and in the same language could help improve processes, reduce inefficiencies and improve consistency of information to reduce the risk of errors and miscommunication.

Implementation Considerations

Any intervention has to be able to work into the everyday work routines in the ED - if it's too difficult to incorporate, it won't be done.

> *"I think it absolutely has to be part of everyday work. It has to be able to fit in with the work flows and the work patterns"*

Interventions are much more likely to succeed if the clinicians can see the value to it and it's not viewed as another checkbox activity.

> *"They work when the clinicians see a value to it. There's value adding, whether it's saving some time, whether it's reducing stress, whether it's getting a clearly better outcome for the patient, people will take it up. But if it's just put in as a thing you have to do then they won't."*

Establishing the social norm that 'this is how things are done' can help embed behaviours as part of the workplace culture. An example in relation to second opinions or reviews is talking to clinicians about why this is done.

> *"This might seem strange to you, or you might be really experienced, and you might think I don't need to do this, but this is just, this is how it's done here, and it's there for all of us to be a team working together." "It's revolutionised the culture in our department, from having that fear around asking questions, to just everybody's constantly doing it."*

The expectations of what the intervention involves also needs to be clearly articulated. For example, it can't just be a cursory exercise, a quick corridor conversation is not adequate to be considered a review. There are of course, logistic difficulties with the busy time-pressured environment. Finding the time to go back and review a case can be difficult.

> *"I think there's been quite a few cases in emergency departments where a senior might be in charge of the whole department, so it can be quite difficult to go back in and take a history, look at the patient, so we've had some diagnostic error around getting a second opinion that you're fed a story which may not be accurate, you don't take it yourself and you don't examine the patient. There's still work to be done in that whole space of how do you supervise in an emergency department?"*

Indeed, time came up frequently as a barrier to interventions.

> *"So time, I think, would be a big barrier, also scrutiny, so like I said before, make it a system wide improvement thing, rather we challenge every one of you that you're always making wrong diagnoses."*

Any intervention needs to take all these factors into account and need to work across all contexts and settings.

> *"And it needs to work 24 hours a day, seven days a week. It's no good if it only works nine to five, Monday to Friday."*

Questions for deliberation

1. What are the biggest challenges in diagnosis in the Victorian ED setting?

2. Which specific conditions present the biggest diagnostic challenges in Victorian EDs and why?

3. What are possible interventions to improve diagnosis for a target condition in Victoria?
    a. Behaviourally focused
    b. Feasible
    c. Testable in the short term i.e. 6-months
    d. Scalable across Victoria
    e. Measurable (i.e. sufficient volume, measurable diagnostic outcomes)
    f. Sustainable

4. Of these, which is the highest priority for a pilot study and why?

5. What are appropriate success measures for a pilot study?

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Appendix 1: Background and Context

VMIA Research and Innovation Program – Patient Safety in Victorian Public Healthcare

The research and innovation program is designed to create, synthesise and translate knowledge into patient safety policy and practice within the Victorian Public Health Sector. This program aims to foster research translation by reflecting on the Victorian Managed Insurance Authority's (VMIA) own policy and practice, partnering with the Department of Health and Human Services (DHHS) and building a broader community of interest around the program through academics, policy makers, clinicians and consumers. A secondary aim of the program is to position VMIA as a thought leader in patient safety and risk management.

About BehaviourWorks Australia

BehaviourWorks Australia (BWA) is an applied behaviour change research enterprise within Monash University's Sustainable Development Institute. BWA was established in 2011 and currently has ten consortium partners, including The Shannon Company, a social marketing firm who have delivered a range of large-scale government campaigns such as WorkSafe Victoria's 'homecomings' campaign and the 'Our Water Our Future' campaign launched during the major drought in Victoria in 2004. BWA's health research draws upon contemporary methods of knowledge translation (KT) designed to translate research evidence into practices, systems, and policies. We have applied this approach to various health projects covering adolescent and indigenous infant vaccination, the recently launched 'Help Save Lives By Saving 000 For Emergencies' campaign, and optimising practice for bladder care following acute spinal cord injury. For more information about BWA, refer to our website: http://www.behaviourworksaustralia.org/

How research projects are identified and prioritised

A series of structured activities to identify and prioritise topics are built into the research and innovation program. An initial 'rapid prioritisation' exercise was conducted in early 2017 which involved an in-depth review of VMIA activities; structured consultation with VMIA and the Victorian Department of Health and Human Services (DHHS); and the systematic development and application of criteria for prioritisation in collaboration with VMIA and DHHS. This resulted in the identification of the first three project areas including the present project (bold):

1. Realising the potential of good governance in preventing harm, improving the patient experience and keeping per capita costs manageable
2. **Reducing under-, mis-, missed-, delayed- and over-diagnosis across sectors and conditions**
3. Ensuring that healthcare choices, program and service design and organisational and system decision-making reflect the values and preferences of patients / caregivers / consumers

Following the rapid prioritisation, an expert panel with significant experience of health systems governance was convened to narrow the focus of the topic to an area that was *behavioural, testable in the short term (within 6 months)* and *scalable.* The resulting topic was ***What strategies to review diagnoses are feasible and sustainable in Emergency Departments?***

The final 3 project areas will be determined through a longer consultation exercise that draws in a wider group of stakeholders. This will involve surveying a Community of Interest representing all stakeholder groups relevant to the Research and Innovation Program to develop an exhaustive list of possible project areas within the scope of the program. Using the same prioritisation criteria developed in Activity 3, we will identify the highest three priorities for research projects. These will undergo the same development, implementation and evaluation process as the other three research projects.

Appendix 2: Methods

The Forum Approach

This project is using the Forum approach, an established method of promoting evidence- informed practice change, which involves four key activities:

1. Defining a major challenge through consultation with key stakeholders to understand the issues and complexities;
2. Gathering from published literature and further consultation the information necessary to properly consider the challenge, and presenting this in a briefing document (i.e. this document);
3. Convening a structured stakeholder dialogue to connect the information from the briefing document with the people representing key stakeholder groups who can make change happen; and
4. Reporting outcomes through a dialogue summary and related academic publications and briefing the organisations and individuals who can effect change about their role in developed strategies.

The Forum approach of evidence review and structured stakeholder dialogue was established by John Lavis in Canada in 2009. Subsequently Dr Peter Bragge and Professor Russell Gruen were funded by the Victoria Transport Accident Commission from 2012 - 2015 to lead the first Australian-based Forum program, which focused on addressing high-priority challenges in brain and spinal cord injury care, research and policy. Outputs of the NTRI Forum program have been published online and in peer-reviewed literature. Satisfaction in the NTRI Forum process was high based up on participant surveys, with a mean score of 6.4 / 7 (where 1 is 'Failed' and 7 is 'Achieved') for ranking of how well the briefing document achieved its purpose (N =114, response rate 45%) and 6.0 / 7 for the stakeholder dialogue (N=192, RR 76%).

Literature Rapid Review

Search Strategy

A comprehensive search of the following databases was undertaken; PubMed, PsychINFO, Web of Science and Google Scholar. The PubMed search strategy is reproduced below:

Table 3: PsychINFO search strategy

	Search string
1	Physician OR clinician OR emergency department OR ED OR health service OR hospital OR consultant OR junior doctor OR consumer OR patient
2	time-out OR time out OR independent review OR differential diagnos?s OR confirm diagnos?s OR second opinion OR expert opinion OR automatic review OR reassess OR red team blue team OR two-hat thinking OR opposing diagnosis OR opposing opinion OR disconfirming information OR confirmation bias OR anchoring bias OR cognitive bias OR team process OR two stream thinking OR patient understanding OR take two think do OR feedback OR time barrier OR understanding specificity OR understanding sensitivity OR active listening OR diagnostic uncertainty OR challenge diagnosis OR perception of time pressure OR level of diagnostic experience OR diagnostic calibration OR confidence
3	diagnostic accuracy OR diagnostic error OR misdiagnos?s OR incorrect diagnos?s OR over diagnos?s OR under diagnos?s OR delayed diagnos?s OR missed diagnos?s OR diagnostic outcome OR ambiguous symptoms

Screening and selection

One reviewer screened the citations against the inclusion and exclusion criteria listed in Table 1. Data extracted from the included articles was used to inform a commentary on the implications of the review for diagnostic review in Emergency Departments

Table 4: Inclusion and Exclusion Criteria

	Included	Excluded
Study type	Systematic reviews and primary studies	Poor quality or small scale primary studies
Study design	Observational or interventional	
Population	Doctors and medical students	Nurses, allied health
Intervention	Interventions to review or revisit diagnoses	
Outcomes	Effectiveness, group processes, decision-making, team work, diagnostic accuracy	
Publication status	English language Peer-reviewed journal publication or public reports	

Table 5: Quality appraisal of included systematic reviews

Criterion (AMSTAR)[27]	Blumenthal-Barby 2014	Bell et al 2014	Lambe et al 2016	Riches et al 2016	Abimajyi-Ochom et al., 2017	McDonald et al., 2013
1. Was 'a priori' design provided?	Yes	Yes	Yes	Yes	Yes	Yes
2. Was there duplicate study selection and data extraction?	Unclear	Unclear	Yes	Yes	Yes	Yes
3. Was a comprehensive literature search performed?	Yes	Yes	Yes	Yes	Yes	Yes
4. Was the status of publication (i.e., grey literature) used as an inclusion criterion?	Yes	Yes	Yes	Yes	Yes	Yes
5. Was a list of studies (included and excluded) provided?	No	No	No	No	No	No
6. Were the characteristics of the included studies provided?	No	Yes	Yes	Yes	Yes	No
7. Was the scientific quality of the included studies assessed and documented?	Yes	No	Yes	Yes	No	Yes
8. Was the scientific quality of the included studies used appropriately in formulating conclusions?	No	No	Yes	Yes	No	Yes
9. Were the methods used to combine the findings of studies appropriate?	N/A	Yes	N/A	Yes	N/A	N/A
10. Was the likelihood of publication bias assessed?	No	No	Yes	Yes	No	No
11. Was the conflict of interest included?	Yes	Yes	Yes	No	N/A	Yes
TOTAL 'yes' / TOTAL applicable items	5 / 10	6 / 11	9 / 10	9 / 11	5 / 9	7 / 10

Practice Review Interviews

Interview Framework

The interviews were semi-structured, allowing the interviewers to explore emerging themes as well as salient issues (Spencer, Ritchie, Lewis, & Dillon, 2003). The interview framework was as follows:

1. What does your role involve?

2. If Clinician, what is the cognitive process of making a diagnosis or working diagnosis in the ED?

3. What are the areas within the ED diagnostic process where you feel there is potential for error? What areas do you think might require support?

4. In terms of addressing diagnostic error in EDs, in particular ways to review diagnoses, what has worked in practice?

5. How successful have these attempts been?

6. What hasn't worked as well as expected, or back-fired (e.g has there been resistance or difficulty in uptake)

7. Are there any poor practices that should be removed/discouraged in ED settings?

Participants

Participants were purposively selected based upon their experience and / or expertise in the area of misdiagnosis in Emergency Departments (Patton, 1990).

Procedure

Participants were contacted via VMIA and invited to take part. Research aims and procedures were outlined in an explanatory statement given to all participants prior to the interview. All interviews were conducted via telephone. Interviews lasted between 25 and 45 minutes. All interviews were conducted by BW in October 2017. Interviews were digitally audio-recorded, transcribed verbatim, anonymised and stored securely.

Analysis

Interview transcripts were coded and analysed thematically (Boyatzis, 1998) using a computer-assisted qualitative data analysis software program (NVivo10, QSR International Pty Ltd 2014). Interview transcripts were coded according to emergent themes and any emerging topics relevant to the topic. Direct quotations from interview transcripts were used to illustrate key themes. The participant categories (I.e. role and responsibilities) have been de-identified.

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