Assessing safety climate in acute hospital settings: a systematic review of the adequacy of the psychometric properties of survey measurement tools

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Abstract

Background: The perceived importance of safety culture in improving patient safety and its impact on patient outcomes has led to a growing interest in the assessment of safety climate in healthcare organizations; however, the rigour with which safety climate tools were developed and psychometrically tested was shown to be variable. This paper aims to identify and review questionnaire studies designed to measure safety climate in acute hospital settings, in order to assess the adequacy of reported psychometric properties of identified tools.

Methods: A systematic review of published empirical literature was undertaken to examine sample characteristics and instrument details including safety climate dimensions, origin and theoretical basis, and extent of psychometric evaluation (content validity, criterion validity, construct validity and internal reliability).

Results: Five questionnaire tools, designed for general evaluation of safety climate in acute hospital settings, were included. Detailed inspection revealed ambiguity around concepts of safety culture and climate, safety climate dimensions and the methodological rigour associated with the design of these measures. Standard reporting of the psychometric properties of developed questionnaires was variable, although evidence of an improving trend in the quality of the reported psychometric properties of studies was noted. Evidence of the theoretical underpinnings of climate tools was limited, while a lack of clarity in the relationship between safety culture and patient outcome measures still exists.

Conclusions: Evidence of the adequacy of the psychometric development of safety climate questionnaire tools is still limited. Research is necessary to resolve the controversies in the definitions and dimensions of safety culture and climate in healthcare and identify related inconsistencies. More importance should be given to the appropriate validation of safety climate questionnaires before extending their usage in healthcare contexts different from those in which they were originally developed. Mixed methods research to understand why psychometric assessment and measurement reporting practices can be inadequate and lacking in a theoretical basis is also necessary.

Keywords: Attitudes of health personnel, Health care surveys/methods, Psychometrics/instrumentation, Surveys and questionnaires, Patient safety, Safety culture, Safety climate
Background
Patient safety in healthcare organizations has received much attention following the publication of the Institute of Medicine’s (IOM) report “To Err Is Human: Building a Safer Health System” in 2000. In its report, IOM highlighted the magnitude of preventable adverse events and identified the underlying “safety culture” as a key element influencing the ability of healthcare organizations to learn effectively from these events and implement preventative measures to reduce related harm to patients [1]. Assessing the status of the existing safety culture in a healthcare organization has been identified as the first step for developing a strong and solid safety culture [2]. Safety culture has been defined as “the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization’s Health and Safety management” ([3], p.23). According to Zohar [4], safety culture can be described as one aspect of an organization’s overall culture reflecting individual performance and organizational features that influence health and safety. Nevertheless, the concept remains poorly defined [5]. Pidgeon [6] has criticized earlier research for being “unsystematic, fragmented and in particular underspecified in theoretical terms” (p.203). Safety climate is often used interchangeably with safety culture [7] and can be perceived as “the measureable components of safety culture” ([8], p.364). It provides a “snapshot” of the perceptions and attitudes of the organization’s workforce about the surface-level aspects of culture during a particular point in time ([9], p.5). Safety culture and safety climate are clearly derivatives of organisational culture and climate [5, 10]. Researchers suggested that the concept of safety culture could be studied within the wider context of organisational culture [5, 11]. According to Neal and Griffin et al. [12], “Safety climate is a specific form of organisational climate, which describes individual perceptions of the value of safety in the work environment” (p.100). Reichers and Schneider [13] tracked the evolution of the two concepts and concluded that “culture exists at a higher level of abstraction than climate, and climate is a manifestation of culture” (p.23). In other words, safety culture is a broader organisational feature while safety climate is a sub-set of safety culture. Guldenmund [5] concludes that safety climate might be considered an alternative safety performance indicator. Cox and Flin [14] describe safety culture as the personality of an organization with its relative stability of systems, procedures and behaviours. Safety climate, on the other hand, was described as a transient mood state as changes in response to external events and pressures. Ginsburg and Tregunno et al. [15] argue for the lack of clarity in defining the construct of safety culture and climate in addition to the construct of patient safety culture. It is, therefore, logical to suggest that the creation of a universal model or definition of safety culture is not straightforward [10]. Yet, it appears that most of the safety culture definitions across different organisations share essential elements including attitude and behaviour of workers in terms of health and safety performance [10]. These common elements indicate the psychological aspect of safety culture. This aspect refers to the highly related concept of safety climate. Safety climate is most commonly assessed by safety climate questionnaires to measure employee attitudes and perceptions of safety, as they are practical to apply in terms of time and cost-effectiveness [5, 16]. Cheyne and Oliver et al. [17] argue that these quantitative measurements apply only to a specific setting at a particular point in time and are subject to short-term fluctuations. Kirk and Parker et al. [18] add that despite their usefulness as safety measures, they offer a superficial evaluation of an organization’s culture. Additionally, Pronovost and Berenholtz et al. [19] demands the need for scientifically sound and feasible measures of patient safety. A range of questionnaire tools have been developed to assess safety climate in acute hospital settings, however the rigour with which they have been developed and psychometrically tested is variable [8, 20, 21]. A lack of rigorous psychometric evaluation makes it difficult to confirm the validity and reliability of survey scores and inform organisational learning and improvement. Thus, it is imperative that questionnaire tools are developed with robust psychometric properties [20]. Against this background, our systematic review aimed to identify and critically review the adequacy of the reported psychometric properties of tools designed to measure safety climate in acute hospital settings.

Methods
Search strategy
Electronic search of Medline, PubMed, CINAHL, Web of Science, PsycINFO, Embase and Scopus was performed, using the key terms: “Safety Culture”, “Safety Climate”, “Safety Attitudes”, “Hospital Safety”, “Patient Safety”, paired with “Health Care Workers”, with manual searches of bibliographies of included papers and key journals. This review covered English language studies published between January 2004 to December 2014. A detailed overview of the search strategies can be found in Additional file 1.

Study selection
Two independent reviewers screened titles and abstracts of relevant records (GA, JM) while a third reviewer validated the data (PB).

Selection criteria
The process of identification and selection of eligible papers was conducted in two stages. The first stage involved evaluating the potential relevance of all titles and abstracts
identified from the electronic database searches. Studies were included if they met the following criteria: (1) described a quantitative method of assessing patient safety climate, (2) described the results of tool development and psychometric evaluation, (3) directed at healthcare staff in a hospital setting. In the second stage, papers that were judged to be potentially relevant were retrieved and reviewed against the full text inclusion and exclusion criteria. To be eligible for inclusion at this stage, studies had to primarily focus on questionnaire development and explicitly state that the purpose of the study was to establish the psychometric properties of the tool as part of tool development, testing and implementation. Also, the tool also had to be designed for general administration to all healthcare staff working in a hospital setting and publically available. Only original tools developed in English-language were included as well as any updated version of an original tool that was produced by the original team in which the latest improved version was included.

The flow chart in Fig. 1 shows the selection process, including the detailed inclusion and exclusion criteria.

Data extraction
Data extracted included a description of study setting; sample characteristics; study method; and tool features including dimensions covered, psychometric performed, theoretical basis and outcome measures (Tables 1, 2, 3).

Quality appraisal
Methodological quality of included studies was assessed based on the quality criteria developed by Flin and Burns et al. [20] (Table 4). Assessment of the quality of each study, included seven items related to the appropriateness of the study methodology, study population, data collection and analysis, response rate and results.

Higher quality studies were considered to be those that met a minimum of six of these seven indicators. Psychometric evaluation of included tools was based on recommendations by [20] and Flin and Burns et al. [20] and included aspects related to content, criterion and construct validity and reliability (Table 3).

Variability in safety climate dimensions across the reviewed papers have led the authors to evaluate the content of included dimensions in each tool. A list was developed including the most common safety climate dimensions that had been previously mentioned in studies addressing safety climate measures in healthcare (Table 5) [20]. Items and their suitability in each dimension were independently evaluated, by the three authors (GA, JM, PB), against the proposed list.

This study updates an earlier review by Flin and Burns et al. [20] of quantitative studies of safety climate in healthcare aimed at examining their reported psychometric properties.

Results
The search strategy identified a total of 3576 potential papers. Of these, 88 papers were reviewed against the full text inclusion criteria. Five studies met the criteria and were included for this review [15, 22–25] (Fig. 1). The tools included the Hospital Survey on Patient Safety Culture (HSOPSC) [23], Safety Attitudes Questionnaire (SAQ) [22], Patient Safety Climate in Healthcare Organizations (PSCHO) [24], Canadian Patient Safety Climate Scale (Can-PSC) [15], and the Safety Organizing Scale (SOS) [25]. The key features and characteristics of each included study and their reported psychometric properties are summarized in Tables 1, 2 and 3. Further information regarding each tool is in Additional file 1.

General characteristics of reviewed studies
The five tools were designed for general assessment of patient safety climate in acute hospital settings. They aimed to assess respondents’ attitudes, perceptions and behaviors about various aspects of patient safety. They also sampled a variety of hospital personnel across different occupations, staff positions and work areas.

Four of the included tools originated from US studies [22–25] while one tool originated from a study in Canada [15].

All survey tools used Likert response scales. Length of survey tools ranged from nine to 60 questionnaire items with a total of 141 items distributed under 36 climate dimensions. Each tool covered between one (e.g. SOS) and twelve reported dimensions (e.g. HSOPSC).

Seven dimensions were addressed by the majority of the reviewed tools including: (1) Top management support, (2) Safety systems, (3) Safety attitudes of staff, (4) Reporting incidents, (5) Communication openness, (6) Organizational learning and (7) Teamwork (Table 5).

A number of tools were adapted from other industries. The SAQ, for example, is an adaptation of a widely used questionnaire in the aviation industry [22]. More recently, tools have been developed specifically for healthcare settings such as the HSOPSC [23].

Four studies used theory to guide their tool development process. Within these studies, the PSCHO & SOS were based on High Reliability Organization Theory (HROT) [24, 25]. The SAQ employed more than one theory. Sexton and Helmreich et al. [22] Stated that the SAQ was based upon two conceptual models: Vincent’s framework for analyzing risk and safety [26] and Donabedian’s conceptual model for assessing quality [27]. Vincent’s framework incorporates the many factors influencing clinical practice including organizational factors and work environment factors while Donabedian’s conceptual model provides a framework for evaluating
the quality of healthcare [26, 27]. The theoretical basis for the Can-PSCS is rooted in Zohar’s definition of safety climate and Hofmann and Mark’s model on safety climate [15]. Zohar’s definition of safety climate stresses management commitment to, and support of safety by leadership at multiple levels [28]. Hofmann and Mark’s model of safety climate emphasizes open communicating and constructive response to errors and the degree to which the social environment encourages these behaviours’ [29]. One study did not provide an explanation of the underlying theoretical basis [23].

**Methodological quality and psychometric assessment of reviewed studies**

Convincing evidence of reliability and validity of any measuring tool can only be established by assessing the methodological quality of the studies. Our analysis focused on performing a comprehensive assessment of the reported psychometric properties in each study.

**Methodological quality of reviewed studies**

Three out of five studies [22, 23, 25] were rated as ‘good’ quality papers while two were rated as ‘fair’ [15, 24].
Table 1  Data extraction results of general features

| Features               | Name of instrument | HSOPSC (1) | SAQ (2) | PSCHO (3) | SOS (4) | Can-PSC (5) |
|------------------------|--------------------|-----------|---------|-----------|---------|-------------|
| Authors                | Sorra & Dyer       | Sexton    | Singer et al | Vogus & Sutcliffe | Ginsburg et al |
| Publication year       | 2010               | 2006      | 2007    | 2007      | 2013    |
| Country                | USA                | USA       | USA     | USA       | Canada  |
| Instrument details:    |                    |           |         |           |         |
| - Number of items      | 42                 | 60 (30 core items) | 38     | 9         | 19      |
| - Type of Likert scale | 5 point            | 5 point   | 5 point | 7 point   | 5 point |
| - Level of analysis    | Individual, Unit, Hospital | Individual, Unit | Individual, Unit, Hospital | Unit | Unit, Hospital |
| - Results Reporting    | Positive percentage scores | Positive percentage scores | Percentage problematic scoring | Not reported | Not reported |
| Setting & Staff        | Hospital setting Healthcare Staff | Hospital setting Healthcare Staff | Hospital setting Healthcare Staff including non clinical staff | Hospital setting Nursing units | Hospital setting Healthcare Staff |

Studies that were rated as ‘good,’ fulfilled six indicators related to: study aim(s), study methodology and design, data collection, study population, response rate, data analysis method(s) and results. The response rate fell below 60% for two of those studies [23, 25]. One study did not report their study population in sufficient detail to allow judgment to be made [22].

Papers rated as ‘fair’ quality, including Singer and Meterko et al. [24] and Ginsburg and Tregunno et al. [15], did not describe their study population in sufficient detail. The response rate was not acceptable in PSCHO while data collection was not sufficiently described in Can-PSC. The quality appraisal results for each individual study are summarized in Table 4.

Psychometric properties of reviewed instruments

The psychometric properties of included safety tools were examined with respect to content validity, criterion validity, construct validity (EFA, CFA) in addition to reliability (Table 6). Other measure included correlation across dimensions, item analysis, test/retest reliability and analysis of variance. All of the reviewed tools covered the standard psychometric criteria, as recommended by Flin and Burns et al. [20] (Table 3). However, three tools, including the HSOPSC, SAQ and SOS, reported more robust psychometric properties following their psychometric assessment in comparison to PSCHO and Can-PSCS.

The quality appraisal results of each survey tools’ psychometric properties are shown in Table 3.

Content validity

Instrument development, in all studies, typically involved the use of literature reviews, opinions of safety experts and user populations to conceptualize the domains of safety culture to be measured, and to generate related questionnaire items. Definitions of safety climate and culture overlapped among the studies although two studies clearly draw a distinction between the two terms and stressed that they set out to measure safety climate [15, 22].

Regarding the theoretical basis of the tools, three studies [15, 22, 25] stated that their survey items were based on a conceptual model but it was not clear how they related theory to their questionnaire items. One exception was the PSCHO where an explanation of its nine-dimension theoretical model was provided [24]. The HSOPSC had no explicit theoretical basis [23].

Two “core” safety dimensions from the non-healthcare industrial sector; ‘management and supervisory commitment to safety’ and ‘safety systems,’ were measured in four studies as components of safety climate in healthcare [20] (Table 2). A plausible explanation is that most of the instruments were based on High Reliability Organization Theory or were derived from tools designed for those specific industries such as the SAQ.

Criterion validity

Three studies had no reported independent outcome measures of safety climate [15, 22, 24]. The HSOPSC included two self-reported outcome measures: ‘Patient Safety Grade’ and ‘Number of Events Reported’. Positive associations have been shown between climate scores and self-reported safety measures [23].

A single study used independent measures to examine significant associations between safety climate scores and outcomes where multilevel regression analysis showed a negative relationship between SOS and reported medication errors and patient falls [25].

Construct validity

Factor structure and internal reliability

All five studies reported the results of a factor analysis (Table 3). CFA was performed in four studies.
| Features | HSOPSC (1) | SAQ (2) | PSCHO (3) | SOS (4) | Can-PSC (5) |
|----------|-------------|---------|----------|--------|------------|
| Safety Climate Dimensions: | | | | | |
| • Number of Dimensions | 12 | 6 | 9 | 1 | 6 |
| Safety Climate Dimensions: | Communication openness, Feedback and communication about error, Frequency of event reporting, Handoffs and transitions, Management support for patient safety, Non-punitive response to error, Organisational learning –Continuous improvement, Overall perceptions of patient safety, Staffing, Supervisor/ manager expectations & actions promoting safety, Teamwork across units, Teamwork within units. | Teamwork, Safety climate, Job satisfaction, Stress recognition, Perception of management, Working conditions. | Senior manager’s engagement, Organisational resources for safety, Overall emphasis on safety, Unit safety norms, Unit recognition and support for safety efforts, Fear of shame, Provision of safe care, Learning, Fear of blame | Self-reported “behaviours enabling safety culture” through collective mindfulness. | Organisational leadership support for safety, Incident follow-up, Supervisory leadership for safety, Unit learning culture, Enabling open communication I: judgment-free environment, Enabling open communication II: job repercussions of error. |
| Theoretical basis | Literature review in areas of safety management; organizational & safety climate & culture; medical error & error reporting; patient safety. Existing safety climate and culture instruments. | Based on Vincent’s framework for analyzing risk & safety, Donabedian’s conceptual model for assessing quality Derived from an aviation safety culture questionnaire | High reliability organizations Derived from a naval aviation safety culture questionnaire | High Reliability organizations | Based on Zohar & Hofmann &Mark's work on safety climate & error literature Adapted from work by Singer and colleagues |
| Key features | Tested on a large sample of hospitals Ability to benchmark data Self-report outcome measures | Tested on a large sample of hospitals Cross-industry comparisons Ability to benchmark data Favourable scores were associated with shorter lengths of stay & fewer medication errors in other studies | Measures safety climate among all hospital personnel and across multiple hospitals of different types Cross-industry comparisons | SOS is negatively associated with reported medication errors and patient falls | Validated for use across a range of care settings |
| Limitations | Supervisor/ Manager Expectations & Actions Promoting Patient Safety CFI =0.88 at unit & hospital levels Item A7 in the Staffing composite had a low within- unit & within hospital factor loading (0.36), Staffing had Cronbach’s alpha =0.62 | (SRMR) model fit statistic at the clinical area level was larger than desirable, indicating further scale refinement | Three individual dimensions demonstrate low internal consistency Selection Bias | Validated using a sample composed exclusively of registered nurses | Questions about generalizability Further research and cross-validation of will be required with international samples More appropriate for improvement and research Data was not suitable for multilevel CFA |

*HSOPSC* Hospital Survey on Patient Safety Culture, *SAQ* Safety Attitudes Questionnaire, *PSCHO* Patient Safety Climate in Healthcare Organizations, *Can-PSC* Canadian Patient Safety Climate Scale, *SOS* Safety Organizing Scale
### Table 3 Psychometric results

| Features                           | Name of instrument | HSOPSC (1) | SAQ (2) | PSCHO (3) | SOS (4) | Can-PSC (5) |
|------------------------------------|--------------------|-----------|--------|-----------|---------|-------------|
| Psychometric properties:          |                    | Yes       | Yes    | Yes       | Yes     | Yes         |
| Content Validity                   |                    | Yes       | Yes    | Yes       | Yes     | Yes         |
| Construct Validity:                |                    | Yes       | Yes    | Yes       | Yes     | Yes         |
| Factor Structure                   |                    | CFA: 12 factors | CFA   | CFA: Single factor | CFA    | CFA         |
| CFA                                |                    | CFI 0.90  | RMSEA 0.03 | CFI > 0.90 | RMSEA 0.06 | RMSEA 0.033 |
| Model fit indices*                |                    | SRMR < 0.08 | SRMR 0.17 between & 0.04 within clinical areas | SRMR 0.033 | –         |             |
| EFA                                |                    | Chi < 0.05 Good model fit | Chi < 0.0001 Satisfactory model fit | Chi < 0.0001 Good model fit | Chi < 0.0001 Good model fit |
| Convergent Validity:              |                    | EFA: 14 factors | EFA: 6 factors | EFA: 7 factors | EFA: 6 factors |
| Convergent Validity:              |                    | Yes       | Yes    | Yes       | Yes     | Yes         |
| Discriminant Validity              |                    | Yes       | No     | Yes       | No      | No          |
| Criterion Validity                |                    | Yes       | No     | Yes       | No      | No          |
| Item analysis                      |                    | Yes       | No     | Yes       | No      | Yes         |
| Test Re-test Reliability           |                    | Yes       | Yes    | No        | No      | Yes         |
| ANOVA                              |                    | Yes       | Yes    | Yes       | Yes     | Yes         |

*Model fit indices recommended criteria: comparative fit index (CFI ≥ 0.90) [6], the standardized root mean square residual (SRMR < 0.08) & the Root Mean Square Error Of Approximation (RMSEA < 0.08) [7], Chi-square (Chi < 0.05) [8]

### Table 4 Quality Appraisal Results

| Quality Appraisal Criteria | HSOPSC Sorra and Dyer (2010) [23] | SAQ Sexton et al. (2006) [22] | PSCHO Singer et al. (2007) [24] | SOS Vogus & Sutcliffe (2007) [25] | Can-PSC Ginsburg et al. (2013) [15] |
|----------------------------|-----------------------------------|--------------------------------|---------------------------------|-----------------------------------|--------------------------------------|
| Aim(s) or research question(s) clearly stated? | ✔✔ ✔ ✔ ✔ | ✔✔ ✔ ✔ ✔ | ✔✔ ✔ ✔ ✔ | ✔✔ ✔ ✔ ✔ | ✔✔ ✔ ✔ ✔ |
| Study methodology and design evident and appropriate? | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ |
| Data collection described and appropriate? | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ |
| Study population described and appropriate? | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ |
| Data analysis method(s) described and appropriate? | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ |
| Response Rate acceptable (60% or above) | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ |
| Results reported in sufficient detail? | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ | ✔ ✔ ✔ ✔ ✔ |
| Total Score | 14/12 | 14/12 | 14/10 | 14/12 | 14/10 |
| 0–5 Poor Quality 6–10 Fair Quality 11–14 Good Quality Yes ✔ ✔ ✔ ✔ ✔ | Good | Good | Fair | Good | Fair |

HSOPSC Hospital Survey on Patient Safety Culture, SAQ Safety Attitudes Questionnaire, PSCHO Patient Safety Climate in Healthcare Organizations, Can-PSC Canadian Patient Safety Climate Scale, SOS Safety Organizing Scale
CFA results are evaluated by examining the items factor loadings (0.40 or greater) and the overall model fit indices. The HSOPSC reported factor loadings ranging from 0.36 to 1.00. The staffing composite had one item with low factor loadings (0.36). The model fit indices were good with the exception of Supervisor/Manager Expectations and Actions Promoting Patient Safety which reported comparative fit indicator (CFIs) below the recommended 0.90 criterion.

SAQ reported factor loadings ranging from 0.40 to 0.99. The overall model fit indices were good. The SOS and the Can-PSC scales reported good model fit indices as well. PSCHO did not report any model fit indices.

EFA was reported to be performed in all studies except the SOS [25].

Reliability was reported in all of the studies (Table 3) and internal consistency (Cronbach’s Alpha) was reported in four out of five studies and exceeded the accepted standard (≥ 0.70), in the majority of the scale composites. The only two exceptions were the HSOPSC (Staffing α = 0.62) and the PSCHO (Learning α =0.50, Fear of shame α =0.58, Fear of blame α =0.61). Raykov’s $\hat{\alpha}$ coefficient was reported as the scale reliability estimate for the SAQ [22]. Raykov’s $\hat{\alpha}$ coefficient value was 0.90, indicating strong scale reliability.

### Intercorrelations

The HSOPSC intercorrelations, both among and between the 12 safety composites and the tool’s two outcome measures, were moderate [23]. SAQ’s reported intercorrelations were significant with a few exceptions [22]. PSCHO reported results confirm that the measure reflects correlated but distinct aspects of safety climate [24]. The Can-PSC showed that discriminant validity was supported for all dimensions with the exception of the incident follow-up dimension [15].

### Discussion

This study aims to provide a comprehensive review of quantitative studies designed to assess safety climate in the hospital setting, with particular focus on questionnaires. The objective of the systematic review was to provide a structured overview of their psychometric adequacy as measurement tools for their stated purpose.

All of the five reviewed safety climate tools have key similarities and common dimensions. Yet, they vary in terms of length, theoretical grounding and reported psychometric properties. Instruments varied in scope, with some covering a more comprehensive range of dimensions while others focused on the assessment of specific dimensions of safety culture. For example, the HSOPSC is a broad 42 items’ tool that covers twelve safety culture dimensions.
Despite the growing body of evidence about the value of establishing the psychometric properties of safety climate tools, there is still a lack of proper reporting of related questionnaire properties across published literature [8, 20, 32, 33]. Studies have shown considerable variation regarding the methods and the standards applied in reporting the psychometric properties [34]. This can be partly explained by the methodological rigor and resources required for safety climate tools to be appropriately developed and psychometrically tested [21].

Flin and Burns et al. [20] proposed that tools must be developed with robust psychometric properties to confirm the validity and reliability of safety climate test scores and enable proper identification of underlying dimensions.

Emerging evidence about the predictive validity of safety climate measures suggest that positive safety climate scores are associated with clinical outcomes including shorter lengths of stay and fewer medication errors [21]. Favourable scores have been linked also to safety-related behaviours and attitudes of healthcare staff [4, 35, 36]. Thus, in order to provide reliable data, it is imperative that tools are developed with robust psychometric properties that enable valid interpretations of patient safety climate test scores [20].

Colla and Bracken et al. [8] and Flin and Burns et al. [20] argued that there was a limitation on reporting the psychometric properties for most of their reviewed safety climate tools. Two notable exceptions were the HSOPSC and the SAQ where more of the indicated psychometric criteria were met. Conversely, Perneger and Staines et al. [37] argue that even the original HSOPSC instrument did not fulfill the standard psychometric criteria of a sound structure as proposed by Hu and Bentler [38] and recommended that the instrument be partially redesigned.

In comparison to earlier studies, where standard psychometric criteria were not reported [12, 39–42], our study showed that all of the reviewed tools covered the standard psychometric criteria, as recommended by Flin and Burns et al. [20]. This provide evidence for an improving trend in reporting the psychometric properties of tools in this area. This, as a result, places safety climate assessment on the right track.

A number of reported adaptations of the HSOPSC, in China, France, Norway and the UK [37, 43–46], have performed less well than the original tool. This might be due to the contextual specificity of the construct of safety culture [47]. As a result, there is a need for appropriate validation of safety climate questionnaires before extending their usage in healthcare contexts different from those in which they were originally developed [34].

### Safety climate dimensions

Over the past 10 years, a number of comprehensive reviews of studies addressing patient safety in general or patient safety climate instruments in particular have been conducted [8, 20, 21, 48–52]. Most studies have
suffered from an absence of clarity in defining the constructs of safety culture and climate in addition to that of patient safety culture [15]. The construct of safety culture has been described by Reason [53] as having the “definitional precision of a cloud” (p.192). This is reflected in a wide range of dimensions being incorporated into safety climate surveys, which may “dilute this domain” ([54], p.2). A significant degree of overlap exists in the content of the dimensions between different surveys (e.g. between the items within dimensions related to teamwork and communication openness), which may be a consequence of using different definitions (broad or narrow) of safety dimensions. Differences in judgment of the content of dimensions between different authors also play a major role. As a results, it is difficult to judge whether measures exploring twelve dimensions have greater or lesser validity than those measures examining only one dimension [21].

The most common dimensions mentioned in the above review studies were used as the basis for our categorization process. Our results show an overlap with those reviews as seven of the included dimensions were covered by our five reviewed tools (Table 7). The results also corroborate the recommendations of Singla and Kitch et al. [21], which suggested that common dimensions including communication, teamwork, and leadership support might be considered “core dimensions” of patient safety culture.

In our view, the SAQ addresses human factors and job satisfaction along with fundamental aspects of safety culture while the HSOPSC includes handoffs and transitions and the role of supervisors in promoting patient safety. Risk-taking behavior, a commonly measured safety dimension in other industries, was only covered by the PSCHO [24]. The SOS was developed as a self-report measure of safety organizing that captures the behaviours theorized to enable a safety culture [25]. It mainly stresses teamwork. Ausserhofer [55] highlighted that the SOS items, compared to the SAQ, might not fully capture the “psychological safety” aspects including fear of blame and shame (p.131). The Can-PSCS focuses on management commitment to patient safety and is recommended for use before patient safety improvement initiatives focusing on learning from errors in order to assess the context for change. Finally, the PSCHO focuses on management commitment to safety, safety systems, and safety attitudes of staff. (Table 2). This diversity in focus is partly related to the tools’ development process as the above models are mainly driven by expert opinion and not necessarily reflect what hospital staff think about patient safety [37].

Most of the reviewed studies failed to examine the influence of local cultural factors as part of their safety climate assessment tools. Almutairi [56] questioned the impact of multicultural workforce on safety climate in healthcare settings and concluded that this diversity can adversely affect the quality of care and patient safety. In a study by Algahtani [57], the author investigated the influence of a multicultural workforce in Saudi Arabia on patient safety and developed a new dimension, Multicultural Workplace, with items relating to local culture to assist in measuring cultural factors related to patient safety. Results showed strong, positive correlations with most SAQ dimensions indicating its relevance and

| Safety culture dimensions | Safety climate/culture studies |
|---------------------------|-------------------------------|
|                           | Colla and Bracken et al. [8] 9 Tools | Flin and Burns et al. [20] 12 Tools | Singla and Kitch et al. [21] 13 Tools | Fleming and Wentzell [52] 4 studies | Halligan and Zecevic [49] 130 Studies | Current systematic review |
| Top management support    | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Teamwork                 | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Safety systems           | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Feedback & Communication | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Reporting Incidents      | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Communication openness   | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Organizational learning  | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Beliefs about the causes of errors & adverse events | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Work Pressure            | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Risk perception          | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Beliefs about the importance of safety | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
| Safety Attitudes of staff | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             | ✓                             |
importance to the safety culture. Another area that is overlooked is the physical environment of a hospital facility, including its technology and equipment, and its effect on patient safety [58]. In addition, little is known about the effect of the psychosocial work environment, including job demands and resources available to cope with them, on safety climate [59].

Overall, these studies highlight the need for robust research to clarify which dimensions belong to the core concept of safety culture, as Flin and Burns et al. [20] have argued for, “a set of universal or core variables that underpin safety climate across work sectors”.

**Theoretical basis**

The lack of theoretical evidence supporting the process of safety climate tools’ development has been clearly articulated by most of the reviews carried out in industry and in healthcare [8, 20, 60]. A theoretical basis is deemed to be an essential component of a psychometrically sound tool to outline the proposed relationships between safety climate and safety outcomes and if theoretical assumptions are not explicit, then evidence on the construct validity of the developed instruments is inadequate. This makes it difficult for organizations to use questionnaires effectively for organizational learning and development aims [49, 61].

Guldenmund [5] conducted a review of safety culture and climate research and concluded that “All in all, the models of safety culture are unsatisfactory to the extent that they do not embody a causal chain but rather specify some broad categories of interest and tentative relationships between those” (p243). Additionally, Groves and Meisenbach et al. [62] argue that it is not surprising for a concept, such as safety culture, collected from multiple disciplines, to lack a strong theoretical basis in a fundamentally different healthcare setting.

The theoretical roots of patient safety culture research lie mostly in high-risk industries [55]. According to Hal- ligan and Zeevic [49], the five most commonly cited theories or models in healthcare research include: [1] High-Reliability Organization Theory (HROT) [2, 63] Donabedian’s Quality of Care Model [64] and its adaptations including the SEIPS model [58] and Quality Health Outcomes Model [3, 65] The Cultural Maturity Model [4, 66] Organizational Theory [63] and [5] System Theory [67]. According to Guldenmund [5]), no single safety culture theory or model has been universally accepted as clearly reflecting the construct of safety culture and safety climate and none of the theories or models may be applicable to all types of organisations.

Safety culture and climate theories in healthcare are clearly limited as none of the reviewed tools draw upon related theory. Additionally, it was stated earlier that four studies used theory to guide their tool development process but none provide an adequate explanation about their guiding theoretical framework nor do they clearly articulate the links between questionnaire items and specific theoretical constructs. Walsh and Boaden [68] point to the HSOPSC as having “no explicit theoretical framework”. HSOPSC, along with SAQ, was developed based on literature reviews, existing safety culture instruments and further input by researchers and hospital administrators. This suggests that researchers overlooked the importance of the epistemological and theoretical roots that underlie the development of their instruments [49] with more focus on the measurement rather than further conceptual development [69].

Groves and Meisenbach et al. [62] add that recent developments in safety culture have heightened the need for a theory that describes the process of keeping patients safe through the interaction between organizational structures at the macro-level and individual actions at the micro-level. They add that such theory is crucial for further progress towards patient safety.

Reiman and Silla et al. [61] stated that most studies overlook defining the underlying concept and frequently jump directly to “operationalisation” of the measure. This makes it difficult to evaluate how well the questionnaire actually measure the phenomena it aims to measure.

Early attempts to measure safety climate were based on adapting existing instruments from other industries (aviation, oil, nuclear) to healthcare settings [70, 71]. For example, the PSCHO and SOS were based on HROT. The theoretical bases of some of the original instruments, explain relationships between safety culture or safety climate in settings “far-removed from healthcare” ([55], p.129). The organisational structures and cultures of such industries are different than those of healthcare organisations [72]. When the processes of safety culture are not clearly understood, this makes it difficult to evaluate how well the questionnaire actually measures the phenomena under study and calls into question the interpretation of survey results [62].

In 2006, Flin et al. reviewed twelve safety climate measures designed for the health care setting. Building on their search criteria, we have uncovered additional measures being applied for different healthcare settings. Nevertheless, these additional measures, arguably, add to the present state of ambiguity in the assessment of safety culture in healthcare.

In this review, a detailed inspection of the included tools revealed a number of limitations to these measures. The limitations and ambiguity center around the concepts of safety culture and climate, their associated dimensions, the methodological rigor associated with the design of these measures and the lack of clarity in the relationship between safety culture and outcomes [62]. The influence of safety climate on patient and worker
safety outcomes is not yet clear, though studies have
started to confirm that safety climate scores can be asso-
ciated with healthcare workers’ safety behaviours or
workers’ injuries [32]. There is a need for more evidence
to understand how the use of safety culture or climate
tools impact on outcomes [73].

In a number of comprehensive reviews of safety cli-
mate tools in healthcare, the HSOPSC and SAQ repea-
tedly emerged as recommended tools [20, 21, 48, 49].
Results of our systematic review seem to mirror find-
ings of previous studies that have examined hospital safety
climate where the three studies that reported the SAQ,
HSOPSC and SOS tools have been reported to have
good assessment of their reported psychometric proper-
ties [22, 23, 25].

Strengths and limitations
The strengths of our review are that it represented a
comprehensive examination of safety climate tools de-
signed for hospitals. A thorough search strategy was
employed with all stages of the review process per-
formed with at least two independent reviewers in order
to avoid selection bias. Study rigor was enhanced using a
pre-set protocol, standardized forms, and a series of in-
dicators to assess the quality of the reviewed studies and
the reported psychometric properties.

There are also several limitations to our study. The ex-
clusion of other bibliographic databases, grey literature,
and non-English language papers could potentially lead
to overlooking some studies. Regarding the assessment
of the quality of the reviewed studies, some quality indi-
cators were not reported in sufficient detail to allow a
judgment to be made. In such cases, the indicator was
marked as unmet and the study quality might have been
underestimated due to under reporting. Finally, despite
using three reviewers to categorise the items, there is
still the possibility that bias was introduced by the qual-
itative nature of the process.

Theoretical and practical implications
Further research is necessary in the development of
safety culture theories in healthcare, to study the links
between culture and outcomes, and to resolve the con-
troversies in the definitions and dimensions of safety
culture and climate [74]. There is also a need for a safety
culture tool to evaluate safety attributes in the “local”
hospital setting bearing in mind the unique characteris-
tics of that particular setting and population.

On a practical level, the development of a standardized
checklist for assessing the quality of climate question-
naires, including reported psychometrics, may be benefi-
cial and help provide a more detailed account of the
questionnaire development process. Additionally, employ-
ing mixed methods tool development approaches may
help to reveal different aspects of an organization’s safety
culture, which can inform and illuminate multiple compo-
nents of this multidimensional construct than is currently
the case [50].

Conclusions
The perceived importance of safety culture in improving
patient safety and its impact on patient outcomes has led
to an increasing number of studies that attempt to define
and assess safety culture in healthcare settings. Several re-
views uncovered a wide variety of safety climate tools
available for use [8, 20, 21]. Still, theoretical and methodo-
logical challenges limit their use as assessment measures.

Pronovost and Sexton [75] warned that “the enthusiasm
for measuring culture may be outpacing the science”.
Critics have increasingly called for more rigorous assess-
ments of safety culture and more in-depth reporting.

It is recommended that research first be conducted to
resolve the controversies in the definitions and dimen-
sions of safety culture and climate, and focus on develop-
ing theoretical models with more evidence to understand
how safety culture or climate impacts on outcomes. Also,
more consideration should be given to psychometric
properties in the design and selection of tools in order to
ensure the robustness of the resulting safety culture data.

Psychometric testing, on its own, does not fully
characterize an instrument with other forms of item
analysis, such as cognitive testing, as they provide rich
insight into locally held attitudes and perceptions related
to patient safety.

When choosing a suitable instrument, healthcare pro-
viders should be guided by a combination of factors includ-
ing intended purpose, target population, and the tool’s
reported psychometric properties. This is likely to be an
identified training need for those interested in understanding
of the differences between the various available instruments
and their limitations. The outcomes of this systematic review
will provide guidance and support to healthcare policy-
makers, survey users and safety researchers to make more
informed decisions when selecting or developing an appro-
site safety climate assessment tool.

Additional file

Additional file 1: Search Strategy. Electronic databases search strategy.
Tools Descriptions. Descriptions of the five tools examined in the systematic
review. (DOCX 42 kb)

Abbreviations
Can-PSC: Canadian patient safety climate scale; CFA: Confirmatory factor
analysis; CFI: Comparative fit index; Chi: Chi-square; EFA: Exploratory factor
analysis; HROT: High reliability organization theory; HSOPSC: Hospital survey
on patient safety culture; IOM: Institute of medicine’s; MCFA: Multilevel CFA;
PSCHO: Patient safety climate in healthcare organizations; RMSEA: Root mean
square error of approximation; SAQ: Safety attitudes questionnaire;
SOS: Safety organizing scale; SRMR: Standardized root mean square residual
Authors’ contributions
GA, PB and JM made considerable contributions to conception and design of the systematic review. GA completed the database searches and identification of relevant literature in addition to conducting manual searches of reference lists. Also, websites and Proquest dissertation & theses database was searched. GA completed screening and review of the initial relevant records. The title, abstract and full text screening of potentially relevant records were completed by two independent reviewers (GA and JM) while a third reviewer validated the data (PB). Data were extracted and assessed using standardized data extraction and quality appraisal forms by GA, JM and PB. GA was involved in drafting the manuscript while JM and PB have contributed to critically reviewing and revising subsequent drafts. All authors have given final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors read and approved the final manuscript.

Ethics approval and consent to participate
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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