**Abstract**

Objective

The objective of this review was to explore current experimental findings and understanding of confidence during medical diagnoses. The results of 79 empirical studies were synthesised to establish broad findings across medical subdisciplines.

Design

A scoping review of both medical and psychological literature was conducted. We then categorised included papers by properties of their methodology and of their research findings.

Data sources

We systemically searched SCOPUS, MEDLINE, PsycINFO and Global Health as well as references from the literature.

Eligibility criteria

Studies were included if they reported quantitative results from an empirical study where clinical participants reported their confidence or certainty during a diagnostic decision. Studies comprised a broad set of medical subdisciplines.

Results

3829 potential articles were identified with 79 papers meeting the inclusion criteria. We find that confidence is not found to be well-calibrated to true diagnostic accuracy across experience levels. Confidence is affected by a number of factors, including patient case complexity, early diagnostic differentials and contextual factors within the healthcare environment. We also find a rich set of literature that demonstrates the effects of confidence later on in a patient’s care pathway, including further testing, medications and referral rates.

Conclusions

This review culminates in a model based on the literature that demonstrates a differing set of factors that affect diagnostic confidence/certainty and diagnostic accuracy. Results from this review have implications for medical education and practice around diagnostic uncertainty and considerations of work from cognitive psychology.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Past work notes the prevalence of diagnostic errors and posits a link between such errors and cognitive biases, with one such bias being overconfidence. This study aims to synthesise past work on diagnostic confidence to understand the factors studied that contribute to clinicians’ confidence in their diagnoses.

WHAT THIS STUDY ADDS

As a result of this scoping review, it is indicated that diagnostic confidence and accuracy have separate contributing factors related to the patient, the clinician making the diagnosis and the environmental context. Confidence is then shown to have a bearing on the subsequent care of patients across multiple studies, hinting at its utility as an area of study and how prompting appropriate confidence is important for patient care.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

This study indicates that future clinical work should focus not only on prompting calibrated confidence but also on appropriate communication of uncertainty, which would have implications for medical education around how diagnostic reasoning is taught and for the workplace culture of healthcare environments. We also posit directions for future research to better model how confidence evolves over the course of a diagnostic decision rather than as a static quantity.

**INTRODUCTION**

Medical diagnoses are core to a doctor’s job, as their accuracy is crucial to high quality and safe patient treatment and care. As the accuracy of diagnoses are important, research on diagnosis has been grounded in the incidence of errors. A report from the US Institute of Medicine1 concluded that most patients will experience a diagnostic error within their lifetime. Around 32% of clinical errors have been found to be caused by clinician assessment, particularly the clinician’s failure to weigh up competing diagnoses2. Studies have also investigated the downstream consequences of diagnostic errors. Unnecessary treatments (or ‘overtreatment’) was estimated to cost the US healthcare system between 158 and 226 billion dollars in 20113. Diagnostic errors have also been found to lead to longer hospital stays and increased patient mortality4.

One account of diagnostic error is that they can stem from cognitive biases during decision making. For example, making a diagnosis may involve considering a hypothesis as likely because the displayed symptoms seem to correspond with a prototypical case of a particular condition5. A clinician may have recently experienced a patient with a particular condition and, upon seeing another patient with what are perceived to be similar symptoms, is then more likely to diagnose that patient with the same condition again6. One other key cognitive bias that has been posited as a contributor of diagnostic error is overconfidence7.

Confidence is viewed within the cognitive psychology literature as subjective assessments of a decision’s quality or accuracy8. In the absence of objective feedback, confidence can be used as a marker of how likely someone is to be correct9. In the case of medicine, a lack of clearly communicated feedback can cause clinicians to proceed as if they have received positive feedback. This means that they do not adequately update their internal model of the patient and hence they increase their confidence inappropriately10.

Confidence/certainty is a form of self-monitoring as it pertains to what we think about our own ability, making it important to study in medical decisions. There may be a tacit assumption that others will calibrate their confidence to true accuracy, meaning that heeding high confidence advice or judgements would be an optimal strategy for maximising accuracy. However, this can be a serious issue when errors made with high confidence lead others astray.

We should note the terms ‘confidence’ and ‘certainty’ are often used interchangeably in the extant medical literature. However, as per research from the cognitive psychology literature, we mark a differentiation between the two that will be used to theoretically ground our review. For the purposes of searching for papers, we use both terms but we emphasise here that they are meaningfully different concepts within cognitive psychology. One way of looking at these differently is that uncertainty can be viewed as an internal state as a result of the integration of sensory stimuli from the environment and imprecise inference of the current state based on these inputs11. In contrast, confidence can be viewed as the external expression of this uncertainty to others. Hence, situations arise where individuals are more or less confident than they should be. For instance, one may appear overconfident (to others) relative to one’s own internal uncertainty in order to increase the chances of being listened to in a group, given that confident judgements tend to exert higher social influence12. It has also been viewed that confidence can have separate public and private mappings within the brain13. Another proposed perspective for viewing these concepts as distinct is by defining confidence as the subjective probability of being correct and certainty as referring to the encoding of probability distributions14. Henceforth, we use the terms interchangeably for brevity but draw a distinction between the two.

We conduct a scoping review in order to collate and synthesise the current work on studying diagnosis as a cognitive process, both in terms of what contributes to appropriate (or ‘calibrated) confidence/certainty and how confidence/certainty is utilised within the wider medical decision making process. Our full research questions can be found in Box 1.

**METHODS**

**Search Strategy**

This review utilised a protocol that was preregistered on the Open Science Framework: <https://osf.io/wz5se>. We aimed to conduct a systematic scoping review of empirical work that studied either confidence and certainty within medical diagnoses. We primarily consulted JBI’s PRIMSA-ScR Checklist for Scoping Reviews15. The search strategy was designed in cooperation with a subject specialist librarian at the University of Oxford’s Bodleian Libraries group. The search string comprised of keywords to capture an intersection of four elements: confidence/certainty, medical diagnoses, decision making and a clinical population (i.e. clinicians, physicians, doctors and medics). The full search terms can be found in Box 1. The databases SCOPUS, MEDLINE, PsycINFO and Global Health were searched during February 2024. The reference lists of the included were also searched by hand to capture other papers not covered by the initial search query.

[INSERT BOX 1]

**Study Selection**

The inclusion criteria for studies were as follows: (1) original empirical studies with quantitative results, (2) written in the English language, (3) experimental paradigm uses medical diagnostic decisions, (4) confidence or certainty is measured as a dependent variable. We exclude editorials, review papers and opinion papers, though we do include dissertations. We do not exclude any medical subdisciplines and do not exclude papers based on publication date. Identified articles were uploaded onto Rayyan, which detects duplicate papers for manual checking and removal.

**Research Synthesis**

The included papers were reviewed to answer the set of research questions that can be found in Box 2. In addressing these questions, papers were first categorised by their broad research methodology (i.e. patient vignettes, in situ questionnaires etc.) and their medical population of study (e.g. medical students, GPs, medics etc.). We reviewed the experimental procedures to extract their key manipulations/independent variables. This included case complexity, use of a cognitive intervention and medical experience or knowledge on the part of study participants. We also extract dependent variables as they pertain to confidence/certainty and, where relevant, recording of both diagnostic differentials and information seeking. Each of paper’s key findings were summarised and then all findings were categorised under recurring themes.

[INSERT BOX 2]

**RESULTS**

**Findings of Scoping Review**

The initial search returned a total of 3332 articles across all four aforementioned databases. Of these, 675 duplicate articles were removed after manual review, leaving 2717 articles for screening. After exclusions based on initial review of the articles’ titles and abstracts, 165 remained for review of the full text. When applying the inclusion criteria described in the Study Selection section, 50 eligible articles were included. Based on these, 439 articles were retrieved for review from the included articles’ citations. After applying both exclusions of duplicates and our inclusion criteria, 29 articles were included. This produced a total of 79 articles for inclusion and synthesis. The PRISMA diagram for this search process can be found in Figure 2.

[INSERT FIGURE 2]

**Broad Characteristics of Studies**

A summary of the included studies are found in Table 1. Our included studies were published between 1991 and 2024. A histogram of showing the distribution of publications over time can be found in Figure 1. We especially note that 36 of the 79 studies (46%) were published from 2019 onwards, indicating a recent surge of research interest in this field and timeliness of such a scoping review. The studies were published over 60 different publications, including both medical and psychological journals. 19 studies were published in a journal related to medical education, making it the most common research area. Other research areas most represented were Primary Care/General Practice, Emergency Medicine and Nursing. When examining the research methodologies, 44 studies (56%) involved the use of clinical patient text vignettes in their study design, making it the most used experimental task.

34 studies (43%) looking at medical experience or training’s effect on confidence, either measured as a dependent variable or by recruiting participants in either a ‘novice’ and ‘experienced’ group. 24 studies (30%) investigated how participants evaluated diagnostic differentials by allowing participants to record multiple differentials in their diagnosis. 19 studies (24%) manipulated the complexity or difficulty of the patient case (excluding the studies that made use of real patient cases in situ). Finally, 10 studies (13%) studied information seeking by measuring or manipulating the extent to which participant sought tests or information to formulate a diagnosis.

**Research Themes**

Calibration of Confidence and Certainty Judgements

On the whole, there is limited evidence of calibrated confidence judgements, either in terms of underconfidence16-18 or overconfidence19-21. We note that calibration was investigated in studies using vignettes in the vast majority of cases, as there is an established ground truth in each case (unlike in situ studies involving real patients) to compare the participants’ responses to in order to gauge accuracy. Calibration is then calculated in a similar for large amount of these studies: participants report their confidence/certainty in their diagnosis and this value is compared to their true accuracy. As vignettes are quick and simple to administer, participants can complete several diagnoses during a single study such that both their confidence and accuracy can be averaged across cases.

Calibration is seemingly affected by a number of factors. Studies have found that calibration is affected by the complexity or difficulty of the presented case22-24. When confidence judgements are not sensitive to the difficulty or complexity of the case, confidence stays fairly constant for difficult cases whilst accuracy decreases, leading to increased overconfidence (and decreased calibration). In past studies, complexity is manipulated by either presenting patient cases with more comorbid conditions23 or by showing more conflicting information about the patient to indicate multiple possible conditions25. Calibration may also be improved by the presence of feedback during a training period26-27.

Contextual factors that pertain to the situated medical environment can also affect confidence, as found using more naturalistic paradigms. For example, clinicians may be constantly interrupted for other tasks28, which can especially happen during busier shifts where they have to manage more patients29 and are not present on rounds when a patient is previously discussed by staff30. Studies that emulated each of these instances found lower diagnostic confidence.

We note that the measure of calibration is operationalised in differing ways based on the experimental procedures used. For instance, 24 studies (30%) allowed participants to input multiple diagnostic differentials rather than a single diagnosis. Confidence is then either measured for each differential or in the set of differentials as a whole. Accuracy is easier to operationalise as a single diagnosis (whether it is correct or not), but it is less naturalistic to how clinicians may consider competing diagnoses in their everyday practice. Hence, measures of how calibrated confidence judgements are to true diagnostic accuracy are heavily contingent on how diagnoses are recorded, which may have a bearing on how reliable findings on overconfidence or underconfidence are.

Experience and Knowledge

Both calibration and case complexity seems to heavily interact with experience such that more experienced clinicians are better able to pick up on when a case is more complex/difficult and adjust their confidence accordingly25,40. We note that calibration interacts with experience such that underconfidence tended to be exhibited by less experienced clinicians (or students), whilst overconfidence was observed more for experienced clinicians. However, a difference in calibration across experience was not always observed in the results41-42. Looking at the link between calibration and experience alone may be too simplistic. There are other aspects of experience that influence diagnoses. Experienced clinicians were found to be less likely to ‘distort’ neutral information to be confirmatory of existing beliefs43. One study found that whilst experienced clinicians were not more accurate in their diagnoses, they were more willing to switch and request more information44 (see below section on Downstream Effects of Confidence).

A minor theme of past work has been a distinction between experience and knowledge however. In medical students, the calibration of confidence judgements were found to improve with years of education but not with medical knowledge as gauged using a standardised assessment45. The aforementioned information ‘distortion’ was found to affect novice clinicians more43 and lower knowledge was found to be related susceptibility to distracting features of a patient that were irrelevant46. However, the latter study found that medical knowledge was not directly associated with confidence.

[INSERT BOX 3]

Downstream Effects of Confidence

With more naturalistic studies, it is possible to isolate ways in which confidence and certainty are utilised within the wider diagnostic process, especially as care of a patient extends outside of an individual to cover a wider medical environment. Past work has attempted to establish a link between confidence and further seeking of patient information and tests with mixed results. Doctor with lower confidence were found to be linked to more test orders29 whilst more metacognitively aware pathologists (i.e. who tended to report confidence judgements that were closer to their true accuracy) were found to be more likely to request further tests when they were unsure42. Confidence has also been linked to prescribing medication, though overtreatment of unnecessary medications was found to linked to both underconfidence47 and overconfidence21. Higher confidence has also been linked to referral rates to other specialists in other departments48 and to a lower willingness to admit mistakes18. Lower confidence has also been found to result in less specific diagnoses for patients in situ49.

Interventions at the Point of Generating Differentials

Generating diagnostic differentials has been studied using manipulations and interventions and their effect on accuracy and confidence. A general theme is that there is tendency toward higher weighting of early information, indicating a primacy effect. Early diagnostic suggestions have been found to be highly influential in the subsequent decision process by clinicians finding these suggestions difficult to ignore and increasing their confidence with them50-51. This also affects the breadth of differentials considered, with fewer differentials considered when provided these suggestions52 and an underweighting of differentials if they were not considered early on in the diagnostic process53. This is where interventions aim to mitigate this tendency by asking clinicians to explicitly consider alternatives, which increases their accuracy and calibration54, or prompt the consideration of the patient’s ‘red flags’ to consider in diagnoses, which was found to increase confidence on simpler cases but not accuracy55. These interventions seemingly have to explicit however, as simply asking clinicians to reflect on their decision without guidance56-57 or participate in an educational training course58-59 does not seem to suffice in improving diagnostic accuracy and calibration.

A subset of past work has also manipulated the manner in which information is presented to clinicians during the diagnostic process affected confidence. Higher confidence was found when clinicians were presented with redundant patient information60 and when given all available patient information rather than having to gather information themselves61. Clinicians were also found to be more confident when presented with an Electronic Health Record of the patient alongside other information62 and when presented patient history first rather than out of order63, indicating a positive effect of a complete patient history available early on in a case on confidence. An erroneous patient history has also been found to cue both novice and experienced clinicians to incorrect diagnoses64.

Framework for Diagnostic Decisions

We synthesise the findings from the included into a theoretical framework to illustrate how various factors distinctly impact diagnostic confidence and accuracy. This framework is shown below in Figure 3. We especially note that the framework both summarises the existing research as described here and proposes directions for future research that has been relatively untapped by the included studies. Namely, the diagnostic decisions that are emulated experimentally view diagnosis as linear processes whilst future work could focus on better simulating the cyclical nature of diagnosis, such as how feedback is integrated into clinicians’ existing knowledge and how confidence and information seeking interact with each other. On the latter, past work has focused on how confidence is related to further testing and information seeking, but not how information seeking itself is related to confidence. Whilst past research has, as a whole, also hinted at a distinction between medical experience and knowledge as they pertain to confidence, there has been little work comparing and contrasting the two directly. This is especially pertinent given the social influence that seniority can have within a group, reducing the likelihood of more junior clinicians speaking up about potential errors in the presence of more experienced clinicians65.

**DISCUSSION**

**Strengths and Limitations**

The strength of this review is in its scope. Whilst similar past reviews have focused on either mapping instances of cognitive biases within medical errors66-68 or on medical uncertainty more broadly69-70, our review is the first to comprehensively map out the literature that links confidence and certainty to medical diagnoses. We shifted from the prior focus on errors, which can be restrictive in a number of ways. Establishing a direct causal link between cognitive biases and diagnostic errors, whilst intuitively sensible, is hard to do within an empirical study. In addition, focusing on errors limits the focus of work to situations where diagnosis goes wrong, rather than first understanding it as a cognitive process that often produces positive results. Our review also highlights the recent interest in this field of work, potentially due to the advent of artificial intelligence for use in diagnostic decision support. As such, there is interest in understanding where diagnostic uncertainty arises. We also show how distributed the research landscape can be due to the sometimes siloed nature of medical subdisciplines, which can be difficult to generalise to medicine as a whole and establish a common ground between these domains. This review is, to our knowledge, the first of its kind in terms of its broad remit to underscore the importance of studying diagnostic confidence across medicine.

As a limitation, we note that a sizeable number of articles were found via reference tracking that were not picked up by the initial search query. We posit a few reasons for this. Firstly, certain medical subpopulations were missed from the initial search, including residents, interns, dermatologists, surgeons, pathologists and medical students. As mentioned, we do not limit this review to any medical subdisciplines in order to capture a more broad set of diagnostic decisions but the search query was not comprehensive enough for this. In addition, several studies found during the reference search did measure confidence/certainty but not as a primary variable of interest. This meant that confidence was not prominently mentioned, instead focusing on diagnostic accuracy or calibration. Finally, some studies framed the experimental task as diagnostic ‘interpretations’ or ‘assessments’, meaning that our search query based on ‘decisions’ did not capture these studies. With these findings in mind, future searches should modify the query to include more medical subpopulations and the use of ‘self-monitoring’ and ‘calibration’ as dependent variables whilst excluding the narrow focus on decision making.

**Implications and Future Clinical Research**

This scoping review shows the importance and the (particular recent) surge in interest in diagnostic confidence. Whilst confidence has been linked to diagnostic error in the past7, studying it requires insights from cognitive psychology to inform medical education and practice71. Past work has rarely shown that confidence and accuracy in diagnoses are aligned. Whilst cognitive interventions such as considering alternative diagnoses and guided reflections have been tested, there is yet to be a standardised cognitive framework to teach non-technical skills such as expression of uncertainty. Notably from these papers, miscalibration of confidence is not only a function of social and environmental factors, as such miscalibration was also observed for vignette studies performed by individual participants. One can imagine however that such factors only serve to amplify systematic tendencies toward misaligned confidence/certainty. When coupled with the aforementioned downstream effects of confidence with patient’s care pathway, a misplaced sense of confidence can have a large impact on patients. It is perhaps from these downstream effects of confidence that errors are more likely to arise, rather than simply from diagnoses themselves. Studying errors directly may therefore not be as fruitful an approach for future work as focusing on prompting clinicians toward displaying certainty or uncertainty appropriately.

Whilst we have reviewed a wide breadth of the available literature on confidence/certainty in diagnoses, there are still many avenues for future work. Namely, the majority of the studies presented here do not study diagnosis as a constantly ongoing and evolving process. In reality, diagnoses feature a back and forth between seeking information and evaluating that information in the context of currently considered diagnostic possibilities. This is likely a function of the methodologies used where participants are asked for diagnoses at a particular point in time, usually after reading all the available information on a patient. Vignette studies are of course much easier for researchers to control for confounding variables in order to standardise the diagnoses made for all participants. More naturalistic, in situ methods can be especially fruitful however. One included study in this review even found that nurses were both less accurate and less confident in a high-fidelity simulation compared to a paper-based vignette72, hinting at limitations in generalising less naturalistic paradigms (e.g. vignettes) to how clinicians would behave in their everyday medical practice. However, for in situ studies, interrupting clinicians to report their diagnostic thinking can be intrusive on their work. Hence, future research should first focus on utilising other methodologies for capturing the diagnostic reasoning of clinicians as it evolves with time and the receipt of new information. This could include getting clinicians to think aloud as they make diagnoses73 or using a visual representation of clinicians’ thought process to capture paths and sources of diagnoses54.

While in situ paradigms can be difficult to administer, there is however considerable value in understanding how contextual and environmental factors can have an impact on confidence and to what extent they are more or less impactful that factors pertaining to the patient or the clinician themselves. The clinician is unlikely to working alone in any given instance. They are part of a wider team, department and healthcare system, all of which can impact confidence on an individual level. Understanding the cognition of diagnosis for the individual can then applied further to make changes to the wider medical context to support accurate and calibrated decisions.

Finally, we note that the papers included in this review uses confidence and certainty as interchangeable terms of the subjective probability, assigned by clinicians, of diagnoses being correct. As previously mentioned, these constructs could be treated as separate entities to differentiate between internal certainty and externally communicated confidence. In particular, future work could seek to identify how the certainty that one has in their mind differs from the confidence that one has to communicate to others (be they patients or other clinicians) in their diagnoses. Clinicians may modify how they communicate certainty with others, especially given the collaborative nature of healthcare and past work that has found that confident members of a group tend to be listened to more12. Again, future work on the differences between internal certainty and external confidence would help illuminate the generalisability of vignette-based paradigms to naturalistic medical contexts where clinicians work alongside others to care for patients.

**CONCLUSIONS**

Through this scoping review, we found that confidence is frequently not calibrated to accuracy during diagnostic decisions. We also found across the literature that different factors affect confidence and accuracy separately, which may help to explain why such instances of overconfidence or underconfidence are observed. Finally we identified several papers that underscore how confidence affects the subsequent care pathway of patients. Taken together, these findings have implications for how diagnostic certainty and confidence should be studied in future clinical work, including the role that information gathering and interpretation has on diagnoses and usage of naturalistic paradigms.

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