The OHS Professional as a Critical Consumer of Research

Core Body of Knowledge for the Generalist OHS Professional

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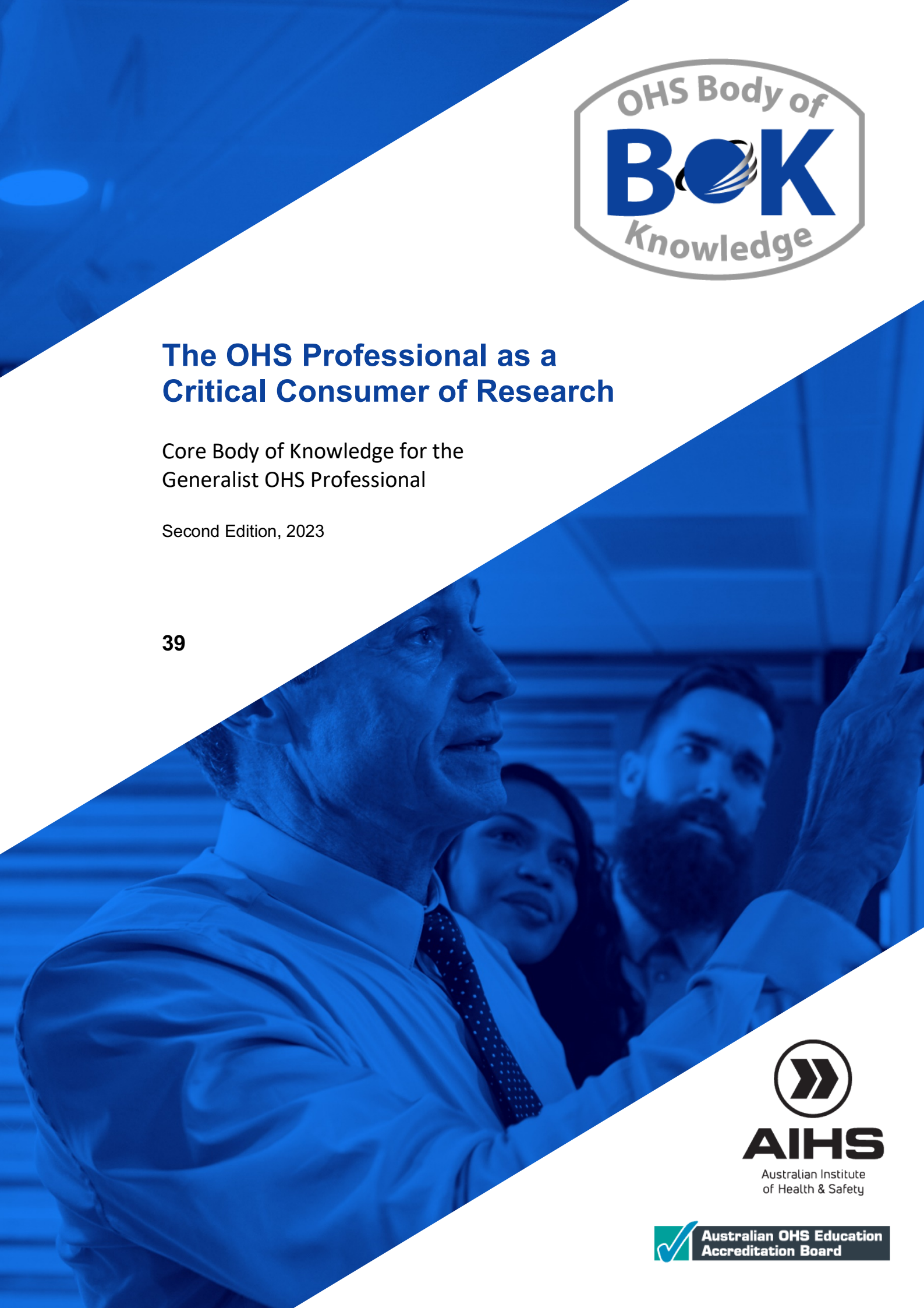

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This new chapter takes a broad view of the types of information OHS professionals may access and replaces the original chapter.

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The OHS Professional as a Critical Consumer of Research

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The OHS Professional as a Critical Consumer of Research

Abstract

Occupational health and safety (OHS) practices should be informed by high-quality, up-to-date evidence. To support this, OHS professionals need to be critical consumers of research literature. This chapter explains how to be such a critical consumer by outlining five principles of evidence-based practice. These principles – adapted from discussions of evidence-based practice in professions such as medicine, nursing and teaching – provide guidance for critically appraising and applying research evidence. The chapter includes theoretical discussion about the role and limits of empirical research evidence in OHS practice as well as practical guidance for OHS professionals on how to identify, obtain, appraise and apply research evidence. The chapter provides OHS professionals with vital information for enhancing OHS practice and maintaining professional credibility.

Keywords

OHS, occupational health and safety, evidence-based practice, evidence-informed, critical appraisal, professional, practice, research, critical consumer

Contextual reading

Readers should refer to 1 *Preliminaries* for a full list of chapters and authors and a synopsis of the OHS Body of Knowledge. Chapter 2 *Introduction* describes the background and development process while Chapter 3 *The Generalist OHS Professional: International and Australian Perspectives* provides a context by describing the role and professional environment.

Terminology

Depending on the jurisdiction and the organisation, terminology refers to 'Occupational Health and Safety' (OHS), 'Occupational Safety and Health' (OSH) or 'Work Health and Safety' (WHS). In line with international practice, this publication uses OHS with the exception of specific reference to the Australian Work Health and Safety (WHS) Act and related legislation.

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1 Introduction

When an occupational health and safety (OHS) professional offers advice, they should not just provide their personal opinion or uncritically repeat the words of others, no matter how famous or popular. A true professional speaks authoritatively as a representative of a community of practice and a body of knowledge. That is why, at the 2017 World Congress on Safety and Health at Work held in Singapore, representatives of government, business, workers and OHS professionals committed to the 'Singapore Accord,' which acknowledged, among several imperatives, "That occupational health and safety professional and practitioner knowledge and skills must be evidence-informed and based on strong scientific and technical concepts" (INSHPO, 2017, p. 4). To this end, *The OHS Professional Capability Framework* detailed the evidence-based practice skills required by OHS professionals to "access, use, critically evaluate and develop the evidence base" (INSHPO, 2017, p. 12).

At first hearing, phrases such as "evidence-informed," "scientific and technical concepts" and "access, use, critically evaluate and develop" sound like they belong in the learning outcomes section of a university course profile. However, a true commitment to evidence-based practice can and should radically transform the day-to-day working life of an OHS worker, marking them as a true professional.

The idea that evidence-based practice should be used to improve the quality of OHS has its origins in evidence-based medicine, which was defined in 1996[1] as:

> …the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. (Sackett et al., 1996, p. 71)

Evidence-based medicine specified a shift from the medical profession's traditional reliance on experience and intuition to inclusion of a rational five-step process in decision making:

1. Ask answerable questions
2. Find the best available evidence
3. Critically appraise the evidence
4. Apply results in practice, and
5. Evaluate effects of the intervention (Sackett et al., 2000).

In 2000, it was observed that the spread of evidence-based practice to many areas of healthcare, the rise of quality assurance and standards of accreditation in industry, and an

[1] For more information about the history of evidence-based medicine, see, for example, Claridge and Fabian (2005).

increasingly critical public were adding pressure for development of evidence-based practice in occupational health: “In this climate it is difficult to see any survivable future for occupational health practice which is not explicitly evidence-based” (Carter, 2000, p. 235). It had become increasingly obvious that a professional is not just someone with formal education and/or lots of experience; rather, at the foundation of every profession is an awareness of the limits of personal experience as a source of reliable knowledge.

Relying solely on personal experience or expert advice is problematic. Even if someone has achieved good results over many years in their OHS practice, with only one strand of observation there is no way of ruling out alternative explanations for their apparent success. Many forces impact health and safety in a workplace. While it is tempting to believe that any apparent improvement is the result of our own efforts, individuals tend to overestimate the importance of their own work and underestimate other contextual factors when evaluating the causes of success. An OHS professional with a strong track record of managing safe organisations may indeed be good at their job but their personal experience does not make them an expert in what does and does not cause OHS improvement.

There is now general agreement that evidence-based practice is a requirement of OHS practice (e.g. EU-OSHA, 2013; SWA, 2012; Schmidt et al., 2021). However, evidence-based practice as a core competency for OHS professionals remains a work in progress, and there is a general lack of clarity about the role of evidence in OHS decision making (Stockwell et al., 2022). Indeed, OHS interventions are often characterised by underutilisation of systematic scientific evidence and overreliance on expert opinion (e.g. Jensen et al., 2020; Teufer et al., 2019; Verbeek, 2018). Various reasons for this have been proposed, including the impact of a wide variety of dynamic contextual factors on OHS (resources, workplaces, organisations, industries, laws and regulations, society); the perceived cost and time requirement of rigorous evaluation of methods; the paucity of high-quality intervention research; and that many OHS professionals lack effective information literacy and critical appraisal skills (e.g. Brämberg et al., 2017; EU-OSHA, 2013; Grajo et al., 2020; Jensen et al., 2020; van Dijk et al., 2010). Most of these problems cannot be solved in the short term. This chapter focuses on how, even in an imperfect world, OHS professionals can enhance their practice by arming themselves with information literacy and critical appraisal skills.

OHS professionals are knowledge workers (Provan et al., 2017). This chapter aims to enhance OHS professionals’ capacity to take action and provide advice based on accurate, up-to-date knowledge. For those OHS professionals who already know how to find, critically appraise and apply the best available research in their practice, this chapter is a refresher. For others, the chapter includes information that may help them stay current and effective in

their OHS practice and become lifelong self-directed learners.[2] Only through continuous self-improvement can those practicing OHS become, and remain, professionals.

This chapter replaces a 2012 edition. Section 2 explains what being a critical consumer of OHS research entails. Section 3 provides a set of principles for evidence-based OHS practice. Section 4 provides practical guidance for becoming a critical consumer of research by developing information literacy and critical appraisal skills. Section 5 considers ways to enhance OHS practice with research evidence, and the chapter concludes with a summary.

2 What is a critical consumer of OHS research?

Critical consumers are not passive recipients of information. With respect to advertising, for example, critical consumers have been described as "active analyzers [who] identify the techniques within each advertisement they encounter [and] actively filter messages so as not to become pawns of those messages" (Abernethy, n.d.). Similarly, a critical consumer of research is someone who engages actively with published information through an understanding of how that information is generated and reported.

Throughout this chapter, and indeed throughout the literature on evidence-based practice, the term *critical* often appears, particularly in phrases such as 'critical thinking,' 'critical evaluation' and 'critical consumer.' The term is used to indicate that not all evidence is equal, and that informed and careful judgement is necessary when selecting and interpreting evidence.

When interpreting an individual piece of research, the necessary skill is sometimes called *critical appraisal*. Critical appraisal has been defined as "the process of carefully and systematically examining research to judge its trustworthiness, and its value and relevance in a particular context" (Burls, 2009, p. 1).

When deciding which research to use, the appropriate skill is sometimes called *information literacy*. Information literacy is the broader ability to "to think critically and make balanced judgements about any information we find and use" (CILIP, 2018, p. 3).

[2] Indeed, Sackett and Rosenberg (1995, p. 622) referred to evidence-based medicine as "a process of life-long, self-directed learning." See also, for example, Akobeng (2005a).

Building on the work of Sackett et al. (2000) and others,[3] a critical consumer of OHS research:

- Identifies the types of literature that may inform practice
- Knows how to locate and access the results of research
- Understands the strengths and weaknesses of different ways of conducting research
- Critically appraises research material to assess its trustworthiness, value and relevance to their local context
- Recognises when they need to do further research or consult with scientific experts to determine the validity of research and the quality of its underlying science
- Translates relevant research outputs into suitable local actions.

OHS professionals should engage critically with OHS research to:

- Update and extend their foundational knowledge as the evidence base grows
- Solve problems by investigating current knowledge about specific workplace issues and potential strategies for addressing those issues.
- Learn about new ideas and tools, and determine whether those innovations are relevant and suitable for their OHS practice.

Being a critical consumer of research is more than just attending conferences and webinars or reading books and academic papers. Uncritical adoption of new ideas is not continuous improvement, it is merely responding to current fashion. While closing the gap between 'what is known' (evidence) and 'what is done' (practice) can be challenging, failure to use the best evidence can result in use of inappropriate interventions and missed opportunities for practice improvement (Grajo et al., 2020; Mallidou et al., 2018).

The idea of being a critical consumer extends beyond research publications to embrace standards, opinion papers, industry and government reports, and many other sources of information. Although this chapter focuses specifically on being a critical consumer of academic research, the principles and methods described may be applied more broadly.

[3] See, for example, Arroyave et al. (2021), Berndt (2009), Burls (2009), Hilton & Hilton (2020), Lewis (2018), McEwan & McEwan (2003), and Potti et al. (2003).

3 Evidence-based practice principles for OHS

The existence of contextual differences between clinical healthcare and OHS practice means that adaptation of the traditional medical approach to evidence-based practice is warranted (Schaafsma, 2007). Because OHS encompasses the myriad of issues that affect health and safety in the workplace, it is an extensive multidisciplinary field that can include "scientific areas such as medicine, physiology, toxicology, epidemiology, industrial hygiene, ergonomics, physics, chemistry, technology, economics, law, and other areas specific to various industries and activities" (Hempel et al., 2016, p.1).

This section explores five key principles of evidence-based practice for OHS professionals:

- Decisions informed by the best available evidence
- Transparency about the quality of evidence informing decisions
- Understanding causes, including mechanisms of interventions
- Evidence interpreted in light of the context in which it will be applied
- Evaluation of evidence as community practice.

3.1 Decisions informed by the best available evidence

Since the early 1990s, when Sackett and colleagues argued that optimal medical practice required identification, critical appraisal and use of the "best possible evidence" (Sackett & Rosenberg, 1995), informing decision making with the best evidence available has been a fundamental cross-disciplinary principle of evidence-based practice. Indeed, practitioners are morally obligated to use the best available evidence (Barends et al., 2014; WHO, 2021). However, as noted in section 1, OHS professionals' approaches to prevention are often not informed by the best available evidence and this may negatively impact their effectiveness and credibility (Van Eerd et al., 2018).

There is risk involved in 'cherry picking' sources to support a particular point of view without considering the quality of evidence and the possibility that other sources may present stronger/conflicting evidence. While peer review offers published academic research better protection than other types of publication, research evidence is susceptible to error and bias[4] (Barends et al., 2014; Gifford, 2016). For example, it is not sound decision making to use the results of a single small-scale study conducted in a workplace unlike your own to justify

[4] Research is subject to various forms of bias relating to, for example, sample selection, performance of compared groups, participant attrition, outcomes detection and reported findings; see, for example, Hempel et al. (2016).

implementation of an OHS intervention without ascertaining whether larger and more relevant research studies have been conducted.

At the apex of the traditional hierarchy of research design (often illustrated as a pyramid, e.g. Wieten, 2018) are those studies considered to be the most internally valid and least subjective, i.e. peer-reviewed randomised controlled trials and well-conducted systematic reviews of such trials.[5] Observational studies occupy a lower level of the hierarchy, with expert opinion/expertise forming the bottom layer. While randomised controlled trials and systematic reviews have long been hailed as the 'gold standard' of research evidence in medicine, as pointed out by Potts et al. (2006), evidence-based practice and randomised controlled trials are not synonymous (see 'The basis for parachute use' below). Indeed, the 'best' research design depends on the nature of the question being asked, for example:

> Systematic reviews and meta-analyses can provide high-quality evidence for answering many different kinds of questions. Well-designed cohort studies provide the best evidence to answer questions about prognosis, incidence, or risk factors for a condition. Qualitative studies or sample surveys offer an excellent tool to understand client or community experiences. Cost–benefit questions call for economic analysis. (Spring & Hitchcock, 2010)

An issue for implementing traditional evidence-based practice in OHS is that while randomised controlled trials and systematic reviews are considered the best evidence for effectiveness of interventions, until recently they have been rare in OHS research, with cross-sectional, observational cohort and case-control studies much more common (e.g. Arroyave et al., 2021; Franco, 2001; Schaafsma, 2007; Verbeek & van Dijk, 2006). In the absence of high-quality evidence, it is particularly important not to rely on single studies when determining the effectiveness of an intervention.

Also, decisions should not be based solely on scientific evidence; rather, the best available research evidence should be integrated with "all relevant internal and external evidence" (Murphy et al., 2014). The World Health Organization specifies that, in addition to the best available research evidence, "decisions should be informed by…factors such as context, public opinion, equity, feasibility of implementation, affordability, sustainability, and acceptability to stakeholders" (WHO, 2021, p. ix). Particularly relevant for OHS are "stakeholder characteristics and contextual factors that bear on the likely applicability, acceptability, and uptake of the intervention(s) best supported by evidence" (Spring & Hitchcock, 2010).

[5] See section 3.5, Table 2, for descriptions of randomised controlled trials, systematic reviews and some other study types.

Identifying, accessing and critically appraising the best available evidence that is relevant to a particular topic or question can be challenging. Section 4 provides guidance for building information literacy and critical appraisal skills relevant for this task.

The basis for parachute use

In 2003, the limitations (and potential folly) of relying on only randomised controlled trials were exemplified in an "entertaining but profound" article in the *British Medical Journal* (Potts et al., 2006). The following is an extract from the article – "Parachute use to prevent death and major trauma related to gravitational challenge: Systematic review of randomised trials" (Smith & Pell, 2003, pp. 1459-1461).

Objectives: *To determine whether parachutes are effective in preventing major trauma related to gravitational challenge.*

Design: *Systematic review of randomised controlled trials. …*

Results*: We were unable to identify any randomised controlled trials of parachute intervention.*

Conclusions*: As with many interventions intended to prevent ill health, the effectiveness of parachutes has not been subjected to rigorous evaluation by using randomised controlled trials. Advocates of evidence-based medicine have criticised the adoption of interventions evaluated by using only observational data. … Only two options exist. The first is that we accept that, under exceptional circumstances, common sense might be applied when considering the potential risks and benefits of interventions. The second is that we continue our quest for the holy grail of exclusively evidence-based interventions and preclude parachute use outside the context of a properly conducted trial.*

What is already known about this topic

Parachutes are widely used to prevent death and major injury after gravitational challenge

Parachute use is associated with adverse effects due to failure of the intervention and iatrogenic injury

Studies of free fall do not show 100% mortality

What this study adds

No randomised controlled trials of parachute use have been undertaken

The basis for parachute use is purely observational, and its apparent efficacy could potentially be explained by a "healthy cohort" effect

Individuals who insist that all interventions need to be validated by a randomised controlled trial need to come down to earth with a bump

3.2 Transparency about the quality of evidence informing decisions

Many OHS interventions lack evidence that would be considered 'high quality' under the standards used for evidence-based medicine (Pedersen et al., 2012). One reason for this is that the conduct of randomised controlled trials is not always appropriate in OHS due to, for example, ethical considerations associated with exposing humans to hazardous chemicals (Rooney et al., 2016). Even when compelling evidence exists, OHS professionals must apply their own judgement to implement that evidence in their local context. Although personal experience and judgement are important in decision making (Guyatt et al., 1992), the further OHS professionals reach beyond the evidence and the more they rely on experience and judgement, the more vulnerable they become to making poor decisions. A

prerequisite for evidence-based practice is for a professional to be honest with themselves and others about the basis of their decision making and advice.

The term ‘evidence-based’ should be applied with caution, and only when it genuinely refers to the availability of trustworthy, relevant evidence (Johnston et al., 2019; Montori & Guyatt, 2008). It is misleading to say that a decision is based on the best available evidence without disclosing the limitations of that evidence.

A decision might be:

- A straightforward application of a body of evidence that has been critically appraised as relevant and reliable
- A reasonable interpretation of evidence that does not precisely match the local situation
- An informed judgement where there is conflicting evidence
- A professional opinion in an area where there is no current reliable evidence.

An OHS professional at a storage facility is asked to make a recommendation for improving worker handwashing during a pandemic. They look for evidence about whether a poster campaign will improve handwashing. They might, for example:

- Find a body of work, across multiple industries, about using posters to encourage hand washing (i.e. a straightforward application of evidence that has been critically appraised as relevant and reliable) or
- Find that most existing work is about handwashing in hospitals, and decide to follow these results (i.e. a reasonable interpretation of evidence that does not precisely match the local situation) or
- Find evidence for and against handwashing poster campaigns, and decide that the studies supporting the campaign are a better match for the current circumstances (i.e. an informed judgement where there is conflicting evidence) or
- Decide that none of the existing research really applies to the local circumstances, and so base their decision on whether previous poster campaigns at the storage facility seemed to work (i.e. a professional opinion in an area where there is no current reliable evidence).

Having accessed a range of information across research and industry sources, the OHS professional makes a recommendation and summarises the quality and relevance of the evidence upon which they relied in making that recommendation.

Obviously, all research evidence is not equally valid. Slack and Draugalis (2001) explained the two main types of validity relevant to assessment of research evidence quality:

- *Internal validity*, which is concerned with the rigour of the study design, refers to “the degree to which a study establishes the cause-and-effect relationship between the treatment and the observed outcome” (p. 2173). If an experimental study lacks

internal validity (assessed on the basis of research design and operational procedures), the results may be attributable to a cause other than the intervention.

- *External validity*, which is concerned with generalisability, refers to the extent to which the results of a study can be extrapolated to other populations and settings. If an experimental study lacks external validity (assessed on the basis of inclusion and exclusion criteria and characteristics of study participants), implementation of the intervention in a local OHS setting may not be useful/successful.

OHS professionals should reflect on the quality of evidence that they apply and, when advocating for or against changes in practice, use language that matches the quality of evidence (e.g. certain versus tentative). One tool that may assist OHS professionals in thinking and talking about quality of evidence is GRADE (Grades of Recommendation, Assessment, Development and Evaluation).[6]

GRADE, an approach to rating the quality of research evidence and recommendations, was developed to be applied to a body of evidence (e.g. for appraising systematic reviews for production of practice guidelines[7]) rather than to individual studies (Balshem et al., 2011). GRADE adjusts for the restrictive simplicity of traditional hierarchies of evidence by allowing "observational studies with dramatic effects to be 'upgraded,' and trials may be 'downgraded' for quality and other reasons" (CEBM, 2011, p. 1).[8] In this manner, high-quality observational trials can receive a higher score than low-quality randomised controlled trials (Wieten, 2018). GRADE's quality of evidence classifications are listed in Table 1 (see also Table 6).

Table 1: Quality of evidence classifications according to the GRADE framework (Balshem et al., 2011, p. 405)

Quality level	Definition
High	We are very confident that the true effect lies close to that of the estimate of the effect
Moderate	We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

[6] See The Grade Working Group at https://www.gradeworkinggroup.org/

[7] For example, World Health Organisation guidelines are based on systematic reviews of evidence and GRADE's systematic approach to recommendation (Verbeek, 2018).

[8] GRADE-CERQual has been developed for critical appraisal of systematic reviews of qualitative evidence (Munthe-Kaas et al., 2019); see Table 6.

Low	Our confidence in the effect estimate is limited. The true effect may be substantially different from the estimate of the effect
Very low	We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

3.3 Understanding causes, including mechanisms of interventions

To determine the "physical, chemical and psychological hazards of occupation," Bradford Hill (1965) proposed nine "aspects of association" for causation – strength of association, consistency, specificity, temporality, biological gradient, plausibility, coherence, experiment and analogy. Bradford Hill wanted to determine how to move from an observed association to a verdict of causation. The aspects of association (now often referred to as the Bradford Hill Criteria) constitute a pre-evidence-based-practice system of appraising evidence and, since 1965, great advancement has been made in our understanding of the mechanistic connections between exposure and disease (Fedak et al., 2015; Howick et al., 2009). Various efforts have been made to update the Bradford Hill Criteria and improve ease of use. For example, Howick et al. (2009, p. 186) organised them into three categories:

- *Direct evidence* from research studies that a probabilistic association between intervention and outcome is causal and not spurious; includes strength of association, experiment and temporality
- *Mechanistic evidence* for the alleged causal process that connects the intervention and the outcome
- *Parallel evidence* that supports the causal hypothesis suggested in a study, with related studies that have similar results.

Whereas direct or statistical evidence (generated by randomised controlled trials and meta-analyses, for example) may provide evidence of an association, or correlation, between an intervention and its outcomes (i.e. between some cause and some effect), it does not always explain how an intervention produces its outcomes. However, if the mechanism can be explained, confidence in the intervention increases. It is now recognised that both direct/statistical and mechanistic evidence are necessary for attribution of causality and establishment of external validity (Clark et al., 2013; Howick et al., 2009; Russo & Williamson, 2007).

Mechanisms explain why an intervention works or does not work (physically, chemically, psychologically or organisationally) as expected (Micheli et al., 2018). The study of mechanisms is fundamental to the 'realist' approach to evaluation (e.g. Pawson et al., 2005).

> The basic idea of the realist analysis is to study how, for whom, and under what circumstances an [OHS] program works. Thus, the key concept is that a program needs

> to have a mechanism that will make a target group in a specific context make changes resulting in the desired outcome. The model is simple: Mechanisms + Context = Outcome, a model of causality. … Interventions are not presumed to have causal powers in themselves, instead context and mechanisms are seen as the factors that initiate or trigger the causal relationships, so, the actual outcome of an intervention varies depending on the intervention, the context, the mechanisms and the interplay between these factors and can be categorized as positive, negative, expected, or unexpected. (Micheli et al., 2018)[9]

Realist analysis suggests that the traditional evidence hierarchy needs "revising to ensure that complementary forms of evidence are treated as complementary, and that evidence of mechanisms, currently treated implicitly, is examined explicitly" (Clark et al., 2013). This chapter advocates such a realist approach for OHS. Indeed, Parkkinen et al. (2018) called for evidence-based medicine (EBM) to be updated to EBM+ (with mechanisms as the +) because causality is more appropriately assessed by integrating evidence of mechanisms and correlation.

Understanding the mechanisms of OHS interventions is vital for OHS professionals. Many OHS interventions that prove effective under controlled experimental conditions do not work as expected in practice (Mitcheli et al., 2018). OHS interventions will always have multiple effects, some intended and some unintended or not anticipated.[10] If OHS professionals do not understand why a particular practice usually works, then how can they judge its suitability for application in their organisation? Importantly, OHS professionals should seek "*evidence* of mechanisms, not descriptions of mechanisms for which there is no evidence…Just as EBM improved clinical practice by scrutinising clinical studies, scrutinising evidence of mechanisms can lead to further improvements" (Parkkinen et al., 2018, p. 12).

An OHS professional for a community care organisation has heard of a training intervention called 'Cockpit Resource Management (CRM)', used initially in aviation but translated successfully to other industries, and wonders if it would be a suitable response to a series of safety incidents involving miscommunication between staff members.

The OHS professional has two questions to answer by critically reading about CRM:

1. Does CRM work? Is there sufficient evidence to suggest that it is generally effective at what it does?
2. By what mechanism does CRM work? Does it work in a way that would be likely to help with the problems that the community care organisation is experiencing?

The OHS professional recognises that these are distinct questions. CRM might work for aviation and other applications, but may not be suitable for the community care organisation. CRM might have a plausible mechanism, but poor evidence that it is generally effective. CRM might even be generally ineffective but have a plausible reason why it could still be worth testing in the community care setting.

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[9] For discussion of the difference between mechanism and context, see, for example, Shaw et al. (2018).

[10] See *OHS BoK* 12.1 Systems and Systems Thinking.

3.4 Evidence interpreted in light of the context in which it will be applied

Academic researchers work with systematic public knowledge and seek to produce results and establish patterns and principles that can be applied in a broad range of situations. However, this knowledge is rarely a perfect 'fit' for a specific organisation at a particular time, and the local context can limit the effectiveness of interventions via enabling or disabling mechanisms (Micheli et al., 2018). OHS professionals, on the other hand, work with local private knowledge, and have an insider's view of what is happening in a particular situation at a particular time. Without systematic knowledge, individual practice risks being out of date, ineffective and potentially dangerous. Without local knowledge, "practice risks becoming tyrannised by [external] evidence" because the evidence might not be applicable or appropriate (Sackett et al., 1996, p. 72). Overreliance on systematised knowledge may result in the marginalisation of local practical knowledge (e.g. about industry-specific hazards and controls) (Almklov et al., 2014).

Evidence-based practice does not require a choice between systematic and local knowledge, but rather a skillful integration of the two. When choosing activities/interventions, OHS professionals should consider the strength of evidence behind each option, as well as the local conditions that may influence the choice. Interpretation of evidence requires:

1. *Understanding the problem to be solved.* This includes investigating how the problem manifests within the organisation, examining available resources to ensure an intervention fits the organisational context, and specifying goals and desired outcomes.
2. *Searching for, and selecting, a previously effective intervention(s).* Candidate evidence-based interventions – which may be characterised as 'best practice' if associated with consistently positive outcomes – should be critically appraised and selected based on the best available evidence.
3. *Clarifying the intervention.* Interpretation of the evidence in light of local factors requires adapting systematic knowledge to the local context while maintaining its core principles:

> …the main and difficult tasks are, on the one hand, to identify which intervention components should remain unchanged (i.e. the most essential and indispensable components for maintaining the intervention's identity and effectiveness) and, on the other hand, to identify which components should be adapted to fit with the social ecology under the new intervention scenario, but without affecting its effectiveness.
>
> (Herrera-Sánchez et al., 2017)

An OHS professional for a construction company has been tasked with reducing the number of items dropped from height. Based on an understanding of the company's operations, and an examination of previous incident reports, the OHS professional determines that tools are dropped in situations where the company does not have direct control over the physical work environment so any solution will need to be based on the workers or the tools, rather than on changes to the physical environment.

The OHS professional accesses a range of literature on dropped tools and determines that training alone is largely an ineffective intervention, but that collaborative assessment and replacement of tools can be effective. The literature suggests several methods of collaborative assessment, all with roughly similar evidence. The OHS professional selects a collaborative assessment method that uses language and formats that they think will appeal to the workers in their company.

3.5 Evaluation of evidence as community practice

Obviously, it is unrealistic to expect individual OHS professionals to conduct a systematic review of the research literature every time they have a question about good practice. Although evidence-based practice emphasises the necessity for academic research to focus on the creation of high-quality systematic reviews and meta-analyses of existing research studies, the mere existence of synthesised evidence does not ensure implementation in practice. For questions or practices where there is a consensus of high-quality evidence, translation into best-practice guidelines is an important next step (Verbeek, 2018).

Guidelines are a type of tertiary evidence source that facilitate knowledge translation[11] (Table 1). If high quality, up to date and based on the best available information, this form of "aggregated evidence" is the most efficient source of evidence for OHS professionals (van Dijk et al., 2010, p. 1264). If, for example, the formation of a guideline has adhered to the Appraisal of Guidelines and Research and Evaluation (AGREE) instrument, OHS professionals can be reasonably confident in its recommendations (AGREE Collaboration, 2003; Hulshof & Hoenen, 2007).[12] However, the variable quality of guidelines[13] makes it important for OHS professionals to critically appraise guidelines before use. As stated by Greenhalgh et al. (2014), evidence-based practice "is as much about when to ignore or over-ride guidelines as how to follow them."

[11] Knowledge translation has been defined as "…the synthesis, exchange and application of knowledge by relevant stakeholders to accelerate the benefits of global and local innovation in strengthening health systems and improving people's health" (WHO, 2006, p. 1) and simply as "the methods for closing the gaps from knowledge to practice" (Straus et al., 2009, p. 165).

[12] See section 4.3.2 Table 6.

[13] For example, on application of the AGREE II checklist (AGREE Next Steps Consortium, 2013): Armstrong et al. (2018) found several International Standard Organization (ISO) standards on biomechanical factors to be based on the opinion of unidentified experts rather than on transparent evidence-based methods; and Nexø et al. (2018) found that, of the 17 guidelines for prevention of work-related mental health problems that they assessed, only two included recommendations based on a systematic review and none met the criteria for all specified domains of quality and transparency.

Given the centrality of codes of practice in both OHS regulation and evidence-based practice, it is particularly important that those responsible for writing and promulgating codes of practice are careful about selecting, interpreting and communicating the best available evidence.

Table 2: Examples of primary, secondary and tertiary sources of research evidence[14]

Evidence source	Example	Description
Tertiary research *Evidence product*	Practice guideline	Developed by government agencies and other authoritative bodies, practice guidelines use the results of systematic reviews and integrated evidence from a variety of sources to make explicit recommendations on good OHS practice and help translate research into action.
Secondary research *Evidence synthesis*	Systematic review	Systematic reviews apply transparent, explicit methods to identify, critically appraise and synthesise the results of relevant primary research studies; they determine research quality by assessing internal validity (risk of bias) and external validity (generalisability or applicability across populations/settings); the methodology, traditionally applied to randomised controlled trials to answer questions of effectiveness ('what works?'), is now applied to a broader range of studies, including qualitative research, and questions (e.g. 'how and why does this work?'); to enhance understanding by non-academics, some authors of systematic reviews make 'plain language' summaries available. (e.g. Dyreborg et al., 2022[15])
	Meta-analysis	Often conducted following systematic reviews, meta-analyses combine sufficiently homogenous data from relevant individual studies, thereby increasing overall sample size, statistical power and precision of the estimate of intervention effect.
Primary research *Evidence inquiry*	Randomised controlled trial	Randomised controlled trials are experimental studies in which participants are randomly assigned to one of two or more intervention groups; generally considered the most powerful and reliable study design for evaluating the efficacy of an intervention due to a rigorous methodology that makes it relatively less susceptible to bias.
	Observational study	In observational studies, researchers document naturally occurring events; they do not feature experimental intervention and may be more appropriate than randomised controlled trials in cases where it is not practical or ethical to randomise participants; types include cohort studies (group of participants followed over time) and case-control studies (comparison of groups with and without an outcome of interest).

[14] Sources for this table include Akobeng, 2005b; Carter, 2000; CRD, 2009; Creswell, 2009; Hempel et al., 2016; Long et al., 2020; Rooney et al., 2016; Tenny et al., 2022; van Dijk et al., 2010; WHO, 2021; and Woodbury, 2004.

[15] A plain language summary of this paper is available at www.campbellcollaboration.org/media/k2/attachments/0225_SWCG_Dyreborg_Work_accidents_PLS_EN.pdf

Evidence source	Example	Description
	Qualitative study	Whereas quantitative studies test objective theories and generate numerical data, qualitative studies explore meaning and provide insight into phenomena such as human experience and behaviours that may be difficult to quantify; types include ethnography, action research and grounded theory, with methods including interviews, focus groups and participant observation; qualitative research can be combined with quantitative research in mixed methods research.

Individual OHS professionals often struggle with translating research evidence from tertiary, secondary or primary sources into OHS practice. Growing interest in closing this 'research-practice gap' has highlighted the benefits of participatory approaches such as practice-based research networks that include both researchers and OHS professionals (Jensen et al., 2020) and communities of practice that "link practitioners to each other in small groups to share reflections, insights, and research evidence on a common population or setting" (Marr, 2017). Also, Kwak et al. (2017) demonstrated the usefulness of a multidisciplinary participatory approach in the development of an OHS guideline for the management of lower back pain.

An OHS professional is unsure of the wisdom of implementing a 'Zero Harm' vision for their organisation. They recognise that this is a question that would be of interest to many OHS professionals. In collaboration with several colleagues, the OHS professional collates a summary report of existing research about Zero Harm and makes it available through their professional association. The report contains a set of conclusions and recommendations. Each conclusion is clearly marked with a statement about the quality of the supporting evidence so that readers can see whether recommendations are based on conclusions that are likely to change if further research is conducted.

4 How to be a critical consumer of OHS research

Stockwell et al. (2022, p. 37) commented that one important reason for the underutilisation of research in OHS practice was that "decision makers might not know how to access [relevant evidence] or distinguish between reliable and unreliable types." To identify the best available evidence for use in their practice, OHS professionals need both information literacy and critical appraisal skills. This section addresses how OHS professionals who have questions to ask of research can locate and access evidence, and evaluate its credibility, quality and relevance for their local context.

4.1 Asking questions of research

OHS professionals may find the need to ask general or specific questions of the OHS research literature. As explained by van Dijk and Caraballo-Arias (2016), answers to general questions (e.g. *What are common causes of occupational skin diseases?*) may be available across many sources, both in books and online; however, specific questions that impact decision making in dynamic practice contexts may require exact and up-to-date answers from credible online sources. Table 3 provides examples of the types of questions that OHS professionals may need to ask. Examples of how to form a variety of questions can be found in van Dijk and Caraballo-Arias (2021).

Table 3: Examples of questions OHS professionals may need to ask of research (van Dijk & Caraballo-Arias, 2016, pp. 13-14)

Domain	Description	Example question
Diagnostic	Assessment of a disease or work disability.	*What is the best diagnostic test to determine the work ability for shift work?*
Aetiology	Causation of a disease, work disability or accident.	*What are the possible risks to reproduction during pregnancy from the inhalation of solvents?*
Interventions	OHS activities used to prevent, control or cure an undesirable condition.	*How protective is education on the use of a specific type of disposable respirator given exposure to asbestos at a work site?*
Predictions	Predicting; prognosis when there is already a disease, injury or disability.	*What are the consequences of a severe depression for safe work as a lorry driver or as a pilot in commercial aviation?*
Frequencies	How often a risk is present in a branch of industry; estimates of current levels of exposure.	*How many workers in the printing industry are exposed to high levels of solvents?*
Prevalence/ incidence	Prevalence/incidence of an occupational injury or disease.	*What is the incidence of burn injuries in mechanics?*
Measurement	Questions concerning methods of measurement.	*What are the best methods for measuring lead pollution, taking into account several contamination routes, for workers in the cable industry?*
Good practice	Questions about good practice on, for example, how to prevent disease or injury	*What are the best preventative measures against asbestos exposure in a garage?*

4.2 Locating research evidence

The main types of research literature that will inform OHS practice are guidelines, codes and standards; systematic reviews and meta-analyses; primary research papers; reports; and books. As indicated in section 3.5, high-quality up-to-date OHS practice guidelines can be valuable resources. Books can provide useful background information, particularly for answering the general type of questions referred to in section 4.1. The types of research that OHS professionals are most likely to have difficulty locating and accessing are systematic reviews/meta-analyses, primary research papers and high-quality research reports. Locating useful and relevant items of these types of research involves conducting a literature search based on topic and/or keywords then broadening the search to find related papers.

Most research papers and reports are published in the form of PDF files, which may be found via:

- Search engines (e.g. Google and Google Scholar)
- Journal websites (e.g. *Safety Science*[16])
- Databases that index published research (e.g. Web of Science, Medline via PubMed) (Table 4)
- Websites and online libraries of authoritative national/international organisations, universities and institutes (Table 4).

Table 4: Examples of database/organisational sources of evidence-based OHS research

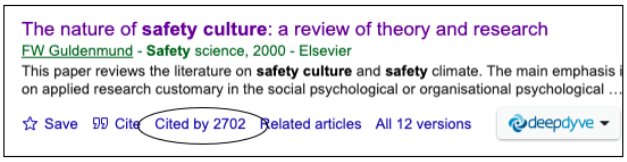
Database/ Organisation	Description	Available at
The Cochrane Collaboration	International, independent, not-for-profit organisation focused on healthcare evidence; database with >7,500 systematic reviews largely focused on effectiveness of interventions; includes the Cochrane Work Review Group; provides plain language summaries of evidence.	www.cochrane.org Cochrane Work: work.cochrane.org
PubMed (including MEDLINE)	US National Library of Medicine's bibliographic database containing >34 million citations and abstracts of biomedical and health literature.	pubmed.ncbi.nlm.nih.gov User guide available at pubmed.ncbi.nlm.nih.gov/help/
International Labour Organization (ILO)	An agency of the United Nations, the ILO sets labour standards, develops policies and programs promoting decent work; website provides access to research reports and	www.ilo.org/global/lang--en/index.htm

[16] https://www.sciencedirect.com/journal/safety-science

Database/ Organisation	Description	Available at
	papers, and the ILO Encyclopaedia of Occupational Health & Safety	www.iloencyclopaedia.org
National Institute for Occupational Safety and Health (NIOSH)	US research agency focused on the study of worker health and safety; part of the US Centers for Disease Control and Prevention (CDC); includes the searchable NIOSHTIC-2 bibliographic database with citations for >74,000 NIOSH-supported publications	www.cdc.gov/niosh/ www2a.cdc.gov/nioshtic-2/
American College of Occupational and Environmental Medicine (ACOEM)	Physician-led organisation that champions the health of workers, safety of workplaces, and quality of environments; provides evidence-based OHS practice guidelines	acoem.org/Guidance-and-Position-Statements/Guidelines
Agency for Toxic Substances and Disease Registry (ATSDR)	US public health agency that focuses on minimising human health risks associated with exposure to hazardous substances; provides publications and resources, including fact sheets and ToxGuides	www.atsdr.cdc.gov e.g. ToxGuides: wwwn.cdc.gov/TSP/ToxGuides/ToxGuidesLanding.aspx
Health & Safety Executive	UK WHS regulator; provides guidance material	www.hse.gov.uk
NHS Health at Work Network	The UK National Health Service provides evidence-based occupational health guidelines	www.nhshealthatwork.co.uk/oh-guidelines.asp
Canadian Centre for Occupational Health and Safety (CCOHS)	Not-for-profit federal departmental corporation governed by a council representing government, employers and labour; provides OHS resources and guidance material	www.ccohs.ca
Safe Work Australia	Australian statutory agency; develops national WHS and workers' compensation policy, including codes of practice	www.safeworkaustralia.gov.au
Jurisdictional WHS regulators	The websites of SafeWork NSW, WorkSafe Victoria, WorkSafe Qld, SafeWork SA, WorkSafe WA, WorkSafe Tasmania, NT WorkSafe and WorkSafe ACT may provide guidance material	

Once a few relevant research publications have been located, it is possible to find additional papers via a 'snowball' strategy by identifying:

- *References cited within a paper*. Backward citation tracking is a way to discover the sources of ideas or information in a paper and potentially reveal clearer explanations of ideas that may have been obscured through reinterpretation.
- *Other publications that have cited a paper*. Forward citation tracking by looking for references to a paper in the work of others can provide information about how the work may have been advanced, contradicted or found relevant.



- *Other publications by the same author.* If a researcher has published a relevant paper on a particular topic, they may have written others of interest.

A search of the research literature may reveal information about a specific paper(s) without providing access to a pdf of the full text. Full-time scholars and researchers may be used to navigating directly to relevant journal websites and databases and, in fields such as medicine and law, practices tend to hold subscriptions to such journals and databases so practitioners are accustomed to using them. This is often not the case in OHS. While the open access movement[17] has increased public access to research generally, many articles remain behind journal paywalls. However, even for those who do not have access to an online library, there are various ways to obtain free pdfs of papers, including via:

- *Google.* Searching for the title of the paper in quotation marks will result in hits from different sites;[18] frequently one or more of these will include a link to a pdf. Also, a Google search on the author's name may reveal a personal webpage or university/institute staff page that may include links to papers
- *Directly approaching the author.* Authors have permission to share their papers and will usually respond favourably to an email expressing interest in their research
- *Asking a colleague with access.* If you know someone with a user account at a university, they may be willing to obtain the paper from the university's library for you.

For more information, listen to *The Safety of Work* podcast, episode 34 'How can practitioners find and access research?' (Rae & Provan, 2020).[19] Other useful sources include van Dijk and Caraballo-Arias (2016, 2021).

4.3 Evaluating evidence

Because the quality of research literature is highly variable, evidence must be evaluated for credibility, trustworthiness, validity and usefulness. Two overlapping 'layers' of evaluation are relevant here. The first involves application of basic information literacy skills and the

[17] "Open access (OA) literature is digital, online, free of charge, and free of most copyright and licensing restrictions. We could call it 'barrier-free' access…" (Suber, 2012, p. 4).

[18] If the title is a general topic, try including the author's surname and 'pdf' in the search.

[19] Available at https://safetyofwork.com/episodes/ep-34-how-can-practitioners-find-and-access-research-T4Ddkf5w

second involves critical appraisal as designed for evidence-based practice. Many tools are available to assist.

4.3.1 Information literacy tools

The Internet and associated ease of information dissemination without traditional indicators of authority accelerated the imperative for information literacy in all aspects of life (e.g. Metzger, 2007). From the late 1990s, librarians and others began to provide education and tools – i.e. checklists – for assessing the credibility of online information (Metzger, 2007). Since then, checklists have been criticised for various reasons[20] and determined by some to be inadequate measures of the trustworthiness of online sources given the increasing sophistication of the Internet (e.g. Fielding, 2019).

One source evaluation checklist that has continued to be widely used, probably due to its memorable acronym, is the CRAAP (Currency, Reliability, Authority, Accuracy, Purpose) test (Blakeslee, 2004).[21] While this checklist is arguably largely focused on "simple surface traits" (Elmwood, 2020), it can be applied usefully as a preliminary stage of evaluation for OHS research papers (Table 5).

Table 5: Applying Blakeslee's (2004) CRAAP test in the context of OHS research literature

Characteristic	Comments and example questions
Currency *Timeliness of the information*	'Recent' research is often considered to be that published in the last five years. Recency is particularly important for literature reviews as older work may be replaced or discredited by more recent findings. However, a very recent paper may not have had a chance to attract critique; it may be wise to wait for some academic assessment of its credibility. Also, accident and injury data can take time to stabilise. • *How recently was the research undertaken?* • *Is the literature review up to date?*
Relevance *Importance of the information for your needs*	To determine whether a paper is relevant to your inquiry, first read its abstract (a short summary of the research aims, methods and findings). If potentially relevant, skim the paper to determine whether it is worth reading in depth. Researchers writing for other researchers will pitch an article differently to those writing to inform practice. OHS professionals should not avoid such articles, but rather be aware of this and possible implications for practice.

[20] Criticisms of information literacy checklists include: impracticality due to excessive number of questions; inadequacy for contemporary application due to failure to consider the wider context or support 'lateral reading;' and involvement of lower-order thinking rather than critical thinking (Benjes-Small et al., 2013; Elmwood, 2020; Fielding, 2019; Liu, 2021; Meola, 2004).

[21] The CRAAP test, along with many other checklists, is a derivative of Kapoun's (1998) 'five criteria for web evaluation' – accuracy, authority, objectivity, currency and coverage.

Characteristic	Comments and example questions
	• *Does the abstract indicate content relevant to your search question/topic?*
Authority *Source of the information*	If, for example, you are reading a paper about statistical analysis and a search on the author's name reveals a substantial list of other publications they have written about statistical analysis, this may be indicative of subject expertise. On the other hand, it may be cause for concern if the search reveals complaints about their work or a potential conflict of interest due to the source of research funding. • *Who is the author/publisher/source/sponsor? Are they reputable?* • *Does the author have subject expertise?*
Accuracy *Reliability and correctness of the content*	The independent review process of reputable journals sets journal articles apart from other publications. Generally, journal article review includes preliminary review by an editor followed by review by two or more 'peers' identified as being familiar with the topic. Peer reviews are typically 'double blind,' in that reviewers do not know who the authors are and vice versa. However, publication in a peer-reviewed journal is not a guarantee of quality as there are many reasons that research can be flawed. A sense of accuracy can be achieved by: 1. Comparing the introduction and the method (did the researchers do what they set out to do and how did they do it) 2. Reviewing the method for relevance and limitations (e.g. surveys provide information about what people are thinking/reporting, not reliable facts) 3. Checking whether the paper accurately represents source material. For historical information, it is important to get as close as possible to the source material because information can become corrupted over time, e.g. Havinga et al. (2022) pointed out that many recent articles credit Neil George, who was working for Inco in Ontario between 1936 and 1947, with inventing the 'five point safety system,' but contemporary descriptions of Inco safety practices do not resemble the original system – the recent articles are retellings of retellings, and less reliable than original accounts. • *Has the paper been peer reviewed?* • *Does the paper appropriately reference source material?* • *Does the methods section transparently describe how the results were obtained?*
Purpose *Reason the information exists*	Most OHS research is published as academic papers in journals or presented at conferences so when evaluating the purpose of OHS information, the main difference will be between academic research papers and everything else, e.g. information about a research study can be a research paper or a second- or third-hand report such as a press release about the research or a newspaper article based on a press release about the research – while all may be useful, they should not be confused. **Academic papers** may be recognised by a header or footer with the journal name and date of publication, a title and list of authors with affiliations, an abstract, citations to other papers and a reference list, and availability of a PDF version. Absence of these features typically indicates that the document has not undergone peer review. **Conference papers** vary in style, format and quality and the nature of their peer review may vary from rigorous to a rapid inclusion/exclusion decision. Conferences often feature new ideas, untested methods and uncritical self-reports and safety improvement initiatives; while interesting, these may not provide the sort of evidence necessary to inform effective practice. In safety science, most authors reserve their highest quality work for journal publication. Of the many **books** on OHS topics available, some are theoretical and written by academics or as an outcome of a peer-reviewed research thesis, some effectively translate research to practice, some present practical perspectives with limited research justification, and some are unashamedly opinion with anecdotes. **Codes of practice** and **guidelines** have a quasi-legal status as practical guides to achieving standards of health and safety under WHS legislation. Courts may regard codes of practice as evidence of what is known about a hazard/risk/control and may

Characteristic	Comments and example questions
	refer to them when determining what is reasonably practicable[22] in the circumstances. Ideally, codes/guidelines are based on a literature review and a synthesis of current best evidence-based practice. Sometimes, especially where the strength of the evidence may be argued, the content is mediated by industry input. When using information from a code of practice or guideline, OHS professionals should be mindful of whether they are using it as a source of knowledge or for legislative compliance. If a source of knowledge, it is appropriate to consider the strength of the evidence base that has informed the code/guideline. **Standards** set by bodies such as the International Organization for Standardization (ISO) and Standards Australia are developed via a consensus process. Although generally informed by research literature, standards structure existing knowledge in a way that can be applied and audited in the workplace. As indicated in section 3.5, the quality of standards and guidelines should not be assumed. • *Is there a clear statement about the aims of the research?*

The many other source evaluation checklists include RADAR (Relevance, Authority, Date, Appearance, Reason) (Mandalios, 2013); SIFT (Stop; Investigate the source; Find better coverage; Trace claims, quotes and media to the original source) (Caulfield, 2019); 5Ws or Journalistic Six (Who, What, When, Where, Why, How) (e.g. Radom & Gammons, 2014; Elmwood, 2020); and the Association of College & Research Libraries (ACRL, 2015) Framework for Information Literacy for Higher Education.

4.3.2 Critical appraisal tools

Evidence-based practice requires supplementation of information literacy with critical appraisal, which is underpinned by critical thinking (Whiffin & Hasselder, 2013). Application of critical thinking goes beyond the "appearance check" of the CRAAP test by focusing on:

> …recognizing basic logic concepts, evaluating arguments and logical fallacies, and examining deductive and inductive reasoning. We cannot conduct a real information evaluation until we look deeply into the source content and assess the arguments. (Lui, 2021).

Critical appraisal, therefore, should interrogate the research paper's underlying science. To be able to "distinguish evidence from propaganda, probability from certainty, data from assertions, rational belief from superstitions [and] science from folklore," Dawes et al. (2006) asserted that practitioners should appraise the validity of research, including "the suitability of the type of study to the type of question being asked, the design of the study and sources

[22] See *OHS BoK* 9.2 Work Health and Safety Law in Australia for an explanation of the determination of 'reasonably practicable.'

of bias, the reliability of outcome measures chosen, and the suitability of the analysis employed."[23]

Table 6 includes examples of critical appraisal tools for some tertiary, secondary and primary research sources. If guidelines, systematic reviews and meta-analyses have been prepared in a rigorous manner consistent with transparent evidence-based practice they are likely to provide good-quality, internally valid evidence. Cochrane systematic reviews, for example, should not require vigorous examination for quality by OHS professionals.[24] However, OHS professionals will still need to assess the generalisability of such evidence to their practice setting. For critical appraisal of individual research papers, the CASP checklists, developed to help people make sense of research evidence, are particularly popular. Whenever possible, OHS professionals should choose the primary research critical appraisal checklist that best suits the type of research study they are evaluating, and seek secondary and tertiary research sources that have been prepared in accordance with an appropriate critical appraisal tool.

Table 6: Example critical appraisal tools

Tool	Description	Available at
For practice guidelines *(tertiary research)*		
AGREE II	Developed by an international collaboration of researchers and policy makers, the Appraisal of Guidelines for REsearch and Evaluation (AGREE) II instrument (23 items in 6 quality domains) assesses methodological rigour and transparency of practice guidelines .	www.agreetrust.org
GLIA 2.0	The GuideLine Implementability Appraisal (GLIA) tool was developed to identify obstacles to guideline implementation; although there is some overlap between GLIA and AGREE items, assessment of implementation can complement assessment of quality .	www.cdc.gov/os/quality/docs/glia_v2.pdf
For systematic reviews and meta-analyses *(secondary research)*		
AMSTAR 2	A MeaSurement Tool to Assess systematic Reviews (AMSTAR) is a checklist for assessing the methodological quality of systematic reviews; developed in Canada by Ottawa Hospital Research Institute and Bruyère Research Institute, it draws on the Cochrane risk of bias (RoB) instruments for random controlled trials .	amstar.ca
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) is a minimum set of items for reporting in	prisma-statement.org

[23] See the *British Medical Journal's* 'How to read a paper' series of articles (www.bmj.com/about-bmj/resources-readers/publications/how-read-paper) and *Epidemiology for the Uninitiated* (www.bmj.com/about-bmj/resources-readers/publications/epidemiology-uninitiated)

[24] Authors of Cochrane reviews apply rigorous methods outlined in the *Cochrane Handbook of Systematic Reviews of Interventions* available at www.training.cochrane.org/handbook

Tool	Description	Available at
	systematic reviews and meta-analyses; the PRISMA 2020 statement updates the PRISMA 2009 statement; it includes checklists and flow diagrams. (Page et al., 2021)	
GRADE	The Grading of Recommendations Assessment, Development and Evaluation (GRADE) is an approach to rating the quality of evidence and strength of recommendations; used to assess bodies of evidence, particularly for systematic reviews with a view to guideline development; the iSoQ tool applies the GRADE-CERQual (Confidence in the Evidence from Reviews of Qualitative research) approach to findings of a synthesis of qualitative evidence.	www.gradeworkinggroup.org training.cochrane.org/resource/grade-cerqual
For individual papers *(primary research)*		
CASP checklists	The UK Critical Appraisal Skills Programme (CASP) website includes checklists for assessment of the trustworthiness, relevance and results of individual types of research studies, including systematic reviews, qualitative studies, cohort studies, diagnostic studies, case control studies, economic evaluations and randomised controlled trials; CASP checklists were designed to cover three main areas of critical appraisal concern – validity, results and relevance. (Burls, 2009)	casp-uk.net/casp-tools-checklists
CEBM worksheets	The Centre for Evidence-Based Medicine (CEBM) at Oxford University provides critical appraisal worksheets for different types of evidence, including systematic reviews, diagnostics, prognosis, randomised controlled trials and qualitative studies.	www.cebm.ox.ac.uk/resources/ebm-tools/critical-appraisal-tools
JBI tools	Australia's Joanna Briggs Institute (JBI) provides checklists for different types of quantitative and qualitative studies, each with 6-11 questions.	jbi.global/critical-appraisal-tools
STROBE checklists	Strengthening the Reporting of Observation studies in Epidemiology (STROBE) is an international collaboration of scientists, researchers and journal editors; the website includes checklists of items that should be included in research papers reporting observational studies.	www.strobe-statement.org

Realistically, lengthy critical appraisal tools are unlikely to be used by OHS professionals operating in a busy OHS practice setting. While the tools listed for individual papers in Table 6 are not among those with the most extensive number of questions to ask of research, some OHS professionals may prefer to take a 'rapid critical appraisal' approach. This entails understanding how to answer the following three broad questions – using criteria and nested questions appropriate for the type of study – that correspond with Burls' (2009; section 2) definition of critical appraisal as examination of the trustworthiness, value and relevance of research (Table 7).

Table 7: Rapid critical appraisal

Question category	Comments and example questions
Are the results valid?	Internal validity (section 3.2) refers to methodological rigour and accuracy, and to whether the research results can be trusted. Establishing internal validity requires consideration of how the study was designed, conducted, analysed and interpreted, including the method of choosing study participants, efforts taken to reduce bias, etc. Questions to ask of the research will require tailoring to the type of research study being appraised. • *Is the research design suitable for addressing the aims of the research?* • *Are data collection and analysis sufficiently rigorous?* • *If primary quantitative research, is the sample adequately described and reflective of the identified population?* • *If primary qualitative research, are major concepts identified and defined, and is participant selection adequately described and justified?* • *If secondary research, is it a systematic review? If not, what is the review method? How many sources informed the review and how is the choice of these justified?* • *Do the discussion and conclusion follow logically from the results?* • *Are ethical issues and study limitations identified and addressed?*
Are the results important?	If the study is quantitative, determining whether the results are meaningful may require a basic understanding of statistics (e.g. effect size, level of significance and confidence intervals[25]). The results should be plausible, robust, appropriately interpreted and able to be reproduced. Make sure correlation is not confused with causality; an intervention can be related to an outcome without being the cause of it. • *Do the results answer the research question?* • *If statistical analysis is undertaken, are the findings statistically significant?* • *Is the mechanism(s) of action identified?* • *Are the findings supported by other papers?* • *Do you need to seek other papers to ensure you are not 'cherry picking' to support your view?*
Are the results applicable to my local setting?	External validity (section 3.2) refers to whether the results are generalisable to your practice setting. There are often considerable differences between, for example, the participants in a study and a particular organisation's employees. The question is whether you can expect the same result, e.g. "The results of a cohort study into the effects of postures adverse to health performed in the meat industry cannot be directly applied to an employee with RSI working for the municipality in the finance department" (Verbeek & van Dijk, 2006, p. 61). Also, practical issues such as feasibility and resources should be considered (Wilson et al., 2022). • *Are the results generalisable and relevant to your OHS practice?* • *Would differences between your local context and the study*

[25] "**Effect size** refers to the strength of the relationship between the variables. The *greater* the effect size, the stronger the relationship…Generally, effect size is designated as small (.2), medium (.5), and large (.8).…The **level of significance** deals with how *likely* something is to happen or not happen…[I]t is often depicted by the p-value, or probability. The smaller the p-value, the less likely it is that the reported results happened because of a fluke or chance…Most studies use a p-value of .05 as "clinically significant." (Wilson et al., 2022) "The **confidence interval** (CI) gives the range of where the truth might lie, given the findings of a study, for a given degree of certainty (usually 95% certainty)" (Burls, 2009, p. 5).

Question category	Comments and example questions
	participants/setting alter the outcomes? • *Do the benefits of implementing the results outweigh the costs?*

To increase confidence in research evidence, whenever possible OHS professionals should seek corroborating information. Indeed, *triangulation* is an approach increasingly adopted by systematic reviewers to consider whether evidence generated via different study designs and methods converges on one conclusion: "If a review recognises different sources of biases across studies and data results are consistent given the possible biases, then triangulation can assist the reviewer in reaching a more certain conclusion" (Arroyave et al., 2021, p. 26).

5 Enhancing OHS practice with research evidence

Having critically appraised the evidence in a research paper(s) and determined it is the best available on a topic, the OHS professional should reflect on how the findings apply to OHS generally and to their practice in particular. The evidence should inform the way they approach OHS problems and add credibility to their formal reports. Translation of systematic knowledge into OHS practice can be a complex endeavour as it involves integration with relevant local knowledge and contextual factors.[26] As noted in section 3.4, evidence requires interpretation for the organisational setting, which means adapting it while maintaining fidelity to the original design (Herrera-Sánchez et al., 2017). Furthermore, implementation of interventions should be followed by evaluation to assess their effectiveness (or ineffectiveness).[27]

It may be appropriate to share research findings (and implementation evaluations) with other OHS professionals, clients, managers or workers. Also, application of evidence-based practice can enhance continuing professional development (CPD), which is a requirement of professional certification. One way that OHS professionals can demonstrate CPD is by reviewing papers and documenting their analysis in a structured way (i.e. by applying information literacy and critical appraisal skills). This structured documentation supports

[26] See, for example, Crawford et al. (2016), Grimshaw et al. (2012), Van Eerd (2019), and Van Eerd and Saunders (2017) for information about knowledge transfer methodologies, strategies and tools.

[27] Herrera-Sánchez et al. (2017) described a detailed 10-element process for implementing interventions.

further enhancement of the CPD process by providing a focus for group discussion of research papers.[28]

The remainder of this section briefly addresses referencing the evidence base in professional reports and engaging in discussion about OHS theory.

5.1 Referencing the evidence base

In section 2 it was stressed that, as critical consumers of research, OHS professionals should update and extend their foundational knowledge, investigate current knowledge about workplace issues, and determine the relevancy and suitability of innovations for their practice. To assist this critical engagement and to support preparation of reports, OHS professionals may benefit from maintaining a personal collection of references to research studies that they consider currently or potentially useful. Tools such as Mendeley Reference Manager[29] and Zotero[30] have been designed to assist with storage and organisation of personal libraries.

OHS professionals also need to be proficient in the use of a recognised referencing style to appropriately acknowledge sources of information in their reports, and to assist others in locating and checking the evidence that has been used. Most reference management tools also provide support for referencing styles.[31] There are various referencing styles that differ in terms of their rules for citing information sources. Briefly, **author-date** citation styles incorporate the author(s)/source name and year of publication within the body of the text, with full bibliographic information for each source provided in a reference list at the end of the document. An advantage of author-date citation is that the source of the information is immediately accessible for the reader; however, a disadvantage is the potential for references to interrupt the flow of the text. Common author-date styles include American Psychological Association (APA) (the referencing style used in the *OHS Body of Knowledge*) and Harvard. In contrast, **notation** styles use in-text numbers (in superscript or square brackets) to refer to references in either footnotes at the bottom of the page or endnotes at the end of the text and, generally, full reference details are provided at the end of the paper. Examples include Vancouver and Institute of Electrical and Electronics Engineers (IEEE). Although footnotes and endnotes do not disrupt the flow of text, they require the reader to

[28] See the Australian Institute of Health and Safety's CPD Program at www.aihs.org.au/cpd

[29] See www.mendeley.com/reference-management/reference-manager

[30] See www.zotero.org

[31] Not referencing sources in a report can constitute plagiarism; see *OHS BoK* 38.4 The Ethical Professional.

leave the text to locate the reference. For more information on referencing and appropriate source acknowledgement, consult one of the many style guides available.[32]

5.2 Discussing OHS theory

Exchange of ideas among professionals is a vital element of professional practice. However, the quality of discussion is important; the OHS profession needs constructive, rational, non-judgemental discussion about what may and may not improve health and safety. Rae and Provan (2021) in *The Safety of Work* podcast pose a series of questions relevant to discussion of OHS theory.[33] In summary, discussion is more likely to be constructive if OHS professionals are thoughtful about choosing what they read, locating original sources, reflecting on theory and taking a collegiate approach. OHS professionals should:

- Carefully select what to read on a topic
    - Seek guidelines and systematic reviews for information on broad topics and individual research papers for depth; determine the credibility, value and relevance of these using information literacy and critical appraisal skills
    - Keep track of authors considered to be reliable interpreters of original sources; set up email alerts for relevant research from valued databases/organisations
    - Ensure strong opinions about a theory are informed by reading the original source (do not accept a description of a theory from an opponent of it)
- Assess original sources
    - Identify whether the original source is a 'field of learning' with many contributors or an idea/theory attributable to a single person or publication
    - Consider how an author's views may have evolved over time resulting in changes to an idea/theory; find out if other authors have modified it
    - Consider the content of the source material in context; perhaps the author was responding to industrial/social conditions and/or specific accidents; what were the prevailing ideas, attitudes and practices in safety?
    - Consider the overall intent and substance of the work; do not confuse the rhetoric used to promote an idea with the underlying work
- Understand the theory
    - Almost all theories try to apply some sort of order or artificial simplicity to accident causation by establishing categories of causes (with particular emphasis placed on certain causes) and relationships between those categories; determine what the theory is saying about how accidents are caused

[32] For example, https://apastyle.apa.org/instructional-aids/reference-examples.pdf or https://guides.library.uq.edu.au/referencing/vancouver/reference-list

[33] *The Safety of Work* episode 67 'How to constructively resolve an argument about safety theory' is available at https://safetyofwork.com/episodes/ep67-how-to-constructively-resolve-an-argument-about-safety-theory-KcN379Wi/transcript

    - Academic debate is a common and important part of theory development; OHS professionals should avoid evangelising particular practices or ideas on behalf of academics, and instead focus on the evidence rather than the debate (which may resolve with consensus or clear evidence) and remain humble and curious about their way of doing things
- Make a constructive contribution
    - There is a need for localised knowledge to move OHS theory forward; this is not about proving or disproving broad theories, but rather about informing practice with theories, adapting evidence-based interventions to local contexts, and collecting reliable information about what works
    - View disagreement as a positive; be less fixed in your opinions and welcome constructive debate
    - Be prepared to share knowledge and experience while recognising the different roles of academics (i.e. broad theories and generalisations) and professionals (i.e. local knowledge, deep understanding of particular circumstances at a particular place and time).

6 Summary

OHS professional practice requires systematic knowledge gained from formal education and ongoing engagement with research evidence and local knowledge gained through personal experience. These forms of knowledge are complementary, with neither source of evidence adequate on its own. However, OHS practice tends to be more informed by local knowledge than by systematic knowledge, which can introduce OHS strategies that are less than optimal, ineffective or negative, and threaten the credibility of OHS practice.

While practicing OHS professionals are rarely academic researchers, they can employ evidenced-based practice by being critical consumers of research. In doing so they:

- Identify the types of literature that may inform practice
- Know how to locate and access the results of research
- Understand the strengths and weaknesses of different ways of conducting research
- Critically appraise research material to assess its trustworthiness, value and relevance to their local context
- Recognise when they need to do further research or consult with scientific experts to determine the validity of research and the quality of the underlying science
- Translate relevant research outputs into suitable local actions.

This chapter espoused five key principles for OHS evidenced-based practice:

- Decisions informed by the best available evidence
- Transparency about the quality of evidence informing decisions
- Understanding causes, including mechanisms of interventions
- Evidence interpreted in light of the context in which it will be applied
- Evaluation of evidence as community practice.

Having stressed the importance of OHS professionals being critical consumers of research literature and applying the principles of OHS evidenced-based practice, the chapter provided practical guidance for locating OHS research literature, evaluating research with information literacy and critical appraisal tools, and using relevant research evidence to enhance OHS practice.

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