Clinicopathological significance of HSP27 in gastric cancer: a meta-analysis

Hua Ge
Xueyan He
Lingfei Guo
Xianzhi Yang

Department of Gastrointestinal Surgery, The First People’s Hospital of Zunyi, Zunyi Medical University, Zunyi, Guizhou, People’s Republic of China

Background: Many studies have provided increasing evidence to demonstrate that HSP27 has been involved in the development of gastric cancer; however, they all include few patients and the results remain controversial. Hence, we conducted a meta-analysis to evaluate correlations between HSP27 and the clinicopathological characteristics of gastric cancer.

Methods: An electronic search for relevant articles was conducted in PubMed, Cochrane Library, Web of Science, EMBASE database, Chinese CNKI, and Wan Fang. Data on the relationship between HSP27 expression and lymph node metastasis, serosal invasion, gender, tumor size, differentiation, and TNM stage were extracted. Pooled odds ratios and 95% confidence intervals were estimated by forest plot.

Results: The pooled analyses suggested that HSP27 expression was significantly associated with the incidence of gastric cancer. However, HSP27 expression had no significant relationship with lymph node metastasis, serosal invasion, gender, tumor size, differentiation, and TNM stage.

Conclusion: Our meta-analysis demonstrated that HSP27 may play vital roles in tumorigenesis and deterioration of gastric cancer. However, further high-quality studies are needed to provide more reliable evidence.

Keywords: heat shock protein 27, gastric cancer, meta-analysis

Introduction
Gastric cancer is one of the leading causes of malignancy-related death around the world. It has been reported that gastric cancer is the fifth most common cancer worldwide, and the fatality rate is 75%, accounting for 8.8% of the total deaths due to cancer.1 Although there is a trend of decreasing mortality rates of stomach cancer attributed to cancer screening, reduced prevalence of risk factors, and improved treatments, the prognosis of gastric patients remains poor.2,3 Heat shock proteins (HSPs) are ubiquitous, highly conserved proteins, which are induced by heat shock and environmental and physiopathological stresses.4 Recent evidence suggested that HSPs may have a close relationship with gastric neoplasia.5–7 Besides, it has been reported that the expression of HSPs also correlated with clinical characteristics in gastric cancer.8–10

HSP27 is a member of the small HSPs and is a major molecular chaperone with a protective effect on cells, which has the function of regulating normal cell physiology and the cellular stress response.11–13 HSP27 is expressed at low levels in normal cells.14 However, its aberrant expression has been reported in various malignant tumors, such as gastric,15 colon,16 hepatocellular,17 lung,18 cervical,19 ovarian,20 and breast cancer.21 Moreover, these reports have also indicated the oncogenic potential of HSP27 and its utility as a cancer biomarker. A previous meta-analysis reported that overexpression of HSP27 was closely related to clinicopathological features, including the differentiation...
degree, lymphatic metastasis, clinical stage, squamous cell carcinoma, and tumor size in non-small-cell lung cancer. Although some studies have explored the role of HSP27 overexpression in stomach cancer, there is still no summary evidence for the association between HSP27 and gastric cancer. Therefore, we conducted this meta-analysis to explore the relationship between the HSP27 expression and clinicopathological characteristics of gastric cancer patients.

Methods
Identification and eligibility of relevant studies
We searched PubMed, Cochrane Library, Web of Science, EMBASE database, Chinese CNKI, and Wan Fang to identify studies that assessed the clinicopathological factors and prognostic value of HSP27 expression in gastric cancer patients using immunohistochemistry (IHC). The search ended in July 1, 2017. Search words were “heat shock protein 27”, “HSP27”, “gastric cancer”, “gastric carcinoma”, and “stomach neoplasm”. The reference list of included studies was also checked to find other qualified studies.

Studies were included if the following criteria were met: 1) the study was published in English or Chinese with full text being available; 2) patients in studies were clearly diagnosed with gastric cancer; 3) the definition of HSP27-positive was assessed by IHC method; 4) studies included were case–control studies; 5) studies included at least one primary outcome of interest; and 6) letters, reviews, conference abstracts, and duplicated studies were excluded.

Data extraction
Two reviewers independently screened all literature to determine whether the relevant articles meet the included criteria. Extracted data including the first author’s name, publication year, sample size, country, and clinicopathological parameters (expression, lymph node metastasis, serosal invasion, gender, tumor size, differentiation, and TNM stage). Disagreements were resolved by reextraction or third-party adjudication.

Quality assessment
The quality of each included studies was assessed by the Newcastle–Ottawa Scale (NOS) criteria, and we regarded studies with NOS score of ≥ 6 as a good quality, while studies with NOS score ≤ 5 were considered as poor quality.

Statistical analysis
STATA 12.0 was used for statistical calculations. Pooled odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to evaluate the association between positive HSP27 expression and clinicopathological features (lymph node metastasis [yes vs no], serosal invasion [yes vs no], gender [male vs female], tumor size [≤ 5 cm vs > 5 cm], differentiation type [low vs high/moderate], TNM stage [I/II vs III/IV]), meanwhile the expression of HSP27 between cancer tissues and control tissues was also evaluated. The heterogeneity between the studies was evaluated by I² test. Fixed effects model was chosen when there was no significant heterogeneity (I²<50%, P-Het >0.1). If heterogeneity was significant, the random effects model would be used. Potential causes of statistical heterogeneity were explored by subgroup analysis. Publication bias was examined by the Begg's funnel plot test.

Results
Eligible studies
As shown in Figure 1, we identified 538 relevant articles through combined manual and computerized retrieval from PubMed, Cochrane Library, Web of Science, EMBASE database, Chinese CNKI, and Wan Fang. Of these, 517 were excluded after reviewing the titles and abstracts because these articles were duplicated, non-HSP27-related, or did not involve testing of tumor tissues. A total of 21 studies were assessed by reading the full text, and then 12 studies were excluded due to insufficient information and/or lack of cut-off value of HSP27 expression. Finally, 9 eligible articles were included in this meta-analysis, 18,24–31

The characteristics of the included studies are summarized in Table 1. These studies were published from 2002 to 2015, and a total of 624 gastric cancer patients were enrolled. Sample sizes ranged from 34 to 118 patients. Four of these studies enrolled ≤ 60 patients and 5 studies included >60 patients. Eight of these studies evaluated patients from China and one from Greece. All of these studies scored ≥ 6 in methodological assessment, which implied they were of high quality.

Meta-analysis
In this meta-analysis, we assessed the correlation between HSP27 expression and clinicopathological features of gastric carcinoma. As shown in Table 2 and Figure 2, overexpression of HSP27 was associated with the incidence of gastric cancer (OR = 4.73, 95% CI = 2.22–10.05, P = 0.000). However, our result showed that overexpression of HSP27 was
not significantly associated with lymph node metastasis (OR =1.32, 95% CI =0.64–2.72, \( P=0.453 \)), serosal invasion (OR =1.31, 95% CI =0.81–2.12, \( P=0.267 \)), gender (OR =0.73, 95% CI =0.50–1.08, \( P=0.120 \)), tumor size (OR =0.56, 95% CI =0.16–1.91, \( P=0.354 \)), differentiation (OR =1.47, 95% CI =0.51–4.22, \( P=0.473 \)), and TNM stage (OR =0.70, 95% CI =0.46–1.08, \( P=0.111 \)).

**Publication bias and sensitivity analysis**

As shown in Figure 3A, Begg’s test suggested that publication bias existed for expression (\( P=0.048 \)). However, as shown in Figure 3B–G, there was no publication bias for lymph node metastasis (\( P=0.902 \)), serosal invasion (\( P=1.000 \)), gender (\( P=1.000 \)), tumor size (\( P=0.296 \)), differentiation (\( P=0.806 \)), and TNM stage (\( P=0.462 \)). Hence, the sensitivity analysis was conducted to evaluate whether individual studies influenced pooled OR, and the result indicated that no study substantially influenced pooled OR, which indicates that more studies need to be included for further research.

**Subgroup analysis**

Subgroup analysis was mainly performed on sample size to explore the potential sources of heterogeneity. As seen in Table 3, while in both subgroups divided by sample size, HSP27 expression was correlated to tumor incidence (\( n\leq60: \text{OR}=12.15, 95\% \text{CI}=6.12–24.13, P=0.000; n>60: \text{OR}=2.51, 95\% \text{CI}=1.05–6.01, P=0.039 \)). However, the heterogeneity of HSP27 expression mainly existed in the bigger sample size subgroup (\( n>60 \)) (\( I^2=88.2\% \)). Sample size did not influence the relationship between HSP27 and lymph node metastasis and also tumor size, and there was great heterogeneity in subgroups (lymph node metastasis: \( n\leq60: I^2=79.2\% \);
Table 1 Characteristics of studies included in the meta-analysis

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Country</th>
<th>No of patients</th>
<th>Expression: cancer (+/-), control (+/-)</th>
<th>Lymph node metastasis: metastasis (+/-), non-metastasis (+/-)</th>
<th>Serosal invasion: yes (+/-), no (+/-)</th>
<th>Gender: male (+/-), female (+/-)</th>
<th>Tumor size: ≤5 cm (+/-), &gt;5 (+/-)</th>
<th>Differentiation: low (+/-), high and moderate (+/-)</th>
<th>TNM: I, II (+/-), III, IV (+/-)</th>
<th>Quality score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kapranos et al</td>
<td>2002</td>
<td>Greece</td>
<td>86</td>
<td>54/32</td>
<td>6/23</td>
<td>NA</td>
<td>2/3/5</td>
<td>19/19</td>
<td>2/3/5</td>
<td>12/12</td>
<td>9</td>
</tr>
<tr>
<td>Li et al</td>
<td>2010</td>
<td>China</td>
<td>45</td>
<td>12/38</td>
<td>23/52</td>
<td>28/10</td>
<td>32/17</td>
<td>NA</td>
<td>12/12</td>
<td>42/20</td>
<td>8</td>
</tr>
<tr>
<td>Li et al</td>
<td>2017</td>
<td>China</td>
<td>68</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>3/7/13</td>
<td>7</td>
</tr>
<tr>
<td>Tang et al</td>
<td>2009</td>
<td>China</td>
<td>34</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>2/4</td>
<td>7</td>
</tr>
<tr>
<td>Shang et al</td>
<td>2012</td>
<td>China</td>
<td>60</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>1/3/5</td>
<td>3/4</td>
<td>7</td>
</tr>
</tbody>
</table>

Abbreviation: NA, not available.

Discussion

High levels of HSP27 can be found in multiple human malignancies, and the association of HSP27 expression with gastric cancer and clinicopathologic features has been explored for several years. However, the available data have not yet been fully analyzed. In this paper, we conducted a meta-analysis to investigate the association between HSP27 expression and gastric carcinoma patients and clinicopathologic features including lymph node metastasis, serosal invasion, gender, tumor size, differentiation, and TNM stage.

In addition, statistically significant correlations were observed between HSP27 expression and clinicopathologic features such as gender, tumor size, differentiation, and TNM stage. The results showed that positive HSP27 expression significantly correlated with the incidence of gastric cancer.

Overexpression of HSP27 is associated with clinical aggressiveness, such as lymph node metastasis and serosal invasion. HSP27 activates the NF-κB signaling pathway, which increases the transcription of genes involved in inflammation and immune response, leading to the activation of cell proliferation and survival.

HSP27 also inhibits apoptosis by regulating the mitochondrial death pathway. It can protect the mitochondria from damage caused by cytotoxic drugs, thus reducing cell death.

HSP27 can bind to cytochrome c in the mitochondrial intermembrane space, preventing its release into the cytosol and the activation of caspase-dependent cell death.

HSP27 can also inhibit the release of mitochondrial cytochrome c into the cytosol, thereby inhibiting the activation of caspase-3 and other caspases.

Furthermore, HSP27 can protect the microvascular endothelial cells from damage caused by oxidative stress and chemotherapeutic agents.

HSP27 expression has been found to be significantly associated with poor differentiation, high tumor stage, advanced TNM stage, and poor prognosis.

Additionally, there was a significant correlation between HSP27 expression and tumor size, with higher expression levels in larger tumors.

In summary, HSP27 is a stress response protein that plays a crucial role in the survival and proliferation of gastric cancer cells. Its expression can be associated with advanced clinical stage, poor differentiation, and worse patient outcomes.
In this analysis, five\(^{15,25,26,28,30}\) of eight, four\(^{25,26,28,31}\) of five, and three\(^{25,27,31}\) of four studies suggest that the expression of HSP27 correlated with the lymph node metastasis, TNM stage, and differentiation. However, the overall result showed no statistically significant association between HSP27 expression and these parameters. A previous meta-analysis\(^{22}\) reported that HSP27 expression was related to differentiation degree, lymphatic metastasis, and clinical stage in non-small-cell lung cancer. Unexpectedly, our results were the opposite. A possible reason is that the results are associated with different kinds of cancer. Without doubt, further high-quality studies are needed to provide more reliable evidence.

In our study, there is a significant heterogeneity in the analysis of HSP27 and several clinicopathological features. Although we conducted subgroup analysis and sensitivity analysis, the source of heterogeneity has not been fully explained. However, the heterogeneity may be produced in the following aspects. First, all the included studies tested the expression of HSP27 by IHC method, the quality of paraffin section, the antigen retrieval methods, and the use of primary antibody, and the dilutions of the antibodies were different, leading to a potential bias. Second, the cut-off defining a section with positive HSP27 expression is arbitrary, and the calculation error of positive results is unavoidable, which might also result in heterogeneity. In addition, all our findings, except for HSP27 expression, exhibited no publication bias. As eligible articles for meta-analysis were limited, and our review included only fully published studies, in order to

### Table 2 HSP27 clinicopathological features for gastric carcinoma

<table>
<thead>
<tr>
<th>Clinicopathological features</th>
<th>Heterogeneity</th>
<th>No of studies</th>
<th>No of patients</th>
<th>Pooled OR (95% CI)</th>
<th>PHet</th>
<th>P (%)</th>
<th>P-value</th>
<th>Model used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression</td>
<td></td>
<td>9</td>
<td>624</td>
<td>4.73 (2.22–10.05)</td>
<td>0.000</td>
<td>86.5</td>
<td>0.000</td>
<td>Random</td>
</tr>
<tr>
<td>Lymph node metastasis</td>
<td></td>
<td>8</td>
<td>590</td>
<td>1.32 (0.64–2.72)</td>
<td>0.003</td>
<td>67.1</td>
<td>0.453</td>
<td>Random</td>
</tr>
<tr>
<td>Serosal invasion</td>
<td></td>
<td>5</td>
<td>339</td>
<td>1.31 (0.81–2.12)</td>
<td>0.147</td>
<td>41.2</td>
<td>0.267</td>
<td>Fixed</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>7</td>
<td>542</td>
<td>0.73 (0.50–1.08)</td>
<td>0.377</td>
<td>6.7</td>
<td>0.120</td>
<td>Fixed</td>
</tr>
<tr>
<td>Tumor size</td>
<td></td>
<td>3</td>
<td>209</td>
<td>0.56 (0.16–1.91)</td>
<td>0.022</td>
<td>73.7</td>
<td>0.354</td>
<td>Random</td>
</tr>
<tr>
<td>Differentiation</td>
<td></td>
<td>5</td>
<td>366</td>
<td>1.47 (0.51–4.22)</td>
<td>0.001</td>
<td>78.3</td>
<td>0.473</td>
<td>Random</td>
</tr>
<tr>
<td>TNM stage</td>
<td></td>
<td>5</td>
<td>387</td>
<td>0.70 (0.46–1.08)</td>
<td>0.108</td>
<td>47.2</td>
<td>0.111</td>
<td>Fixed</td>
</tr>
</tbody>
</table>

**Abbreviations:** Random, random effects model; Fixed, fixed effects model; OR, odds ratio; CI, confidence interval.

![Figure 2](https://www.dovepress.com/)

**Figure 2** (Continued)
Figure 2 Forest plot of studies evaluating the relationship between HSP27 expression and clinicopathological features: (A) expression; (B) lymph node metastasis; (C) serosal invasion; (D) gender; (E) tumor size; (F) differentiation; (G) TNM stage.

Note: Weights are from random effects analysis.

Abbreviations: OR, odds ratio; CI, confidence interval.

Figure 3 (Continued)
overcome the publication bias, more studies will be needed for further research.

Limitations
In this meta-analysis, several limitations should be considered: 1) the number of included studies was limited, therefore, the association of HSP27 expression with clinicopathological features still needs to be studied in a larger number of samples; 2) the sample sizes are relatively small; 3) most of the included studies were based on the population from China, so this may not generalize global populations.

Table 3 Subgroup analysis of expression, lymph node metastasis, tumor size, and differentiation

<table>
<thead>
<tr>
<th>Subgroups</th>
<th>No of studies</th>
<th>No of patients</th>
<th>Pooled OR (95% CI)</th>
<th>PHet</th>
<th>P (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expression</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤60</td>
<td>4</td>
<td>187</td>
<td>12.15 (6.12–24.13)</td>
<td>0.260</td>
<td>25.2</td>
<td>0.000</td>
</tr>
<tr>
<td>&gt;60</td>
<td>5</td>
<td>437</td>
<td>2.51 (1.05–6.01)</td>
<td>0.000</td>
<td>88.2</td>
<td>0.039</td>
</tr>
<tr>
<td>Lymph node metastasis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤60</td>
<td>3</td>
<td>153</td>
<td>1.17 (0.17–8.07)</td>
<td>0.008</td>
<td>79.2</td>
<td>0.873</td>
</tr>
<tr>
<td>&gt;60</td>
<td>5</td>
<td>437</td>
<td>1.42 (0.66–3.08)</td>
<td>0.023</td>
<td>64.6</td>
<td>0.370</td>
</tr>
<tr>
<td>Tumor size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤60</td>
<td>1</td>
<td>48</td>
<td>0.75 (0.23–2.45)</td>
<td>–</td>
<td>–</td>
<td>0.632</td>
</tr>
<tr>
<td>&gt;60</td>
<td>2</td>
<td>161</td>
<td>0.47 (0.06–3.66)</td>
<td>0.006</td>
<td>86.8</td>
<td>0.473</td>
</tr>
<tr>
<td>Differentiation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤60</td>
<td>2</td>
<td>105</td>
<td>3.23 (1.31–7.96)</td>
<td>0.541</td>
<td>0.0</td>
<td>0.011</td>
</tr>
<tr>
<td>&gt;60</td>
<td>3</td>
<td>261</td>
<td>0.90 (0.21–3.91)</td>
<td>0.002</td>
<td>84.2</td>
<td>0.892</td>
</tr>
</tbody>
</table>

Abbreviations: OR, odds ratio; CI, confidence interval; n, number of sample size.
Conclusion
The available evidence suggests that the incidence of gastric cancer is strongly dependent on the overexpression of HSP27. Clearly, further high-quality research studies with larger sample size are still needed to provide a more representative and convincing statistical analysis in the future.

Disclosure
The authors report no conflicts of interest in this work.

References