Epidemiological and clinical characteristics of elderly burns: A 15-year retrospective analysis of 2554 cases in Wuhan Institute of Burns

Hong Wu
Wuhan Institute of Burns, Tongren Hospital of Wuhan University (Wuhan Third Hospital)

Maomao Xi
Wuhan Institute of Burns, Tongren Hospital of Wuhan University (Wuhan Third Hospital)

Weiguo Xie (✉️ wgxie@hotmail.com)
Wuhan Institute of Burns, Tongren Hospital of Wuhan University (Wuhan Third Hospital)

Research Article

Keywords: geriatrics, burns, epidemiology, mortality, risk factors

Posted Date: November 28th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2274293/v1

License: ☑️ This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Geriatrics on March 22nd, 2023. See the published version at https://doi.org/10.1186/s12877-023-03883-5.


Abstract

Background

With the increase of geriatric burns, it's urgent to summarize its characteristics. The aim of this study was to analyze the epidemiological and clinical characteristics of burn in the elderly in a large center, and to provide suggestions for the prevention and treatment of geriatric burns.

Methods

This retrospective study was conducted at Wuhan Institute of Burns which is the largest burn center in central China between 2004 to 2018. Demographic and clinical data of the 60 years or above older burn inpatients were collected from medical records, analyzed and compared among groups.

Results

This study analyzed 2554 elderly burns, which included 50.9% in young geriatric group (60–69 years old), 32.9% in middle geriatric group (70–79 years old) and 16.2% in the oldest geriatric group (80 years old or above). The most common causes of elderly burns were flames (1081, 42.3%) and scalding (1041, 40.8%). Elderly burns with total body surface area (TBSA) of 0–9% accounted for 60.6% and the larger TBSA, the fewer number of patients. The majority of patients (70.5%) injured at home. The median of time interval from injury to admission was 7 hours and the oldest geriatric group (24 hours) was highest. One hundred and twenty-one cases (8.5%) were treated by cooling treatment, and 72.7% of these patients were treated less than 10 minutes. The median number of pre-injury diseases was one. Ninety patients (6.3%) had inhalation injury. The median length of stay (LOS) was 14 days. The median hospital cost was 10410 CNY or 2137 CNY per % TBSA, which was correlated with TBSA, LOS, surgery, inhalation injury, number of pre-injury diseases and etiology. The mortality rate was 3.0% and correlated with TBSA, inhalation injury, pulmonary disease and Alzheimer's disease.

Conclusion

Geriatric burns was still common and even increasing in central China, with flame burns and scalds the most common causes, majority of whom injured at home and often had problems such as few cooling treatment, improper emergency management and delayed admission. TBSA, etiology, pre-injury diseases and inhalation injury were the risk factors of length of stay, hospital cost and treatment outcomes.

Background

The world's population is ageing, with almost every country having an increasing number and proportion of older people in its population. Globally, the population aged 65 or over is growing faster than all other
age groups. World Population Prospects 2022 states that the share of global population at ages 65 or above is projected to rise from 10% in 2022 to 16% in 2050, with women accounting for 55.7% and 54.5% of the elderly, respectively [1].

Since China entered an aging society in 2000, the proportion of the elderly population has increased by 8.4% in the last two decades, according to the results of the seventh National Population Census of the Chinese mainland [2]. As of November 1, 2020, the total number of elderly people 60 or above in the mainland area is 264 million, accounting for 18.7% of the total population. The population of elderly people aged 60 or above in Hubei Province is 11.795 million [3], accounting for 20.42% of the permanent population, which is 6.49 percentage points higher than in 2010. The permanent population of Wuhan is 12.326 million, and the population of 60 or above is 2.124 million, accounting for 17.23%, an increase of 4.55% points from 2010.

Elderly patients often suffer from a variety of chronic diseases, and aging leads to thinning skin, reduced sensory abilities, and reduced ability to care for themselves [4,5,6]. Burns caused by cooking, bathing, and heating at home are more common in the elderly [7–8], and the ability of the elderly to save themselves is limited. At the same time, it is also difficult to treat patients due to various diseases and advanced age [4–5].

Most of the current epidemiological analyses of burn in the elderly are single-center retrospective analyses of medical records, and no epidemiological analysis of burn in the elderly has been reported in Wuhan. Our burn center is the largest burn referral center in Wuhan. It has 150 burn beds, 200 expansion beds and 9 BICU beds. This burn center treats a large number of elderly burn patients each year, which is representative of the situation in Wuhan and surrounding areas. This study retrospectively analyzed the situation of elderly burn patients at the center to provide a reference for the prevention and treatment of burn patients.

Methods

Patient inclusion and exclusion criteria

This retrospective study included burn patients aged 60 or older who were admitted to the burn center at Tongren Hospital of Wuhan University (Wuhan Third Hospital) between January 2004 and December 2018. Elderly burns in this study included flame burns, scalds, electrical contact burns, electrical flash burns, low-temperature burns caused by heating, contact burns with hot objects, medical-related burns, chemical burns, hot crush injury and excluded patients with frostbite, radiation ulcers, and the purpose of treating chronic wounds, scars, and plastic surgery, etc. Ethical approval for data collection was granted by the Human Research Ethics Committee of the Tongren Hospital of Wuhan University (Wuhan Third Hospital) (No. KY2018-030).
Data Collection And Grouping Definition

The following data were collected from the medical records: age, gender, etiology of injuries, admission date, total burn surface area (TBSA), depth of burn, location of accident, pre-hospital emergency management, time interval between injury and admission, pre-injury disease, complications, surgery, surgery cost, length of hospital stay (LOS), hospital cost, outcomes. Patients whose data for the above items were missed or unclear in their medical records were excluded from the item analysis.

Patients were grouped by age as young geriatric group (60–69 years), middle geriatric group (70–79 years), and the oldest geriatric group (≥ 80 years). Patients were grouped by TBSA as small area (< 10% TBSA), medium area (10–29% TBSA), large area (30–49% TBSA) and extra-large area (≥ 50% TBSA). Pre-injury disease was defined as a chronic organ disease diagnosed and treated prior to the burn. The treatment outcomes were grouped as cured (when being discharged all wounds healed or only with scattered wounds which could be cured spontaneously), and death.

Statistical analysis

SPSS22.0 and GraphPad Prism 6 were used for data analysis and graphing. Continuous variables were presented by mean ± standard deviation or median (25-75th percentile, Q1-Q3). Non-parametric test (Mann-Whitney U test) was used for comparison between the two groups, and analysis of variance and Kruskal Wallis test were used for comparison among multiple groups. Spearman rank correlation test was used for bivariate correlation test. The categorical variables were presented in terms of number of cases and percentage, and comparisons between groups were performed using Chi-squared test or Fisher exact probability method. Bonferroni correction was applied to the P values for multiple comparisons between groups. Multivariate logistic regression and multivariate linear regression were used for multivariate analysis. The lethal area 50 (LA50), a measure of burn survivability for the TBSA at which there will be 50% mortality, was calculated using probit analysis. Statistical significance was considered at a probability of P value < 0.05.

Results

Demographic characteristics

This retrospective study included 2554 burn patients aged 60 years and older among 29,151 burn patients admitted to the burn center of Tongren Hospital of Wuhan University (Wuhan Third Hospital) between January 2004 and December 2018. In addition to the total number of burn inpatients affected by the refurbishment and relocation of wards in 2009, 2011 and 2016, there has been a gradual increase in the number of elderly burns over the past 15 years. Moreover, the percentage of elderly burns in total burn patients increased from 5.7% in 2004 to 9.9% in 2018 (Fig. 1). The average age of elderly burns was 70.5 ± 8.1 years, including young geriatric group (1299 cases, 50.9%), middle geriatric group (841 cases, 32.9%), and oldest geriatric group (414 cases, 16.2%). The number of elderly burns decreased with
increasing age (Fig. 2). There were 1385 males (54.2%) and 1169 females (45.8%), with a male: female ratio of 1.2:1.

Etiology

Among the elderly burns in this study, flame burns were the most common (1066 cases, 41.7%), followed by scalds (1045 cases, 40.9%), electrical contact burns (139 cases, 5.4%), low-temperature burns caused by heating (90 cases, 3.5%), contact burns with hot objects (63 cases, 2.5%), medical-related burns (59 cases, 2.3%), chemical burns (55 cases, 2.2%), electrical flash burns (27 cases, 1.1%), hot crush injury (10 cases, 0.4%) (Fig. 3). The age difference of elderly burns with different etiologies was statistically significant ($F = 10.696, P < 0.001$). The average age of each etiology from high to low was: 73.6 ± 8.7 years old for low-temperature burns caused by heating, 73.5 ± 8.2 years old for hot crush injury, 71.1 ± 8.3 years old for scalds, 71.7 ± 8.2 years old for contact burns with hot objects, 70.4 ± 8.0 years old for flame burns, 70.6 ± 6.5 years old for medical-related burns, 67.1 ± 7.2 years for chemical burns, 66.4 ± 6.0 years for electrical contact burns, and 64.2 ± 3.9 years for electrical flash burns. The average age of elderly burns with electrical contact burns or electrical flash burns was significantly lower than the average age of patients with low-temperature burns caused by heating, scalds and flames, respectively ($P < 0.05$). There was a significant difference in the male:female ratio for different etiologies ($\chi^2 = 148.959, P < 0.001$). Among them, the male:female ratio of electrical contact burns was the highest (4.1:1), followed by hot crush injury (2.3:1), contact burns with hot objects (2.0:1), flame burns (1.5:1), chemical burns (1.3:1), low-temperature burns caused by heating (1.1:1), medical-related burns (1.1:1), and scalds (0.8:1), and the percentage of male with electrical contact burns was significantly higher than that of male with other etiologies ($P < 0.001$) (Table 1).
Table 1
Differences in age and gender ratio for different etiologies of elderly burn inpatients

<table>
<thead>
<tr>
<th>Etiology</th>
<th>N (%)</th>
<th>Age (y)</th>
<th>Male/female ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flame burns</td>
<td>1066 (41.7)</td>
<td>70.4 ± 8.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Scalds</td>
<td>1045 (40.9)</td>
<td>71.1 ± 8.3</td>
<td>0.8</td>
</tr>
<tr>
<td>Electrical contact burns</td>
<td>139 (5.4)</td>
<td>66.4 ± 6.0</td>
<td>4.1</td>
</tr>
<tr>
<td>Low-temperature burns caused by heating</td>
<td>90 (3.5)</td>
<td>73.6 ± 8.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Contact burns with hot objects</td>
<td>63 (2.5)</td>
<td>71.7 ± 8.2</td>
<td>2.0</td>
</tr>
<tr>
<td>Medical-related burns</td>
<td>59 (2.3)</td>
<td>70.6 ± 6.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Chemical burns</td>
<td>55 (2.2)</td>
<td>67.1 ± 7.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Electrical flash burns</td>
<td>27 (1.1)</td>
<td>64.2 ± 3.9</td>
<td>/</td>
</tr>
<tr>
<td>Hot crush injury</td>
<td>10 (0.4)</td>
<td>73.5 ± 8.2</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>2554 (100.0)</td>
<td>70.5 ± 8.1</td>
<td>1.2</td>
</tr>
<tr>
<td>(\chi^2/F)</td>
<td>-</td>
<td>10.696</td>
<td>148.959</td>
</tr>
<tr>
<td>(P) value</td>
<td>-</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

TBSA: total burn surface area; LOS: length of stay. Male/female ratio of electrical flash burns could not estimate because there was no female patients caused by this etiology.

Season Of Injury

Season of injury data was available in 2448 patients (95.8% of the total elderly burns), and most cases of elderly burns were in winter (December to February, 693 cases, 28.3%), followed by summer (June to August, 665 cases, 27.2%), spring (March to May, 609 cases, 24.9%), and autumn (September to November, 481 cases, 19.6%). Different etiologies tended to have significantly different seasonal distribution \((P<0.001)\), among which low-temperature burns caused by heating, contact burns with hot objects, and flame burns mostly occurred in winter (51 cases, 60.7%; 21 cases, 33.3%; 310 cases, 30.5%, respectively), hot crush burns, chemical burns, and scalds mostly occurred in spring (3 cases, 42.9%; 20 cases, 38.5%; 279 cases, 27.7%, respectively), and electrical contact burns and electrical flash burns mostly occurred in summer (62 cases, 45.9%; 9 cases, 36.0%, respectively).

Total Burn Surface Area (Tbsa) And Depth Of Burn
Accurate TBSA were available for 2208 patients (86.5% of the total elderly burns). The median TBSA was 7% (25-75th percentile, Q1-Q3, 2%-15%) and ranged from 0.1–99.0% TBSA. In addition, depth of burn data were available in 1430 patients (56.0% of the total elderly burns). Regarding the maximum burn depth, most patients had full-thickness burns (65.5%, 937 cases) and the median full-thickness burn area was 0.7% (Q1-Q3, 0%-3%). The larger the burn area, the smaller the number of elderly burns (Fig. 4). The results revealed that most elderly burns (60.6%) were in small area group. There was a significant difference in the depth of burns among different etiologies ($\chi^2 = 167.693, P < 0.001$). The percentage of elderly burns with full-thickness burns from high to low was electrical contact burns (100.0%), low-temperature burns caused by heating (97.6%), medical-related burns (96.6%), contact burns by hot objects (93.5%), chemical burns (77.1%), flame burns (63.7%), scalds (52.1%), and electrical flash burns (36.0%).

**Location Of Accident**

Location of accident data were available in 1150 patients (45.0% of the total elderly burns), and the percentage of the location of accident from high to low was 70.5% (811 cases) at home, 24.7% (248 cases) in outdoors, 3.0% (35 cases) in the workplace, and 1.7% (20 cases) in other places such as hospitals or old age homes.

In the comparison of location of accident of elderly burns in different age groups, there was a significant difference in the percentage of injuries occurred at home ($\chi^2 = 22.945, P < 0.001$). The results showed that older people were more likely to be injured at home. The proportions of elderly burns injured at home were 64.7% (366 cases) in the young geriatric group, 73.3% (283 cases) in the middle elderly group and 81.8% (162 cases) in the oldest geriatric group, respectively (Oldest geriatric group vs. young geriatric group: $P < 0.001$; middle geriatric group vs. young geriatric group: $P = 0.015$).

**Pre-hospital Emergency Management**

Accurate pre-hospital emergency management data were available for 1420 patients (55.6% of the total elderly burns). There were 1113 cases (78.4%) did not do any pre-hospital emergency management after burn, 158 cases (11.1%) underwent self-treatment (such as scald cream, alcohol or iodophor, etc.), 47 cases (3.3%) used some folk remedies (such as toothpaste, eggs, soy sauce, vinegar, salt, etc.). In addition, there were 121 cases (8.5%) performed the cooling treatment, but most of them (88 cases, 72.7%) did it for less than 10 minutes.

Among elderly burn patients of different age groups, there was a statistically significant difference in the proportion of self-treatment after burn ($\chi^2 = 10.527, P = 0.005$). In the elderly burns, the older they were, the more they did self-treatment. Moreover, the proportion of self-treatment in the young geriatric group, the middle geriatric group and the oldest geriatric group were 8.2%, 9.7% and 15.5%, respectively (Oldest geriatric group vs. young geriatric group: $P = 0.003$) (Table 2).
Table 2
Comparison of pre-hospital emergency management stratified per age category

<table>
<thead>
<tr>
<th>Age categories (years)</th>
<th>Total (N = 1420)</th>
<th>60–69 (n = 791)</th>
<th>70–79 (n = 403)</th>
<th>80+ (n = 226)</th>
<th>$\chi^2$</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without any emergency management</td>
<td>2.686</td>
<td>0.261</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1113 (78.4%)</td>
<td>624 (78.9%)</td>
<td>321 (79.7%)</td>
<td>168 (74.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>307 (21.6%)</td>
<td>167 (21.1%)</td>
<td>82 (20.3%)</td>
<td>58 (25.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling treatment</td>
<td>2.709</td>
<td>0.258</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>121 (8.5%)</td>
<td>76 (9.6%)</td>
<td>29 (7.2%)</td>
<td>16 (7.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1299 (91.5%)</td>
<td>715 (90.4%)</td>
<td>374 (92.8%)</td>
<td>210 (92.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of cooling treatment</td>
<td>0.691</td>
<td>0.708</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;10 min</td>
<td>78 (64.5%)</td>
<td>51 (67.1%)</td>
<td>17 (58.6%)</td>
<td>10 (62.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 10 min</td>
<td>43 (35.5%)</td>
<td>25 (32.9%)</td>
<td>12 (41.4%)</td>
<td>6 (37.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-treatment</td>
<td>10.527</td>
<td>0.005</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>139 (9.8%)</td>
<td>65 (8.2%)</td>
<td>39 (9.7%)</td>
<td>35 (15.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1281 (90.2%)</td>
<td>726 (91.8%)</td>
<td>364 (90.3%)</td>
<td>190 (84.5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital consultation within 24 h</td>
<td>5.699</td>
<td>0.058</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>890 (62.7%)</td>
<td>513 (64.9%)</td>
<td>249 (61.8%)</td>
<td>128 (56.4%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>530 (37.3%)</td>
<td>277 (35.1%)</td>
<td>154 (38.2%)</td>
<td>99 (43.6%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There were 1420 patients (55.6% of the total elderly burns) who the time interval between injury and admission, the median of time interval between injury and admission was 7 (Q1-Q3, 2-144) hours, and 890 cases (62.7%) were admitted within 24 hours after burn. There was a significant difference in the
time interval between injury and admission after burn among different age groups ($\chi^2=6.026$, $P=0.049$). And, the median of the time interval between injury and admission in the young geriatric group, the middle geriatric group and the oldest geriatric group was 6 (Q1-Q3, 2-120) hours, 8 (Q1-Q3, 2-168) hours, and 24 (Q1-Q3, 2-192) hours, respectively (Oldest geriatric group vs. young geriatric group: $Z = 2.356$, $P = 0.018$).

**Pre-injury Diseases And Complications**

There were 1429 patients (56.0% of the total elderly burns) who had pre-injury diseases information, the average number of pre-injury diseases in these elderly burns was $1.0 \pm 1.1$, and median of it was 1 (Q1-Q3, 0–2). There were 635 cases had no pre-injury diseases (44.4%), 407 cases (28.5%) had one kind of pre-injury disease, 237 cases (16.6%) had two kinds of pre-injury diseases, 118 cases (8.3%) had three kinds of pre-injury diseases, 28 cases (1.1%) had four kinds of pre-injury diseases, 3 cases (0.2%) had five kinds of pre-injury diseases, and one case (0.1%) had 6 kinds of pre-injury diseases.

The number and percentage of pre-injury diseases of elderly burns from high to low was: 512 cases (35.8%) with hypertension, 199 cases (13.9%) with diabetes, 170 cases (11.9%) with heart disease, 123 cases (8.6%) with cerebral infarction, 51 cases (2.0%) with pulmonary disease, 43 cases (3.0%) with digestive tract disease, 30 cases (2.1%) with Alzheimer’s disease, 23 cases (1.6%) with epilepsy, 14 cases (1.0%) with cancer and 9 cases (0.6%) with mental illness.

There were significant differences in the percentage of hypertension, heart disease, diabetes, cerebral infarction, pulmonary disease and Alzheimer’s disease among elderly burns of different age groups ($P<0.05$), while there were no significant differences in other pre-injury diseases. Among them, the percentages of hypertension, heart disease, cerebral infarction, pulmonary diseases and Alzheimer’s disease were significantly higher in the oldest geriatric group than in the younger group. In addition, the percentage of heart disease and cerebral infarction in the oldest geriatric group was significantly higher than that in the middle geriatric group, and the percentage of diabetes in the middle geriatric group was significantly higher than that in the oldest geriatric group (Table 3).
### Table 3
Comparison of pre-injury diseases stratified per age category

<table>
<thead>
<tr>
<th>Age categories (years)</th>
<th>Total (N = 1429)</th>
<th>60–69 (n = 796)</th>
<th>70–79 (n = 406)</th>
<th>80+ (n = 227)</th>
<th>χ²</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>512 (38.5%)</td>
<td>252 (31.7%)</td>
<td>153 (37.7%)</td>
<td>107 (47.1%)</td>
<td>19.254</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Heart disease</td>
<td>170 (11.9%)</td>
<td>71 (8.9%)</td>
<td>49 (12.1%)</td>
<td>50 (22.0%)</td>
<td>28.966</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes</td>
<td>199 (19.3%)</td>
<td>104 (13.1%)</td>
<td>71 (17.5%)</td>
<td>24 (10.6%)</td>
<td>6.918</td>
<td>0.031</td>
</tr>
<tr>
<td>Cerebral infarction</td>
<td>123 (8.6%)</td>
<td>51 (6.4%)</td>
<td>34 (8.4%)</td>
<td>38 (16.7%)</td>
<td>24.013</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Pulmonary disease</td>
<td>51 (3.6%)</td>
<td>21 (2.6%)</td>
<td>14 (3.4%)</td>
<td>16 (7.0%)</td>
<td>10.06</td>
<td>0.007</td>
</tr>
<tr>
<td>Alzheimer's disease</td>
<td>30 (2.1%)</td>
<td>8 (1.0%)</td>
<td>10 (2.5%)</td>
<td>12 (5.3%)</td>
<td>16.117</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Bonferroni correction was applied to the P values for multiple comparisons between groups.

- a 60-69y vs 80+y, P < 0.001; b 60-69y vs 80+y, P < 0.001; c 60-69y vs 80+y, P < 0.001; d 60-69y vs 80+y, P = 0.006; e 60-69y vs 80+y, P < 0.001; f 70-79y vs 80+y, P = 0.003; g 70-79y vs 80+y, P = 0.019; h 70-79y vs 80+y, P = 0.003.

The mortality of the elderly burns with pulmonary disease (10.6%), Alzheimer's disease (20.0%), and cancer (16.7%) was significantly higher than that of the patients without corresponding diseases (2.4%; 2.3%; 2.5%, respectively) (P = 0.003; P < 0.001; P = 0.039, respectively).

There were 90 patients (6.3%) with inhalation injury and 70 patients (4.9%) with shock on admission. The median (Q1-Q3) burn area of elderly burns with inhalation injury [28 (12–60)% TBSA] was significantly higher than that of patients without inhalation injury [7 (2–13)% TBSA] (Z = 10.502, P < 0.001). Elderly burns with shock on admission had significantly higher median (Q1-Q3) burn area [48 (35–70)% TBSA] than patients without shock [7 (2–13)% TBSA] (Z = 12.829, P < 0.001).

### Surgery

There were 2448 patients (95.8% of the total elderly burns) with information about whether to have surgery or not, among which 915 patients (37.4%) had undergone surgery during hospitalization, the average number of surgeries was 1.4 ± 1.1 and median of it was 1 (Q1-Q3, 1–2), and the average surgery cost was 9986 ± 12842 CNY and median of it was 5530 (Q1-Q3, 2820–11510) CNY. Among the elderly...
burns undergoing surgery, there were 688 cases (75.2%) of skin grafting, 125 cases (13.7%) of flap operation, 50 cases (5.5%) of amputation, and 35 (3.8%) cases of negative pressure sealing drainage.

There was a significant difference in the percentage of elderly burns undergoing surgery with different etiologies ($\chi^2 = 182.988, P<0.001$). The proportion of surgery from high to low was as follows: 74.6% of medical-related burns (44 cases), 74.1% of electrical contact burns (100 cases), 71.4% of hot crash injury (5 cases), 61.9% of low-temperature burns caused by heating (52 cases), 60.3% of contact burns with hot objects (38 cases), 46.2% of chemical burns (24 cases), 33.6% of scalds (338 cases), 30.6% of flame burns (311 cases) and 12.0% of electrical flash burns (3 cases).

**Length Of Stay And Hospital Cost**

After excluding patients who were not cured or gave up treatment, there were 2231 patients (87.4% of the total) with hospital stay information, with a mean (SD) and median (Q1-Q3) of length of stay of 20.7 (27.9) days, and 14 (8–25) days, respectively.

There was a significant difference in the length of stay for different etiologies ($\chi^2 = 29.527, P<0.001$), and the median (Q1-Q3) length of stay of each etiology from high to low was: hot crush injury (22 days, 19–27 days), electrical contact burns (17 days, 10-33.5 days), flame burns (15 days, 8–27 days), scalds (13 days, 8–23 days), contact burns with hot objects (13 days, 7.5–21.5 days), low-temperature burns caused by heating (13 days, 7.8–18.3 days), electrical flash burns (12 days, 7–16 days), medical-related burns (11 days, 7–17 days) and chemical burns (10 days, 5–15 days). Multiple linear regression showed that the factors influencing the length of stay of the elderly burns in this study included burn area (standard coefficient = 0.210, $P<0.001$), number of surgery (standard coefficient = 0.418, $P<0.001$).

After excluding patients who were not cured or gave up treatment, there were 1269 patients (46.7% of the total elderly burns) who had hospital cost information, with an average hospital cost of 31243 ± 78183 CNY and median of 10410 (Q1-Q3, 5798–23942) CNY, and an average hospital cost of per % TBSA of 8056 ± 44201 CNY and median of 2137(Q1-Q3, 891–5971) CNY.

There was a significant difference in the average hospital cost of per %TBSA among elderly burns with different etiologies ($\chi^2 = 345.428, P<0.001$). The mean (SD) and median (Q1-Q3) hospital cost of each etiology from high to low was: electrical contact burns with 25905 ± 28045 CNY, 16304 (8014–29030) CNY, low-temperature burns caused by heating with 23678 ± 30662 CNY, 11172 (4390–34381) CNY, medical-related burns with 22274 ± 38951 CNY, 13564 (8107–24865) CNY, contact burns with hot objects with 8654 ± 12869 CNY, 4435 (1564–10657) CNY, chemical burns with 9000 ± 12919 CNY, 3755 (1964–10449)CNY, flame burns with 3184 ± 5780 CNY, 1480 (763–3395) CNY, scalds with 6902 ± 68673 CNY, 1427(831–3968)CNY, and electrical flash burns with 1937 ± 3469 CNY, 948 (682–1529) CNY (Fig. 5).

Multiple linear regression showed that the factors affecting the hospital cost of the elderly burns in this study included burn area, length of stay, surgery, inhalation injury, number of pre-injury diseases, and
etiology (Table 4).

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E.</th>
<th>Beta</th>
<th>95% CI</th>
<th>t</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBSA</td>
<td>2709.457</td>
<td>116.022</td>
<td>0.498</td>
<td>2481.838</td>
<td>2937.077</td>
<td>23.353</td>
</tr>
<tr>
<td>Length of stay</td>
<td>867.364</td>
<td>49.131</td>
<td>0.360</td>
<td>770.977</td>
<td>963.751</td>
<td>17.654</td>
</tr>
<tr>
<td>Surgery</td>
<td>26251.054</td>
<td>3185.291</td>
<td>0.166</td>
<td>20001.968</td>
<td>32500.141</td>
<td>8.241</td>
</tr>
<tr>
<td>Inhalation injury</td>
<td>17901.488</td>
<td>7577.727</td>
<td>0.048</td>
<td>3035.066</td>
<td>32767.909</td>
<td>2.362</td>
</tr>
<tr>
<td>Number of Pre-injury</td>
<td>3380.895</td>
<td>1387.340</td>
<td>0.047</td>
<td>659.131</td>
<td>6102.658</td>
<td>2.437</td>
</tr>
<tr>
<td>Etiology</td>
<td>1582.376</td>
<td>713.898</td>
<td>0.044</td>
<td>181.810</td>
<td>2982.943</td>
<td>2.217</td>
</tr>
</tbody>
</table>

B: nonstandard coefficients; S.E.: standard error; Beta: standard coefficients; CI: confidence interval. Age, TBSA, length of stay, and number of pre-injury diseases were continuous variables; The categorical variables were included: Gender (male = 1, female = 0); depth of burn (partial-thickness = 0, full-thickness = 1); Etiology (scalds = 0, flame burns = 1, electric flash burns = 2, contact burns with hot objects = 3, chemical burns = 4, medical-related burns = 5, low-temperature burns caused by heating = 6, electrical contact burns = 7); Inhalation injury (No = 0, yes = 1); Surgery (No = 0, yes = 1); Shock on admission (No = 0, yes = 1).

### Treatment Outcomes

After excluding those patients who were transferred to outpatient or other hospitals for treatment (183 cases) or gave up treatment (34 cases), there were 2448 patients (95.8% of the total elderly burns) with treatment outcome information, including 2163 patients (97.0%) cured, and 68 patients (3.0%) died. The lethal area 50% (LA$_{50}$) for total admitted elderly burns was 78.3% TBSA (95% confidence interval [CI] = 69.8 ~ 89.9% TBSA). The results showed that the age of elderly burns was negatively correlated with LA$_{50}$. The LA$_{50}$ was 82.9% TBSA (95% CI = 73.3 ~ 95.8% TBSA) in the young geriatric group, 69.6% TBSA (95% CI = 59.2 ~ 83.5% TBSA) in the middle geriatric group and 61.6% TBSA (95% CI = 50.9 ~ 75.3% TBSA) in the oldest geriatric group. Multivariate logistic regression showed that the risk factors for mortality were TBSA, inhalation injury, pulmonary disease and Alzheimer’s disease (Table 5).
Table 5
Multivariate logistic regression analysis of risk factors of mortality

<table>
<thead>
<tr>
<th></th>
<th>Crude</th>
<th></th>
<th>Adjusted for case mix</th>
<th></th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
<td>OR</td>
<td>95% CI</td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>TBSA group</td>
<td>0.243*</td>
<td>1.507–8.876</td>
<td>6.552</td>
<td>1.572–27.299</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Small area = reference</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Medium area</td>
<td>-</td>
<td>3.657</td>
<td>1.507–8.876</td>
<td>6.552</td>
<td>1.572–27.299</td>
</tr>
<tr>
<td>Large area</td>
<td>-</td>
<td>10.841</td>
<td>3.848–30.539</td>
<td>21.941</td>
<td>4.196–114.745</td>
</tr>
<tr>
<td>Extra-large area</td>
<td>-</td>
<td>97.040</td>
<td>42.309–222.570</td>
<td>153.108</td>
<td>32.817–714.317</td>
</tr>
<tr>
<td>Inhalation injury</td>
<td>0.367*</td>
<td>27.867</td>
<td>13.700–56.684</td>
<td>5.505</td>
<td>2.049–14.790</td>
</tr>
<tr>
<td>Pulmonary disease</td>
<td>0.097*</td>
<td>4.906</td>
<td>1.879–20.332</td>
<td>13.164</td>
<td>3.238–53.512</td>
</tr>
<tr>
<td>Alzheimer's disease</td>
<td>0.152*</td>
<td>10.491</td>
<td>0.107–6.776</td>
<td>26.477</td>
<td>6.190–113.252</td>
</tr>
</tbody>
</table>

Total burn surface area (TBSA), small area (< 10%TBSA), medium area (10–29%TBSA), large area (30–49%TBSA), extra-large area (≥ 50%TBSA); R: spearman contingency coefficient; OR: odds ratio; CI: confidence interval. * means P value < 0.05.

There were thirty-four elderly burns who gave up treatment (1.3% of the total elderly burns), with an average age of 74.6 ± 9.4 years, a median (Q1-Q3) burn area of 41.0 (32.5–67.5)% TBSA, a median (Q1-Q3) full-thickness burn area of 31.3 (10.3–40.8)% TBSA and a median (Q1-Q3) length of stay of 1 (1-3.3) day. Moreover, there were 18 males (52.9%) and 16 females (47.1%) in the gave up elderly burns.

There were significant differences in the percentage of elderly burns who gave up treatment to the total number of elderly burns in different age groups ($\chi^2 = 7.937, P = 0.019$). The were 11 cases (0.9%) in the young geriatric group and 12 cases (1.5%) in the middle geriatric group, and 11 cases (2.8%) in the elderly geriatric group, respectively.

There were significant differences in the percentage of elderly burns who gave up treatment to the total number of elderly burns in different burn area groups ($\chi^2 = 85.574, P<0.001$). The were 2 cases (0.2%) of small area burns, 6 cases (1.0%) of medium area burns, 13 cases (9.0%) of large area burns, and 13 cases (12.5%) of extra-large area burns.
The percentage of elderly burns with full-thickness burns who gave up treatment (31 cases, 3.3%) was significantly higher than that of elderly burns with partial-thickness burns (1 case, 0.2%) \( (\chi^2 = 14.209, P<0.001) \).

**Discussion**

Population aging has become one of the most important social trends in the 21st century, and China is striding towards an aging society. In 2020, the proportion of population aged 60 or over in the total population on the Mainland China reached 18.7%, and the proportion will gradually increase in the future. Due to China's vast territory, large population, huge regional differences in medical conditions and imperfect medical data statistical system, there is still a lack of epidemiological data on elderly burn patients in China, and most of the literature reports are single-center analysis of hospitalized elderly burn patients.

At present, the reported proportion of elderly burns in China has increased from 3.4\% \[9\] (patients admitted from 1999 to 2004) or 3.8\% \[7\] (patients admitted from 2003 to 2009) in the early stage, to 7.5\% \[5\] (patients admitted from 2010 to 2016) in the recent stage. This study showed that the proportion of elderly burns has increased from 5.7\% in 2004 to 8.6\% in 2018, which was generally consistent with previous reports, but lower than that in developed countries such as the Netherlands \[10\] (10.0\%, patients admitted from 2009 to 2015), the United States \[11\] (10.1\%, patients discharged from 1997 to 2010). This may be related to the lack of medical resources and ability to pay for medical expenses in China, leading to more elderly burns being treated in outpatient clinics or even at home. In the past 15 years, the number of elderly burns had gradually increased, which is consistent with the rising trend of elderly burns found in domestic and foreign studies \[5,12,13\]. Therefore, China and even the whole world should strengthen the capacity building of the prevention, first aid and medical treatment of the elderly burns in order to cope with the increasing number of elderly burn cases.

Due to various reasons such as physical function, living condition and social environment, the elderly burns have many different characteristics from burns in children and young and middle-aged people, and their disease development, treatment process and outcomes are also very different. Therefore, the study on the epidemiology of elderly burns is of great significance for the prevention, treatment and rehabilitation of burns in the elderly. This study showed that the majority of the elderly burns occurred at home, especially in the elderly aged 80 or over, with the proportion reaching 81.8\%, which is similar to the previous report \[9,14\].

The most common causes of elderly burns are flame burns and scalds, which account for more than 80\% of the total number of patients in this study. As a mega-city in central China, Wuhan has a hot and humid summer and cold winter climate, and the main heat source for residents in daily life is gas. Therefore, accidental indoor gas fire is a common cause of elderly burns. In addition, cooking at home, drinking hot soup or tea, and traditional bathing methods (such as bathing with hot water in a basin), are the main causes of elderly burns in this area.
Elderly people who live alone and are slow to move, while lack of care and have some dangerous habits such as smoking in bed, also have an increased risk of burns. In addition, there is also an obvious age difference in elderly burns. Contact burns with hot objects are common in middle-aged and elderly people (70 years or over), while electrical burns are more common in young male elderly people (60–69 years old) who have more chance to do electric contacting jobs or fishing under high-voltage electrical power lines. However, the elderly often lack correct on-site emergency management after burns. Most of them (78.4%) did not receive any emergency management after burns. Only 8.5% of them were washed with cold water after burns, but the washing time was mostly less than 10 minutes.

Based on the time interval between injury and admission, nearly 40% of elderly burns went to hospital more than 24 hours, and the older the age, the longer the time of admission, which may be related to the elderly's dependence on help, difficulty in seeking medical treatment and lower desire for medical treatment. Some elderly people use some folk remedies to treat wounds at home after burns, such as toothpaste, eggs, soy sauce, vinegar, salt, which increased the risk of wound contamination and infection. According to the above risk factors and characteristics of elderly burns, taking corresponding preventive and educational measures can help reduce the incidence rate of elderly burns, and avoid or reduce the risk of wound deepening, pollution and infection caused by improper post-injury treatment.

Since elderly burns are often accompanied by pre-injury diseases before injury [5,6,15], most patients in this study had one or more pre-injury diseases. Previous studies have shown that age is positively associated with heart disease and cerebral infarction. In this study, older burn patients with pulmonary disease, Alzheimer's disease and cancer were increased mortality. What's more, the pre-injury diseases increased the difficulty of treatment, hospital costs and mortality. In this study, the mortality rate of elderly burns in this study was 3%, which is lower than 8%-14.9% [9,13] reported in domestic and foreign studies. The LA50 of elderly burns in this group was 76.4% TBSA, which is much higher than that of high-income countries (about 30% TBSA) [16] such as the United Kingdom (26% TBSA) [14] and the United States (30% TBSA) [17], as well as low-income countries such as Iran (45.3% TBSA) [18], which may be related to the large number of elderly burns in this center, the accumulation of more treatment experience and the higher level of treatment. Through the analysis of the risk factors for elderly burns mortality, it was found that the elderly burns with extra-large area or inhalation injury had higher burn mortality, which was consistent with results of most previous researches [17,19].

The treatment of elderly burns involves many problems such as medical aid system and social ethics [6, 10]. In this study, 34 patients (1.3%) gave up treatment by themselves or their families. Patient age and burn area were positively correlated with the proportion of abandoned treatment. Severe trauma, long and painful treatment process, and unbearable economic burden often make elderly burns and their families lose confidence in treatment, leading to some patients to give up treatment. Nevertheless, with the gradual improvement of China's medical security system and the full coverage of medical insurance for urban and rural residents, the number of elderly burns who give up treatment for economic reasons has gradually decreased in recent years. Nevertheless, it is still very important to provide adequate
psychological, affectional and financial supports to elderly people with severe burns to prevent them from giving up. Medical staff should provide correct and professional information support and guidance to patients and their families, so as to reduce their anxiety, and help those with financial difficulties to obtain funding through community, government, charity organization, non-governmental organization, online social platform and other channels, which will help reduce the abandonment of treatment.

As there is no national epidemiological study on burns in the elderly in China at present, our burn institute is one of the top burn centers in China, with the biggest numbers of annual admission of burn patients in central China, and the patients come from Wuhan and the surrounding provinces of central China, so that data in this study may represent not only epidemiological trends of elderly burns in the provincial capital city and the whole province, but also more or less that of central China. However, because of the variation of patients population and lack of accurate records of demographic data, further multi-center research for gerontology patients is necessary in the future.

Conclusion

Geriatric burns was still common and even increasing in central China, with flame burns and scalds the most common causes, majority of whom injured at home and often had problems such as few cooling treatment, improper emergency management and delayed admission. TBSA, etiology, pre-injury diseases and inhalation injury were the risk factors of length of stay, hospital cost and treatment outcomes.

Abbreviations

TBSA
total body surface area (TBSA)
LOS
length of stay
SD
standard deviation
Q1-Q3
25-75th percentile
LA<sub>50</sub>
lethal area 50.

Declarations

Ethics approval and consent to participate

The study protocol was evaluated and approved by the Human Research Ethics Committee of the Tongren Hospital of Wuhan University (Wuhan Third Hospital) (No. KY2018-030), and the need for informed consent was waived due to the nature of the retrospective study.
All methods were carried out in accordance with relevant guidelines and regulations.

Study procedures were performed in accordance with the Declaration of Helsinki ethical principles for medical research involving human subjects.

**Consent for publication**

Not applicable.

**Availability of data and materials**

The data sets used for the analysis in the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

**Funding**

This study was supported by grants from Health commission of Hubei Province scientific research project (WJ2019H433) and Wuhan Municipal Health Commission scientific research project (WG19B02; WG18Q10). The funders were not involved in the study design, data collection, analysis and interpretation, and manuscript writing.

**Authors’ contributions**

WX and HW conceived, designed, drafted and revised the article; MX and WX were responsible for data analysis and interpretation, revision. All authors approved the final article.

**Acknowledgments**

We would like to thank the nursing team of our burn center and the staff of the Wuhan Institute of Burns for their contributions to data collection.

**References**


Figures

Figure 1

Number of elderly burn inpatients and their percentage in total burn inpatients from 2004 to 2018

Figure 2

Age distribution of the elderly burn inpatients.
Figure 3

Percentages of different etiologies of the elderly burn inpatients.
Figure 4

Distribution of TBSA in different etiologies of the elderly burn inpatients.

Figure 5

Comparison of mean per % TBSA cost of different etiologies.