A UK perspective on human factors and patient safety education in pharmacy curricula

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REVIEW

**Human Factors and Patient Safety Education in Pharmacy Curricula: a UK Undergraduate Perspective with Lessons for Pharmacy Education**

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**ABSTRACT**

**Objectives.** Avoiding unnecessary harm is increasingly a priority for healthcare organisations and this focus has seen the emergence of patient safety as a distinct discipline. The value of Human Factors and Ergonomics (HFE) approaches in underpinning this safety science is becoming recognised. This shift in professional priorities has been slow to filter into educational curricula, and little is known about how providers support students in developing safety competence. With respect to pharmacy education, this is problematic, given the high occurrence of drug-related adverse events. The aim of this review was to take a systematic approach to exploring patient safety teaching in healthcare curricula.

**Findings.** Key findings included a lack of formally articulated patient safety curricula, which means that student learning about safety is largely informal and influenced by the quality and culture of the practice environment. Human Factors and Ergonomics appeared largely absent from curricula.

**Summary.** Despite its absence from healthcare curricula, Human Factors and Ergonomics approaches offer a vehicle for embedding patient safety teaching. The authors suggest a model for a future curriculum.

**Keywords:** patient safety, human factors, ergonomics, pharmacy, hidden curriculum
INTRODUCTION

Growing awareness of healthcare-related ‘harm’ can be tracked through public responses to landmark events. In 1990, the US Institute of Medicine (IOM) published ‘To Err is Human’, which estimated that 100,000 deaths per year result from preventable medical error\(^1\). Recent updates suggest this is closer to 200,000, making it the third leading cause of death in the US\(^2\). Similar stories are seen worldwide, including the UK, where failings at Mid-Staffordshire NHS Foundation Trust caused 1200 unnecessary deaths\(^3\). While these failings ultimately resulted in poor care, they were considered to be the result of a wider lack of care and safety management. The personal and financial costs of such events have triggered considerable strategic documentation (including the UK’s ‘Berwick Report’\(^4\)), committing to ‘place quality of… care, especially patient safety, above all other aims,’ and also influenced the emergence of patient safety as a distinct discipline.

Cresswell et al (2013) describe patient safety as “a product… of a highly complex sequence of actions by multiple people and technologies\(^5\).” One challenge is to understand the systems that produce safety-related outcomes and the cultures that influence the behaviour of the ‘actors’ within these systems. Recognition of harm as an outcome suggests that the primary goal should be to design and maintain work systems that support good performance\(^6\). There is an increasing realisation that Human Factors/Ergonomics (HFE) approaches have much to offer in this regard\(^7\). HFE takes a systems-level approach to optimise system performance and human wellbeing. HFE approaches are design-based, ensuring that tasks are fitted to workers, rather than the other way round. In the UK, this recognition has resulted in increased interest in this approach. For example the Human Factors Concordat\(^8\) outlines the commitment made by professional, statutory, and regulatory bodies to support front-line staff in realizing the benefits of HFE practices. Other UK recommendations are to include HFE in serious incident investigations\(^9\). One of the initiatives to implement the Concordat was a series of HFE taster workshops by the UK professional body for HFE, the Chartered Institute of Ergonomics & Human Factors (CIEHF)\(^10\).
Changes in professional priorities must be reflected in educational curricula, but development with respect to patient safety has been slow. Regulatory bodies have a growing safety focus, but provide little direction for teaching. In 2011, the World Health Organisation (WHO) published a patient safety curriculum for educational staff\textsuperscript{11}, but little is known about how education providers ensure learners develop patient safety competencies and even less about teaching HFE principles\textsuperscript{5,12-16}.

In Scotland, 15\% of hospital admissions are drug-related and preventable with over half resulting from monitoring and/or prescribing errors\textsuperscript{17}. While these errors have complex causality, the pharmacist represents a key point in the error chain. It is proposed that developing capacity in pharmacist safety knowledge and skills could contribute to improving work systems to support not only medication safety, but also other aspects of patient safety. Undergraduate pharmacy courses in the UK are regulated by the General Pharmaceutical Council (GPhC) which provides a framework for guiding course design as Educational Standards for Pharmacists\textsuperscript{18}. Standard 1 states the importance of patient safety, but there is limited recurrence of the term; where it is mentioned, it is generally negative (‘students… must not… jeopardise patient safety’), rather than a positive requirement for developing patient safety skills.

A similar picture is seen across the world. In the US, for example, the Accreditation Council for Pharmacy Education 2016 Standards\textsuperscript{19} for PharmD programs describe how output from the IOM report\textsuperscript{1} led to recognition of the need to improve safety and outcomes and it is cited as a significant driver for the development of the Standards. However, as in the UK, beyond this introduction there is limited re-iteration of the term, and no guidance on embedding safety teaching within the curriculum. There is no direct mention of HFE, whilst one outcome includes the ‘analysis of the systems- and human-associated causes of medication errors [and] exploration of strategies designed to reduce/eliminate them’. It seems that there may be a global mismatch between the aspirations of regulatory bodies and the delivery capability of education providers. The aim of this review was to explore patient
safety teaching in pharmacy and other healthcare curricula, particularly in relation to how educators ensure students achieve patient safety competencies.

METHOD

The review took a systematic approach using selected databases to search for relevant literature: Scopus, Ergonomics Abstracts, Medline and PubMed. The search terms were: patient safety; ergonomics OR human factors; education OR curriculum; pharmacy; pharmacy education; these terms were used in Boolean combination (AND). The search was restricted to primary studies reported in academic journals, in English language and restricted to 2006-2017 (as a scoping search revealed very few prior studies). Inclusion criteria: studies meeting the search criteria. Exclusion criteria: Educational studies not about healthcare curricula; HFE studies concerned with prevention of staff injuries; reviews, editorials and opinion pieces. Additional sources of papers included colleagues working in the field (3 papers) and ‘snowballing’ references (3 papers). These additional papers all met the inclusion criteria. The review was carried out by a single researcher (HV). The search strategy is detailed in a PRISMA flowchart (Figure 1).

Data extraction (study characteristics (aims and design); participant characteristics; ethics and governance; setting and intervention; outcome measures; strengths and limitations) was followed by critical appraisal using the Critical Appraisal Skills Programme (CASP) checklist. Findings were synthesised using NVivo qualitative data analysis software (v10). NVivo has a ‘node’ feature which allows sources to be thematically analysed (‘coded’). Themes with the highest frequencies (based on number of sources and comments coding at each node) are discussed in this review.

FINDINGS

Selected papers are summarised in Table 1. Findings are summarised in Table 2, whilst noting that research in both patient safety and patient safety education is sparse. Studies indicated that there was very little formal safety teaching, and mostly uni-professional, with patient safety learning largely absorbed from the clinical environment.
(described as ‘informal’ and ‘hidden’ curricula). While HFE is considered to have much to offer, it is rarely taught in healthcare curricula (including pharmacy), and there is a lack of faculty expertise in HFE. The themes with the highest coding frequency were:

1. Importance of embedding patient safety throughout curricula
2. Measuring learning
3. Hidden curriculum
4. Understanding errors
5. Value of HFE approaches
6. Competence of staff in teaching patient safety
7. Patient safety and pharmacy

**DISCUSSION**

Although all the reviewed papers agreed the patient safety agenda is critical, the same few references were quoted in each. These references describe the events that led to the recognition of the importance of patient safety, rather than new research, reflecting that empirical evidence for the value of patient safety programmes is limited. Definitions of patient safety were discussed, but most researchers appeared content with domains defined by the WHO.1-4

1. **Importance of embedding PS throughout curricula.**

This was generally agreed to form part of professional identity development.13 Donaldson, introducing the WHO curriculum, states ‘[undergraduate education] has been under-used and under-valued… for addressing challenges of… improved patient safety.’ The reviewed studies concurred, indicating that few healthcare curricula have formal patient safety outcomes and there are very few articulated strategies for supporting students in developing such skills. Where formal educational activities were described, they were mostly single modules rather than embedded curricula.26 There was also relatively little information about the content and delivery of patient safety teaching, although some studies did comment that there was little in the way of interprofessional patient safety teaching. Health professions are at different stages, as evidenced by the disproportionate number of studies involving
medicine, but this is further complicated by a teaching ‘skills-gap.’ This was most clearly illustrated in the Quality and Safety Education for Nurses (QSEN) project\textsuperscript{27}. Core quality competencies were derived\textsuperscript{13} based on the 2003 IOM report ‘Health professions education\textsuperscript{28},’ and explored in a survey and focus groups for teaching staff knowledge/attitudes with respect to these competencies. The combined data suggested that while staff believed the competencies were being taught, they did not understand key concepts and were unable to articulate pedagogical strategies. There are limitations with this study (primarily sampling), but it raises some important issues. The authors conclude that the skills gap needs to be addressed, which a number of the other studies agreed with\textsuperscript{5,27,32}. However, the observation that perception of competence does not necessarily reflect reality raises the point that accurate measurement of competency is critical.

2. Measuring learning

Patient safety, as a professional competence, is the product of knowledge gained and clinical experience, as well as organizational factors shaping these experiences\textsuperscript{5}. Few validated tools could be applied in this context. Existing tools measure impact of specific interventions and have not been rigorously validity-tested. Ginsburg et al (2012) developed the Health Professional Education in Patient Safety Survey (H-PEPSS), to capture self-reported competency in the patient safety domains of the WHO curriculum\textsuperscript{23}. While confirmatory factor analysis (CFA) supported development of a robust tool and international face validity was reported, it did measure self-reported competence which, as shown by the QSEN study\textsuperscript{13}, is flawed. Furthermore, in order to achieve ‘good fit’ with the model proposed in the CFA, several items were removed, affecting the scope of the factor ‘Recognise and respond to reduce harm’ limiting validity in this domain. H-PEPSS has been used to explore self-reported competence in medical students in a Canadian university\textsuperscript{29}, showing temporal increases in confidence, but also that clinical exposure does not necessarily increase perception of competence. The authors suggested that clinical exposure increases students’ awareness of ‘what they don’t know’ as a reason, but it is worth further exploration.

Behavioural change models, such as the Geller model\textsuperscript{30}, describe the step from ‘unconscious’
to ‘conscious incompetence’ as critical for learning. It is also possible that cultural dimensions of the environment negatively impact on confidence.

An interesting application of H-PEPSS involved new graduates from medicine, nursing and pharmacy. This study revealed that common to all was lack of confidence for managing risk and handling errors, with nurses scoring highest in most safety dimensions. However, self-reported competence with respect to ‘working in teams’, ‘communicating effectively’ and ‘culture of safety’ declined from classroom to clinic. This reflects findings well-documented elsewhere that ‘healthcare hierarchies,’ most notably played out in terms of power differentials between doctors and nurses, create tensions undermining safety cultures. These cultures will be one of the influences that impact on student learning about safety in practice.

3. The hidden curriculum:

The complexity of drivers shaping student internalisation of standards has led to the coining of terms ‘informal’ and ‘hidden’ curricula. Unlike the formal curriculum, they are neither articulated nor associated with defined learning outcomes. ‘Informal’ describes experiential learning, while ‘hidden’ describes unintended transmission of attitudes and values. When the culture of the learning environment is good, these curricula were seen to contribute positively to patient safety education.

The studies indicated that much of the ‘hidden curriculum’ is delivered implicitly through clinical experiences, usually by non-academic staff during placement, underscoring the importance of how educators work with practice providers to ensure patient safety skills are appropriately developed. This is an area of disparity between disciplines. Some, including pharmacy in the UK, have almost no access to the clinical environment and students may seek employment to gain experience, exacerbating the undefined nature of informal curricula. Students may also rely on faculty-delivered, explicit patient safety teaching which may focus on ‘ideal’ rather than ‘real’ environments experienced during placement. A critical professional skill is recognising when deviations from ‘ideal’ may impact on safety. Courses
with regular clinical exposure have opportunities to discuss, with students learning from
others’ experience.

4. Understanding errors:

Teaching more complex patient safety aspects appears to primarily be approached
through significant event analysis, with little focus on causal errors, incident reporting and
systems thinking\textsuperscript{34}. Event analysis can suggest adverse events result from exceptional
circumstances, rather than arising from convergence of ‘routine’ errors. It appears dealing
with errors is not taught and that educational requirements may contribute to this omission.
None of the reviewed studies considered the pharmacy education context directly, but there
are other information sources that shed light on influences driving error management
teaching. There is a UK regulatory expectation from the GPhC that students making errors
should fail assessments\textsuperscript{18} if the outcome could cause patient harm. This is problematic for a
number of reasons. Firstly, ‘unsafe practice’ is a vague concept and making errors is not
necessarily ‘unsafe’, as safety threats actually emerge from the failure to manage error.
Secondly, assessment strategies promoting zero-tolerance of error miss the value of learning
from error. Gordon et al (2013) explored prescribing behaviours of medical graduates who
reflected on the causes of error and used these experiences to positively shape prescribing\textsuperscript{35}.
There is a strong case for developing learning activities around error, perhaps using
simulation, allowing students to err in safety. This also addresses a potential limitation of the
work of Gordon et al, as requiring disclosure of ‘real’ error can suffer social acceptability bias
where poor behaviours are omitted, or a positive spin (such as claiming errors as learning
experiences) makes reporting more palatable. Error management is a cornerstone of HFE
practice, and therefore HFE may be useful as a framework to support safety teaching.

5. The value of HFE approaches:

Patient safety must consider safety threats but also provide solutions to deal with
these. In 2000, the UK Department of Health published ‘An organisation with a memory,’
reporting on the findings of an expert group regarding ‘learning from adverse events\textsuperscript{36}.’ The
report defined a number of key observations, including that:
• harms within the NHS are disturbingly repetitive;
• research into learning from failure in healthcare is underdeveloped, but much more is available from other organisations;
• lessons from adverse events rarely become embedded in practice;
• analysis of adverse events tends to focus on blaming individuals, which points to a lack of systems understanding among healthcare practitioners.

The report recognised that culture was a major contributor to safety, but was seen as a ‘mysterious intangible entity’, rather than as a set of elements that can be captured and measured. It was suggested that healthcare organisations should aim to become high reliability organisations (HROs) to improve safety with robust safety cultures. The authors also recognised adverse events arise from interactions of professionals and patients with their environment, highlighting the usefulness of HFE. In response to the report, the UK Patient Safety Research Portfolio (PSRP) was established. Waring et al (2010) found the majority had a common theoretical underpinning, namely that HFE approaches of the type adopted by HROs could improve safety, with the limitation that the author panel did not include HFE expertise to assess the HFE approaches.

Very few of the studies reviewed involved HFE, although Timmons et al (2015) reflected on the lack of qualitative research in HFE patient safety in their work which involved a longitudinal qualitative study exploring emergency department and operating theatre staff perception of aviation-style HFE training. While staff considered the training invaluable, this was perhaps expected as participants were ‘self-selected HF enthusiasts.’ The main findings concerned perceived barriers to implementation including, for example, junior staff struggling with challenging senior colleagues. There were also differences regarding acceptability of change. If change was seen as owned by clinical staff, then it was accepted, but management-imposed change was problematic. Culture is thus critical not just to safety, but to change implementation. This is worth exploring because organizational change is necessary for delivering patient safety teaching agendas. The authors considered this fear of
change to manifest itself in institutions hiding behind ‘excessive pride in professionalism’ as alluded to by Robson et al, (2013). Thirteen English nursing schools all indicated they considered patient safety a priority and that it featured prominently in curricula. The majority also stated HFE was taught, but as with the QSEN study, this did not withstand deeper scrutiny. HFE education was sparse; with limited non-technical (non-specialist) skills training rather than HFE. The authors also believed that lack of educational corporate responsibility is seen where students are not offered appropriate access to clinical environments or academic-practitioner relationships are insufficiently developed to support effective learning. Institutions may also fail to adequately resource courses, including recruiting and retaining staff with appropriate expertise.

6. Competence of staff in teaching patient safety:

Cresswell et al (2013) offered a robust exploration of patient safety teaching across institutional and professional contexts. The study had strong methodological underpinning, based on Eraut’s framework. This framework describes the informal and formal nature of the acquisition of professional knowledge, including the hidden curriculum. A mixed-methods approach developed case studies in medicine, nursing, pharmacy and physiotherapy across eight institutions. The results confirmed the largely implicit nature of patient safety teaching, lack of ‘formal’ curricula and heavy reliance on ‘hidden’ teaching. They suggested that the main challenge was lack of expertise in patient safety science.

These findings echo earlier studies and the challenge seems to be translating patient safety knowledge into curricular change. As discussed, hidden curricula can be valuable and work best when all staff are involved in ‘teaching’ with strong, consistent safety messages transmitted to students. A similar cross-sectional staff expertise is required across the whole undergraduate curriculum. This is unlikely to exist at any institution, and anxieties about threats posed by this ‘identification of ignorance’ are possibly behind reluctance of some educators to accept that integrated patient safety teaching is critical.

One suggestion is increasing expert input. Role models are needed, in both clinical practice and academia, and staff may need further training. HFE bridges across engineering,
design, architecture, psychology and safety management programmes among others and many institutions are likely to have access to such expertise. Pharmacy faculty may be able to make use of this expertise in developing their own safety competence.

Some of the reviewed studies discussed quality improvement (QI) as being an important part of patient safety education, although no case was made for it as an educational strategy, and elsewhere in the literature there is evidence to suggest it is not always effective in improving safety. QI and HFE share similar origins, although QI is more process-focused compared with HFE, which considers ‘whole-system optimisation’. One weakness of QI is lack of tools for supporting redesign of healthcare systems, and this systems-level understanding is critical if safety issues are to be successfully addressed. However, the practice of QI is generally well understood within healthcare and it offers a starting point for change. Furthermore, Hignett et al. (2015) suggest it might be integrated with HFE, yielding a powerful approach to patient safety, building on existing knowledge and training materials.

7. Patient safety and pharmacy:

There were no outputs for literature searches involving HFE and undergraduate pharmacy education, and very little with respect to patient safety and pharmacy undergraduate teaching. Two of the studies did include pharmacy students, but there was little consideration in any of the studies for the specific pharmacy education context.

Lack of clinical experience for pharmacy students is compounded by a lack of good quality placements, which may only comprise short visits and tend to be (i) observational and (ii) lacking in consistency in terms of student experience. Placements must be quality assured, and achieved (in the UK) through compliance with the UK Quality Code for Higher Education. This indicates that depth of quality assurance should be related to risks posed to the curriculum. One-day placements are unlikely to contribute (directly) to achievement of learning outcomes and quality assurance is therefore often weak.

Given the importance of culture to informal and hidden curricula, a study by Ashcroft and Parker (2009) involving the development of a community pharmacy safety climate
questionnaire offered some insights with respect to the congruence between the organisation’s official safety stance and actual practice. Likert scale-type responses captured participants’ agreement with statements on safety-related themes. Elements were tested using principal components analysis, and some themes merged, resulting in the Pharmacy Safety Climate Questionnaire. This was validated in later studies, including the Phipps and Ashcroft (2012) exploration of the concept of subgroups within community pharmacy with respect to their PS views, and was based on previous findings regarding the existence of safety culture ‘archetypes.’ The questionnaire was sent to a random sample of community pharmacists on the UK national register with cluster analysis of the responses. Four subgroups were described who perceived their workplaces to range from ‘perilous’ to ‘safety focussed.’ All clusters showed significant similarities with respect to pressures of work, but differences appeared to derive from how much support pharmacists received to meet these challenges. A potential limitation of this study is the data (rather than theory)-driven analysis. The study raises an interesting question for pharmacy education. Many of these pharmacies provided placement experiences for students and new graduates, and were contributing to informal and hidden curricula. A recent study by the Phipps and Ashcroft group (2017) has explored how a combination of incident reporting data and work domain analysis can be used to explore the contextual factors that contribute to degraded safety in community pharmacy environments.

Such robust approaches to safety will hopefully begin to strengthen the pharmacy hidden curriculum.

Bradley et al (2011) explored the nature of the hidden curriculum in MPharm courses with a purposively selected sample of UK pharmacy schools. They suggested that teaching and learning activities based around patient safety were evident in curricula, but confirmed findings that much is implicit.

While patient safety is high on the agenda for all healthcare disciplines, the need for pharmacy educational reform may be particularly urgent, largely due to the expanding clinical practice element of the role. Across the world, healthcare reform demands a patient-centred care delivery model, with the pharmacist taking a central role in the management of
‘pharmaceutical care’46-48. If pharmacists are to take responsibility for patient outcomes, then they must enter the workplace equipped with the competencies that will allow them to deliver safe care.

Limitations

As with any systematic review there are methodological limitations. For example a pragmatic decision was made to select databases and there may be others (e.g. PsychInfo) which could have identified additional literature sources. Potential bias was managed by offering a transparent process for article selection (PRIMSA), and critical appraisal tool (CASP) with high face validity and application in healthcare.

SUMMARY

This review reveals that robust research into patient safety is under-developed with the literature around pedagogical strategies for teaching patient safety even less developed. The literature concerning teaching of patient safety to pharmacy students is limited; a critical concern given the number of preventable errors that are medication-related. The limited patient safety education literature available indicates that formal safety curricula are rare across all healthcare disciplines, with most teaching implicit, and learning heavily influenced by informal and hidden curricula. Given that pharmacy students have limited access to placement they may be denied these other sources of learning and rely heavily on other sources such as relevant paid employment and on formally provided, academic scenarios that may not capture real-life work environments.

It is certainly timely to consider strategies for formalising patient safety teaching by clearly articulating safety-related outcomes within course curricula. The findings of this review suggest that one of the major barriers to this is a lack of understanding of safety science, and how practical safety competencies relate to the role of the healthcare professional. This is exacerbated by the hidden curriculum which means that academic staff have very little understanding of the factors that influence student learning about safety. The findings also underline the value of HFE in providing systems-based tools for delivering patient safety outcomes, which involves recognising the need for appropriate staff expertise.
Addressing this issue requires the design of a good patient safety curriculum, and the authors propose a model (Figure 2) which reflects these findings with HFE as the central supporting structure around which the curriculum may be designed.

ACKNOWLEDGMENTS

The authors would like to thank Ed Watson for providing the artwork for Figure 2.

REFERENCES

48. Scottish Government. Prescription for excellence: A vision and action plan for the right pharmaceutical care through integrated partnerships and innovation. 2013; Scottish Government
Table 1. Summary of Papers Selected for Appraisal

<table>
<thead>
<tr>
<th>Paper</th>
<th>Title</th>
<th>Methods/Study design</th>
<th>Outcome measures</th>
<th>Results/Conclusions</th>
<th>Themes arising</th>
</tr>
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<tbody>
<tr>
<td>Alper et al., 2009</td>
<td>Patient safety education at US &amp; Canadian medical schools</td>
<td>Survey measuring implementation of safety curricula sent to Institutional Members of the Clerkship Directors of Internal Medicine (83/110 responded).</td>
<td>Likert-type scales</td>
<td>Only 25% of schools have explicit PS curriculum; 72% believed it should be taught.</td>
<td>1, 2, 4</td>
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<td>Andermann et al., 2011</td>
<td>Core competencies for patient safety research</td>
<td>‘Patient safety research competency development process’ (Delphi-type), involving the 21 members of the WHO PS Task Force.</td>
<td>Draft list of competencies</td>
<td>Consensus achieved</td>
<td>1, 2, 5</td>
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<td>Ashcroft and Parker, 2009</td>
<td>Development of the pharmacy safety climate questionnaire</td>
<td>Unspecified qualitative element used to modify existing tool. 998 community pharmacists responded and principal components analysis was conducted.</td>
<td>Internal consistency (Cronbach’s α). Inter-component correlations (Pearson correlation coefficients).</td>
<td>A 34-item (7 component) questionnaire produced. Components included incident investigation; team work; communication&amp; education.</td>
<td>7</td>
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<td>Blasiack et al., 2014</td>
<td>A cross-sectional study of medical students’ knowledge of PS and QI</td>
<td>Survey of perception of knowledge and past educational experience; included questions to objectively assess knowledge. 1 medical school; 790 students;</td>
<td>Previous educational experience, PS and QI knowledge were scored. Inferential statistics explored links between experience &amp; knowledge.</td>
<td>Students with previous exposure to PS and QI education scored significantly better on questions assessing PS knowledge. Overall, PS/QI knowledge was low.</td>
<td>1, 2</td>
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<td>Cresswell et al., 2013</td>
<td>Patient safety in healthcare pre-registration educational curricula</td>
<td>Audit/observation capturing explicit teaching. Interviews/focus groups capturing implicit teaching. 8 case studies (different professions). Interviews with course leads (n=17); Focus groups (staff/ students: n = 49 /91 respectively).</td>
<td>Quantitative: not presented. Qualitative: Thematic analysis.</td>
<td>Main themes: Tension regarding appropriate way to teach; Lack of consideration of the ‘real life’ environment; absence of systems teaching; opportunities to apply PS knowledge are critical.</td>
<td>1, 2, 3, 4, 5, 6</td>
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<td>Cronenwett et al., 2007</td>
<td>Quality and safety education for nurses</td>
<td>Workshops/emails used to define KSAs. These were shaped by feedback from nursing staff through focus groups. 16 universities in the IHI HPEC were involved, &amp; unspecified number of institutions</td>
<td>A set of competency-related KSAs published for comment from wider stakeholders</td>
<td>Development of KSAs revealed results of the QSEN (Smith et al., 2007) study did not withstand deeper scrutiny. QSEN indicated most staff believed PS to be explicitly and effectively taught. Focus groups developing KSAs</td>
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<td>Paper</td>
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<td>Doyle et al., 2015</td>
<td>Self-reported patient safety competence among Canadian medical students and postgraduate trainees</td>
<td>Hypotheses were set: (i) self-reported PS competence increases with clinical exposure &amp; (ii) increases with progression through training. 255 students; 1 university; H-PEPSS</td>
<td>Results were statistically analyzed and compared across years and between settings.</td>
<td>Self-reported competence increases across years of study. 'Weaker' areas were sociocultural aspects of safety. Clinical exposure could be negative. Uncertainty around error reporting (all groups).</td>
<td>1, 2, 4, 5</td>
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<td>Flin et al., 2009</td>
<td>Year 1 medical undergraduates’ knowledge of and attitudes to medical error</td>
<td>Electronic survey composed of items relating to safety. Items scored on a 5-point Likert-type scale to and analyzed to capture attitudes of students. 296 Year 1 students completed the survey.</td>
<td>Descriptive &amp; inferential statistics (parametric testing of Likert-type data). Properties measured: Cronbach’s $\alpha$; principal components analysis.</td>
<td>Student perception of knowledge regarding error and PS issues assessed as ‘medium-low to average.’ Students understand importance of speaking out, but fear consequences.</td>
<td>1, 2, 4</td>
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<td>Ginsburg et al., 2012</td>
<td>H-PEPSS: an instrument to measure health professionals’ perception of patient safety competence at entry into practice</td>
<td>WHO PS domains used as the basis for draft survey containing 23 items modelling PS competency. Confirmatory factor analysis (CFA) was used to test the model (and re-test after modification). 1247 graduates completed the survey (multi-professional)</td>
<td>Comparative fit indices and root mean square error of approximation were used to evaluate the model fit. Internal consistency measured (Cronbach’s $\alpha$).</td>
<td>CFA was used to modify the survey, resulting in a six factor, 16-item model which can be used in a variety of ways to support patient safety education.</td>
<td>1, 2, 3, 6</td>
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<td>Ginsburg et al., 2013</td>
<td>Self-reported patient safety competence among new graduates in medicine, nursing and pharmacy</td>
<td>H-PEPSS survey tool to measure self-reported competence in PS domains (n=4496; medics 1779; nurses 2196; pharmacists 521).</td>
<td>Data patterns (rather than absolute levels of self-reported competence).</td>
<td>Confidence in managing risks, handling errors and understanding systems is low; In most dimensions, nurses report higher levels of confidence; nurses’ confidence is undermined in team settings.</td>
<td>1, 4, 6, 7</td>
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<td>Gordon et al., 2013</td>
<td>Human factors perspective on the prescribing behaviour of recent medical graduates: implications for educators</td>
<td>Phase 1: 205 recent graduates (161 FY1; 45 FY2). Randomly allocated to control/intervention groups. 3 questionnaires (baseline, 4 weeks and 12 weeks). Phase 2: 11 semi-structured interviews with participants</td>
<td>Thematic analysis of qualitative data. Development of a model to describe behavior.</td>
<td>Recent graduate prescribing behavior changed with experience, which brings awareness of importance of non-technical skills. Participants learn safe prescribing through an iterative process of behavioral modification: experience of error is key.</td>
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<td>Myung et al., 2012</td>
<td>The PS curriculum for undergraduate medical students as a first step toward improving PS</td>
<td>Curriculum developed and taught to 156 2nd year students. Students completed questionnaires on self-assessment of awareness of PS before and after the intervention.</td>
<td>Likert scale-type responses. Results were analyzed parametrically (paired t-tests).</td>
<td>The largest perceptional change identified concerned understanding of the scale of medical errors.</td>
<td>1, 2, 4, 5, 6</td>
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<td>Phipps and Ashcroft, 2012</td>
<td>An investigation of occupational subgroups with respect to patient safety culture</td>
<td>Random sample of pharmacists from RPSGB database. 868 respondents; survey with 3 elements (2 different measures of perception of job characteristics as well as the Pharmacy Safety Climate Questionnaire; all elements ‘self-reporting’).</td>
<td>Quantitative: hierarchical cluster analysis. Qualitative: Comparison of data between clusters using a cross case analysis method to identify similarities and differences between/within clusters.</td>
<td>Identification of curricula described in terms of ‘characteristics’.</td>
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<td>Pingleton et al., 2010</td>
<td>Characteristics of quality and safety curricula in major teaching hospitals</td>
<td>In-depth interviews with leadership staff and residents in 6 major US teaching hospitals (~50 participants).</td>
<td>Identification of curricula described in terms of ‘characteristics’.</td>
<td>Identification of curricula described in terms of ‘characteristics’.</td>
<td>1, 2, 3, 6</td>
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<td>Robson et al., 2013</td>
<td>Teaching PS and human factors in undergraduate nursing curricula in England</td>
<td>Electronic survey sent to faculty working in 20 schools of nursing in England. Questions included topics taught and time devoted to teaching etc.</td>
<td>Descriptive summary of whether or not PS and HF were taught, what topics were covered (and the time devoted to each).</td>
<td>PS and HFE are being taught, but only limited elements. HFE limited – focus is on team training. Awareness of external resources was poor.</td>
<td>1, 2, 4, 6</td>
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<td>Smith et al., 2007</td>
<td>Current assessments of quality and safety in nursing education</td>
<td>Electronic survey sent to all member schools of the American Association of Colleges of Nursing (195/572 responded). Questions covered competencies, curriculum and pedagogical strategies.</td>
<td>Outcomes were essentially quantitative (although some responses were Likert-scale type)</td>
<td>For most competencies (including safety, teamwork and patient-centered care) most respondents indicated these were taught, and indicated high satisfaction with student achievement.</td>
<td>1, 2, 4, 6</td>
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<td>Stahl et al., 2011</td>
<td>Assessing the impact of teaching PS principles to medical students during surgical clerkships.</td>
<td>A two-part CRM curriculum was devised, with all participants (n=110) attending part 1 in year 1 of their studies. In year 3, 67 students received further PS training.</td>
<td>Survey responses and scores on knowledge test as well as self-reported behaviors were compared between the groups using t-testing.</td>
<td>Significantly more students in the group receiving 2-part CRM training reported speaking up and intervening in a safety-critical situation than those who had only undertaken the first part.</td>
<td>1, 5</td>
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<td>Timmons et al., 2015</td>
<td>Implementing human factors in clinical practice</td>
<td>1 UK NHS Trust; 20 senior professionals trained by aviation HF experts. Two focus groups and 10 semi-structured interviews with faculty; 11 semi-structured interviews with participants.</td>
<td>Thematic analysis of qualitative data.</td>
<td>Aviation HF training acceptable to – and useful for – medical staff. Course participants reported difficulties in trying to overcome resistance caused by organizational structures.</td>
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PS = Patient safety; QI = Quality improvement; IHI HPEC = Institute for Healthcare Improvement Health Professions Education Collaborative; QSEN = Quality and Safety Education for Nurses study; KSA = Knowledge, skills and attributes; Health Professional Education in Patient Safety Survey; RPSGB = Royal Pharmaceutical Society of Great Britain; CRM = Crew resource management; HF/E = Human Factors/Ergonomics
<table>
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<th>Findings</th>
<th>Summary</th>
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| Lack of research | • While there is extensive literature concerning undergraduate PS education, very little describes primary studies  
• There is even less research concerning the teaching of HFE approaches for patient safety  
• The ‘underdevelopment’ of the literature is commented on in most of the studies reviewed |
| Addressing the patient safety agenda | • Most studies discussed the urgency of the PS agenda and agreed that undergraduate education was an important element of this  
• There was general agreement with the notion of PS as an emergent discipline (both a science and a practice)  
• PS was also recognised as a professional competence, setting knowledge and skills within a context-specific, values-driven framework |
| Where PS is taught explicitly, it is uni-professional | • Typically, reported studies concern single institutions and/or professions  
• Medicine is the most frequently studied  
• Nursing also studied; very little literature concerning patient safety education for pharmacists  
• Some studies (reviewed here) have attempted to broaden perspectives |
| The vast majority of PS education is implicit | • Teaching relies on ‘professionalisation’ through clinical exposure  
• Some of this comes from ‘experiential learning’ as students complete placement activities (the ‘informal curriculum’)  
• Other aspects are derived from the unconscious transmission of attitudes and values, shaped by the workplace culture (‘the hidden curriculum’) |
| Complexity is a challenge | • Studies reveal staff and student anxieties around teaching and learning in more complex areas of patient safety  
• These include ‘systems thinking’; ‘understanding the causes of errors’; reporting incidents  
• There is an increasing recognition that HFE approaches may be valuable  
• There was a recognition of a lack of staff expertise for teaching HFE |
| Lack of robust tools for measuring PS competencies | • Some of the studies reviewed concern the development of tools for measuring educational outcomes  
• Some for these have high face validity  
• All rely on self-reporting, which is potentially flawed (especially at the higher confidence end – students ‘don’t know what they don’t know’) |
Figure 1: PRISMA Flow Diagram capturing databases searched and retrieval results

Records identified through database searching (n = 2778)

Additional records identified through other sources (n = 6)

Duplicates removed (n = 601)

Papers removed: 543 (pre-2006); 679 (title not relevant); 917 (abstract not relevant) (n = 2139)

Full-text articles assessed for eligibility (n = 44)

Full-text articles excluded according to inclusion/exclusion criteria (n = 26)

Studies included in qualitative synthesis (n = 5)

Studies included in quantitative synthesis (n = 13)
A traditionally constructively aligned healthcare curriculum reflects professional behaviour, articulated in the programme outcomes. Assessment is designed to capture these outcomes, and appropriate teaching and learning activities established to support student success in assessment. Appropriate staff expertise is required to deliver the course. The model proposed above develops this further by:

(a) recognising the importance of the ‘hidden curriculum’ in driving student learning and behaviour. This hidden curriculum must be mapped by working in partnership with students who are the ‘experts’ in this. Space must be provided within the curriculum to allow student-led exploration of all the experiences that contribute to their professional development.

(b) recognising that curriculum content must be driven by the needs of the practice role and assessment must be authentic, effectively measuring professional competencies. This may require a move away from traditional assessment formats, requiring staff to challenge their existing practice.

(c) proposing that HFE provides the tools to deliver on all of these aspects, and should be central to the curriculum, in both delivery and design.