

天津港“8·12”特别重大火灾爆炸事故危重伤员伤情及近期并发症和隐匿伤的多中心分析

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【摘要】 目的 观察天津港“8·12”特别重大火灾爆炸事故危重伤员距爆炸中心的距离与病情严重程度及预后的关系,分析本次事故的伤情特点以及伤员近期并发症和隐匿伤的发生特点,为创伤救治提供依据。**方法** 采用多中心回顾性研究方法,收集2015年8月12日23:35至12月12日23:35由天津市10家医院、12个重症医学科或专科监护室收治的天津港“8·12”特别重大火灾爆炸事故全部危重伤员共58例,根据伤员受伤时所处位置分为室外组(29例)和室内组(29例),每组再按照伤员受伤时距爆炸中心的距离分为近距离(≤ 200 m)、中远距离(200~1000 m)和远距离(> 1000 m)3个亚组;比较各组伤员距爆炸中心不同距离与致伤因素、致伤部位、病情严重程度和预后的关系。同时根据受伤时间分为伤后1 d内、2~3 d、4~6 d、7 d后4个时间段进行观察,分析近期并发症和隐匿伤在不同时间段的分布特点。**结果** (1)室外组近距离、中远距离和远距离伤员分别为14、13、2例,室内组分别为3、22、4例。①室内外两组伤员均以冲击波直接或间接致伤为主。室外组近距离和中远距离伤员受各致伤因素影响均较大,以冲击波直接致伤(14/14和12/13)、冲击物砸伤(12/14和4/13)和破片伤(12/14和12/13)最多;远距离伤员较少,仅出现冲击波直接致伤和冲击物砸伤各1例。室内组伤员以近距离和中远距离致伤因素影响较大,仍以冲击波直接致伤为主(2/3和14/22),火焰伤、破片伤及受冲击后摔伤的情况少于室外组,但被冲击物砸伤的情况较多;远距离伤员较少,但仍存在破片伤。②室内外两组伤员致伤部位主要分布于体表和头面部,其次为胸部、下肢、骨盆、臀部等,以近距离和中远距离伤员表现最为明显;而颈部、腹部及盆腔、脊柱、上肢等部位损伤较少。③室内外两组损伤严重度评分(ISS)、多器官功能障碍综合征(MODS)评分、急性生理学与慢性健康状况评分系统II(APACHE II)评分均随伤员远离爆炸中心而逐渐降低,说明伤员距爆炸中心距离越近伤情越重;当处于相同距离时,室内组伤员的伤情较室外组伤员更重,室内中远距离和远距离组ISS评分明显高于室外相应距离组(分:中远距离为 25.56 ± 3.34 比 11.83 ± 1.62 ,远距离为 13.53 ± 3.96 比 5.50 ± 0.71 ,均 $P < 0.05$),室内远距离组MODS评分明显高于室外远距离组(分: 6.53 ± 1.62 比 2.50 ± 0.71 , $P < 0.01$)。除室内远距离组重症加强治疗病房(ICU)住院时间明显短于中远距离组外(d: 5.23 ± 2.03 比 8.23 ± 4.96 , $P < 0.05$),两组伤员距爆炸中心不同距离时机械通气和ICU住院时间均无明显差异。ICU伤员28 d死亡情况为室外近距离组2例,室内中远距离组2例。(2)近期并发症:①全身反应及MODS:以高应激反应、高代谢反应、毛细血管渗漏综合征(CLS)及呼吸、心血管、血液、胃肠等器官功能障碍较多见,伤后1 d内发生率均达50%以上;随时间延长,所有并发症发生率均逐渐下降,直至7 d后均降至10%以下。②感染:以皮肤软组织感染为主(25.9%),其次为肺部感染和呼吸道感染(分别为19.0%和15.5%),其他部位感染发生率从高到低依次为腹腔感染(6.9%)、颅内感染(3.4%)、眼部感染(1.7%);伤后1 d内无感染发生,感染高峰发生在伤后2~3 d,之后逐渐减少。在医院获得性感染中,仅伤后4~6 d和7 d后发生呼吸机相关性肺炎(VAP)各1例,发生率为1.4%,且无其他医院获得性感染发生。③其他并发症:以下肢及颅脑并发症最多(分别为22.4%和19.0%),胸部和面部并发症较少(分别为10.3%和1.7%),且集中出现在伤后1 d内,随后逐渐减少。(3)隐匿伤:隐匿伤主要集中在面部(23例,39.7%),其次为下肢、骨盆、臀部

15例(25.9%),上肢7例(12.1%),头部、胸部、腹部及盆腔较少,颈部、脊柱、体表等部位未发现隐匿伤;隐匿伤发生在伤后1d内较少,2~3d达高峰,随后逐渐减少。**结论** 在天津港“8·12”特别重大火灾爆炸事故危重伤员中,无论在室外还是室内,均表现出距爆炸中心越近损伤越重的趋势,以室外伤员表现更加典型;当处于同样的中远距离或远距离时,室外伤员伤情轻于室内伤员;ICU内伤员死亡原因主要集中在颅脑损伤。危重伤员中,并发症和隐匿伤在早期较少,伤后2~3d达峰值后逐渐减少,但至7d后仍有隐匿伤出现;主要以全身反应和MODS发生率较高,感染主要发生在皮肤软组织、肺部和呼吸道,其他并发症主要发生在颅脑和四肢;隐匿伤主要发生在面部和肢体,但致命性创伤较少。

【关键词】 天津港爆炸; 复合伤; 受伤距离; 致伤因素; 危重程度; 并发症; 隐匿伤; 预后

The analysis of injury characteristics, short-term complications and hidden trauma in critical patients in Tianjin port "8·12" special major explosion accident: a multicentre study

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【Abstract】 Objective To observe the correlation between the distance from the center of explosion and severity as well as prognosis in critical patients in Tianjin port "8·12" special major explosion accident, and to investigate the characteristics of the injury, short-term complications and hidden trauma in the accident, so as to provided the basis for trauma care. **Methods** A multicenter retrospective study was conducted. Fifty-eight patients with critical wound admitted to 12 related intensive care units (ICUs) or specialist ICUs in 10 hospitals in Tianjin since 23:35 on August 12th, 2015 to 23:35 on December 12th, 2015 were enrolled. The patients were divided into two groups according to the location when they were injured: outdoor group ($n = 29$) and indoor group ($n = 29$), the patients in each group were subdivided into three subgroups according to the distance from the center of explosion: close distance (≤ 200 m), middle long distance (200–1 000 m) and long distance ($> 1 000$ m). The relationships between the different distance from the center of the explosion and injury factors, injury site, severity and prognosis were analyzed in the two groups. Meanwhile, the patients were divided into four groups according to the time: within 1 day, 2–3 days, 4–6 days, and 7 days after injury. The distribution characteristics of the short-term trauma complications and hidden trauma in different times were observed. **Results** (1) In outdoor group, 14 patients were in close distance, 13 in middle long distance, and 2 in long distance, and in indoor group, 3, 22 and 4 in each distance respectively. ① The patients in outdoor group and indoor group were given priority to blast injury directly or indirectly. In outdoor close distance and middle long distance groups, all injury factors had great influence on the patients, especially blast injury directly (14/14 and 12/13), impact eject hurt (12/14 and 4/13), and blast-fragment injury (12/14 and 12/13). The patients in outdoor long distance group were less, only blast injury directly and impact eject hurt was found in 1 case, respectively. In indoor close distance and middle long distance groups, injury factors had more effect on the patients, mainly was blast injury directly (2/3 and 14/22), and the flame injury, fragment injury and blast bruise were less than outdoor group but with more impact eject hurt. There were less patients, and mainly blast-fragment injury in the indoor long distance group. ② The injury parts in both outdoor group and indoor group mainly distributed in the body, head and face followed by chest, leg, pelvis, hip, etc., especially in close distance and middle long distance group. There were less injury in neck, abdomen and pelvic cavity, spine, and upper limb. ③ In both outdoor and indoor group, injury severity score (ISS), multiple organ dysfunction syndrome (MODS) score, acute physiology and chronic health evaluation II (APACHE II) score were gradually decreased with the

injured away from the explosion center, suggesting that the nearer distance from the center of the explosion, the heavier the injury was. In the same distance, the injury in indoor group was heavier than outdoor group. ISS in indoor middle long distance group and long distance group was significantly higher than outdoor corresponding distance groups (25.56 ± 3.34 vs. 11.83 ± 1.62 in middle long distance, $P < 0.05$; 13.53 ± 3.96 vs. 5.50 ± 0.71 in long distance, $P < 0.01$). MODS score in indoor long distance group was significantly higher than outdoor long distance group (6.53 ± 1.62 vs. 2.50 ± 0.71 , $P < 0.01$). The length of ICU stay in indoor long distance group was significantly shorter than middle long distance group (days: 5.23 ± 2.03 vs. 8.23 ± 4.96 , $P < 0.05$). No statistical differences in the duration of mechanical ventilation and length of ICU stay among different distances from the center of the explosion were found in the both groups, as well as between indoor group and outdoor group. The 28-day mortality of 58 cases patients were that 2 patients in outdoor close long distance group and 2 in indoor middle long distance group dead. (2) Short-term complications: ① systemic reactions and MODS: high stress, high metabolic reactions and capillary leak syndrome (CLS), and organ failure of respiratory, cardiovascular, hematological, and gastro intestinal systems were frequent within 1 day after injury with the incidence of above 50%. With the prolongation of time, all complications were gradually decreased, until 7 days after injury, the incidence was decreased to less than 10%. ② Infection: sorted by the sites, by skin and soft tissue infection primarily (25.9%), followed by pulmonary infection (19.0%) and respiratory tract infection (15.5%), the incidence of other part from high to low were abdominal cavity infection (6.9%), intracranial infection (3.4%), eye infection (1.7%). Sorted by the time, no infection was found within 1 day after injury, and infection peak occurred in 2-3 days after injury, then the infection was gradually reduced. In the respect of hospital-acquired infection, only ventilation-associated pneumonia (VAP) was found in 2 patients, respectively occurred in 4-6 days and 7 days after injury, and with the incidence of 1.4%, and no other hospital acquired infection appeared. ③ Other complications: other complications ranks as lower limbs (22.4%) and cerebral (19.0%), chest (10.3%) and facial (1.7%) were relatively few, and all appeared mainly within 1 day after injury, then gradually reduced. (3) Hidden traumas: in 58 patients, hidden traumas were given priority to facial (23 cases, 39.7%) followed by lower limbs, pelvic and hip (15 cases, 25.9%) and upper limb trauma (7 cases, 12.1%); head, chest, and abdominal were fewer. No hidden trauma was found in neck, spine, and body surface. Within 1 day after injury, hidden trauma were less, peaked in 2-3 days after injury, and reduced later gradually. **Conclusions** No matter outdoor or indoor groups of critically wounded patients in Tianjin port "8·12" special major explosion accident, the closer from the center of explosion injury, the heavier the injury was, particularly in outdoor group. In middle long distance or long distance, the injury severity in the indoor wounded patients group was more serious than outdoor group. In ICU wounded patients, the causes of death were mainly concentrated in craniocerebral injury. In the wounded patients in the accident, the early incidence of short-term complications and hidden trauma was less, peak in 2-3 days after injury, reduced later gradually, but hidden trauma can happen 7 days after injury. The incidence rate of systemic reactions and MODS were high, infection-related complication mainly occurs in skin and soft tissue, pulmonary and respiratory tract, and other complications mainly occurred in cerebral and lower limbs. The hidden trauma mainly occurred in face and limbs, but lethal trauma was less.

【Key words】 Tianjin port explosion; Combined injury; Distance of injury; Injury factor; Severity; Complication; Hidden trauma; Prognosis

严重创伤通常是指多发伤和复合伤^[1],严重多发伤定义为危及生命且损伤严重度评分(ISS)超过16分^[2]。研究表明,爆炸致冲烧毒复合伤伤员的致伤因素和伤情与其距爆炸中心距离有关^[3]。天津港“8·12”特别重大火灾爆炸事故危重伤员大多为复合伤,在救治过程中,重症医学科作为危重伤员的抢救平台,与多学科密切合作,对伤员实施了及时有效的救治^[4-6]。救治创伤并发症、及时发现并处置隐匿伤是本次救治中重症医学科的重要任务之一。通过分析本次事故中危重伤员的临床资料,探讨伤员距爆炸中心距离与致伤因素、致伤部位和预后的关系,并对创伤近期并发症及隐匿伤的特点进行分

析,以期今后的创伤救治提供参考。

1 资料与方法

1.1 临床资料:采用多中心回顾性研究方法,收集2015年8月12日23:35至12月12日23:35由天津市第五中心医院、天津市泰达医院、天津港口医院、天津医科大学总医院、武警后勤学院附属医院、天津市第四医院、天津市第一中心医院、天津市环湖医院、解放军第二五四医院、天津市天津医院共10家医院、12个重症医学科或专科监护室收治的58例危重伤员信息。其中男性50例,女性8例;年龄(35.73 ± 14.81)岁;受伤时距爆炸中心距离(516.09 ± 335.31)m;28例接受救命性手术伤员受伤

至手术时间 3.0(2.0, 3.0)h,其余 30 例伤员受伤至就诊时间(3.01±1.14)h;ISS(16.45±7.54)分,多器官功能障碍综合征(MODS)评分(6.71±2.34)分,急性生理学与慢性健康状况评分系统 II(APACHE II)评分(16.78±6.86)分。

1.2 伦理学:本研究符合医学伦理学要求,经医院伦理委员会批准,所有治疗和抢救方案得到家属或患者同意,并签署知情同意书。

1.3 监测及治疗:部分伤员在转入重症医学科前接受了确定性手术或损伤控制性手术。伤员进入重症医学科后均给予生命体征、内环境和器官功能监测;多学科联合进行创伤并发症和隐匿伤筛查。根据伤员具体情况实施救命措施,或进行内环境调整、机械通气、液体治疗、血管活性药物应用、纠正凝血功能障碍、血液净化、镇痛镇静、营养支持及抗菌药物应用等相应治疗;由专科医生进行伤口换药、烧伤创面多次切削痂或再次手术等。

1.4 观察指标及方法:根据伤员受伤时所处位置分为室外组(29例)和室内组(29例),每组再按照伤员受伤时距爆炸中心距离分为近距离(≤200 m)、中远距离(200~1000 m)和远距离(>1000 m)3个亚组;分析不同距离与致伤因素、致伤部位及病情严重程度和预后的关系。同时根据受伤时间分为伤后1 d内、2~3 d、4~6 d和7 d后4个时间段,分析创伤并发症和隐匿伤的发生特点。

1.4.1 致伤因素:包括火焰伤、冲击波直接致伤、冲击物砸伤、破片伤、受冲击后摔伤等。

1.4.2 致伤部位:按简明损伤定级标准(AIS)2005版的9区域法^[7]划分,根据国际疾病分类(ICD-10)进行创伤诊断,并进行ISS评分。

1.4.3 病情严重程度:MODS、APACHE II评分。

1.4.4 预后指标:机械通气时间、重症加强治疗病房(ICU)住院时间和28 d病死率。

1.4.5 创伤并发症:①全身反应及MODS;②感染:部位相关性感染和医院获得性感染;③附加损伤;④其他并发症。

1.4.6 隐匿伤:损伤部位按照AIS 2005版的9区域法^[7]划分,并根据ICD-10进行创伤诊断。

1.5 统计学处理:建立危重伤员信息数据库,采用SPSS 17.0软件进行统计学分析。符合正态分布的计量资料以均数±标准差($\bar{x} \pm s$)表示,组间比较采用独立样本t检验;符合非正态分布的计量资料以中位数(四分位数)[$M(Q_L, Q_U)$]表示,组间比较采

用Wilcoxon两样本比较的秩和检验;计数资料比较采用 χ^2 检验。 $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 距爆炸中心距离与致伤因素的关系(表1):室内外两组伤员均以冲击波直接或间接致伤为主。在室外组中,近距离和中远距离伤员受各致伤因素影响均较大,以冲击波直接致伤、冲击物砸伤和破片伤最多;远距离伤员较少,仅出现冲击波直接致伤和冲击物砸伤各1例。室内组伤员仍以近距离和中远距离致伤因素影响较大,以冲击波直接致伤为主,火焰伤、破片伤及受冲击后摔伤的情况少于室外组,但被冲击物砸伤的情况较多;远距离伤员较少,但仍存在破片伤。

表1 室外和室内组危重伤员距爆炸中心不同距离时各致伤因素的分布

组别	例数(例)	致伤因素(例)				
		火焰伤	冲击波伤	冲击物砸伤	破片伤	摔伤
室外近距离组	14	9	14	12	12	11
室外中远距离组	13	5	12	4	12	7
室外远距离组	2	0	1	1	0	0
室内近距离组	3	2	2	2	2	3
室内中远距离组	22	1	14	9	9	4
室内远距离组	4	0	3	4	3	0

注:伤员受伤时距爆炸中心≤200 m为近距离,200~1000 m为中远距离,>1000 m为远距离

2.2 距爆炸中心距离与致伤部位的关系(表2):室内外两组伤员致伤部位主要分布于体表和头面部,其次为胸部、下肢、骨盆、臀部等,以近距离和中远距离伤员表现最为明显,而颈部、腹部及盆腔、脊柱、上肢等部位损伤较少。

2.3 距爆炸中心距离与病情严重程度和预后的关系(表3):无论是在室外还是室内,伤员距爆炸中心距离越近伤情越重,ISS、MODS、APACHE II评分均随伤员远离爆炸中心而逐渐降低(均 $P < 0.05$);处于相同距离的室内组伤员伤情较室外组伤员更重,ISS、MODS、APACHE II评分均明显升高,以ISS和MODS评分升高最为显著(均 $P < 0.05$)。除室内组远距离伤员ICU住院时间明显短于中远距离伤员($P < 0.05$)外,两组伤员距爆炸中心不同距离时机械通气和ICU住院时间差异均无统计学意义(均 $P > 0.05$)。28 d重症医学科死亡4例伤员,室外近

距离组 2 例,室内中远距离组 2 例。

2.4 创伤并发症发生情况

2.4.1 全身反应及 MODS(表 4): 伤后 1 d 内,除低温-凝血功能障碍-酸中毒综合征(HCA)及肾脏、肝脏、神经系统功能障碍等并发症发生率较低外,其他全身反应及器官或系统功能障碍的发生率均在 50% 以上;伤后 2~3 d 除 HCA 及肾脏、肝脏、心血管、神经系统功能障碍等并发症发生率较低外,其他并发症发生率均在 30% 以上;伤后 4~6 d,所有全身反应及 MODS 并发症的发生率均降到 20% 以下;7 d 后均降到 10% 以下。

2.4.2 部位相关性感染: 58 例危重伤员中部位相关性感染发生率为 72.4%(42/58)。① 按部位分: 皮肤软组织感染占 25.9%,肺部感染占 19.0%,呼吸道感染占 15.5%,腹腔感染占 6.9%,颅内感染占 3.4%,眼部感染占 1.7%。② 按时间分: 伤后 1 d 内无部位相关性感染发生;感染高峰发生在伤后 2~3 d,其中颅内感染 2 例,眼部感染 1 例,呼吸道感染 9 例(吸入性烧伤后感染 4 例,误吸后感染 5 例),肺部感染 10 例(吸入性烧伤后感染 4 例,误吸后感染 6 例),腹腔感染 4 例,皮肤软组织感染 11 例(烧伤创面合并感染 4 例,小腿蜂窝织炎 5 例,右上臂皮肤创面感

表 2 室外和室内组危重伤员距爆炸中心不同距离时各致伤部位的分布

组别	例数(例)	致伤部位(例)								
		头部	面部	颈部	胸部	腹部及盆腔	脊柱	上肢	下肢、骨盆、臀部	体表及其他
室外近距离组	14	9	7	0	6	2	0	6	9	14
室外中远距离组	13	4	5	0	6	5	0	2	4	13
室外远距离组	2	1	1	0	0	0	0	0	1	1
室内近距离组	3	3	2	0	2	1	0	1	2	3
室内中远距离组	22	10	10	2	14	5	1	6	4	11
室内远距离组	4	3	3	0	1	0	0	0	1	3

注: 伤员受伤时距爆炸中心 ≤200 m 为近距离, 200~1000 m 为中远距离, >1000 m 为远距离

表 3 室外和室内组危重伤员距爆炸中心不同距离时病情严重程度和预后相关指标比较

组别	例数(例)	ISS(分, $\bar{x} \pm s$)	MODS 评分(分, $\bar{x} \pm s$)	APACHE II 评分(分, $\bar{x} \pm s$)	机械通气时间 [d, M(Q _L , Q _U)]	ICU 住院时间(d, $\bar{x} \pm s$)	28 d 病死率 [% (例)]
室外近距离组	14	21.35 ± 9.12	6.62 ± 2.85	15.85 ± 1.92	2.00(1.00, 3.00)	8.66 ± 5.12	14.29(2)
室外中远距离组	13	11.83 ± 1.62 ^a	5.99 ± 0.97	14.03 ± 1.12	1.50(1.00, 3.00)	8.13 ± 4.96	0 (0)
室外远距离组	2	5.50 ± 0.71 ^{ac}	2.50 ± 0.71 ^{ad}	10.50 ± 0.71 ^d	1.50(1.00, 1.00)	7.50 ± 4.95	0 (0)
室内近距离组	3	28.00 ± 10.39	10.00 ± 2.00	23.33 ± 2.31	2.00(1.00, 3.00)	6.33 ± 3.06	0 (0)
室内中远距离组	22	25.56 ± 3.34 ^e	6.87 ± 1.87	19.84 ± 4.42 ^b	2.00(1.50, 3.50)	8.23 ± 4.96	9.09(2)
室内远距离组	4	13.53 ± 3.96 ^{cf}	6.53 ± 1.62 ^{bf}	18.34 ± 4.23	1.50(1.00, 7.00)	5.23 ± 2.03 ^d	0 (0)

注: 伤员受伤时距爆炸中心 ≤200 m 为近距离, 200~1000 m 为中远距离, >1000 m 为远距离; ISS 为损伤严重程度评分, MODS 为多器官功能障碍综合征, APACHE II 为急性生理学与慢性健康状况评分系统 II, ICU 为重症加强治疗病房; 与本组近距离伤员比较, ^aP<0.01, ^bP<0.05; 与本组中远距离伤员比较, ^cP<0.01, ^dP<0.05; 与室外组同距离伤员比较, ^eP<0.01, ^fP<0.05

表 4 58 例危重伤员伤后不同时间点全身反应及 MODS 并发症的发生情况

伤后时间	例数(例)	全身反应发生率 [% (例)]				MODS 发生率 [% (例)]						
		高应激	高代谢	HCA	CLS	呼吸	肾脏	肝脏	心血管	血液	神经	胃肠
1 d 内	55	74.5(41)	70.9(39)	20.0(11)	52.7(29)	70.9(39)	23.6(13)	27.3(15)	74.5(41)	76.4(42)	30.9(17)	58.2(32)
2~3 d	50	38.0(19)	36.0(18)	2.0(1)	42.0(21)	50.0(25)	20.0(10)	24.0(12)	16.0(8)	30.0(15)	16.0(8)	34.0(17)
4~6 d	45	13.3(6)	11.1(5)	0(0)	11.1(5)	13.3(6)	15.6(7)	17.8(8)	11.1(5)	13.3(6)	11.1(5)	4.4(2)
7 d 后	35	5.7(2)	5.7(2)	0(0)	5.7(2)	8.6(3)	5.7(2)	11.4(4)	2.9(1)	11.4(4)	8.6(3)	5.7(2)

注: MODS 为多器官功能障碍综合征, HCA 为低温-凝血功能障碍-酸中毒综合征, CLS 为毛细血管渗漏综合征; 括号内为每个时间段仍然存在和新发例数之和

表5 58例危重伤员伤后不同时间点隐匿伤的发生情况

伤后时间	例数(例)	隐匿伤发生率[% (例)]								
		头部	面部	颈部	胸部	腹部及盆腔	脊柱	上肢	下肢、骨盆、臀部	体表及其他
1 d内	55	0 (0)	7.3(4)	0(0)	1.8(1)	0 (0)	0(0)	0 (0)	0 (0)	0(0)
2~3 d	50	2.0(1)	14.0(7)	0(0)	10.0(5)	2.0(1)	0(0)	8.0(4)	12.0(6)	0(0)
4~6 d	45	0 (0)	15.6(7)	0(0)	0 (0)	2.2(1)	0(0)	2.2(1)	15.6(7)	0(0)
7 d后	35	0 (0)	14.3(5)	0(0)	0 (0)	2.9(1)	0(0)	5.7(2)	5.7(2)	0(0)

注：括号内为每个时间段新发例数

染、右股部蜂窝织炎各1例)；伤后4~6 d发生头皮切口感染、吸入性肺炎、小腿蜂窝织炎、烧伤创面感染各1例；7 d后仅发生小腿蜂窝织炎1例。

2.4.3 医院获得性感染：伤后4 d内无医院获得性感染发生；伤后4~6 d和7 d后各发生呼吸机相关性肺炎(VAP)1例。至观察结束时，58例危重伤员总机械通气日为142 d,发生VAP 2例(1.4%)。

2.4.4 附加损伤：58例危重伤员未发生附加损伤。

2.4.5 其他并发症：①按部位分：颅脑相关并发症11例(19.0%)，面部相关并发症1例(1.7%)，胸部相关并发症6例(10.3%)，下肢相关并发症13例(22.4%)。②按时间分：伤后1 d内发生脑疝4例，中枢性尿崩症2例，肺不张、胸腔积液、小腿骨筋膜室综合征各1例；伤后2~3 d发生脑疝、中枢性尿崩症各1例，脑性盐耗综合征、小腿骨筋膜室综合征各2例；伤后4~6 d发生脑性盐耗综合征、肺不张、胸腔积液、膝关节积液各1例，小腿肌间静脉血栓形成6例；7 d后发生继发性青光眼、胸腔积液各1例，肺不张2例，小腿肌间静脉血栓形成3例。

2.5 隐匿伤发生情况(表5)：①按部位分：主要集中在面部，其次为下肢、骨盆、臀部和上肢，而头部、胸部、腹部及盆腔较少，颈部、脊柱、体表等部位未发现隐匿伤。②按时间分：伤后1 d内隐匿伤较少，其中右心房破裂1例，双侧角膜损伤2例，鼓膜穿孔2例；伤后2~3 d隐匿伤数量开始增多，其中头皮血肿1例，鼓膜穿孔3例，前房出血、眼球穿通伤、眼球内异物、眶骨骨折各1例，双肺爆震伤、肋骨骨折各2例，锁骨骨折1例，肾挫伤1例，上肢骨折4例，下肢骨折3例，左侧睾丸挫伤、左侧阴囊血肿各1例，双足部烧伤1例；伤后4~6 d隐匿伤数量仍较多，其中鼓膜穿孔6例，前房出血1例，肾挫伤1例，上肢骨折1例，下肢骨折5例，左膝关节胫侧副韧带断裂、左膝后交叉韧带断裂各1例；7 d后隐匿伤数量逐渐减少，其中鼓膜穿孔4例，鼻骨骨折

1例，腹膜后血肿1例，右桡骨小头脱位、右手钩状骨骨折各1例，下肢骨折、阴囊皮裂伤各1例。

3 讨论

复合伤发生后多个器官损伤引起的病理生理学和血流动力学效应可以相互叠加,使全身和局部的创伤反应更加剧烈和持久,机体的变化更为复杂。而且爆炸复合伤发生后会发生严重并发症,也可能存在隐匿伤,使得伤情更加凶险和复杂^[2]。本研究结果显示,在天津港“8·12”特别重大火灾爆炸事故中,危重伤员的致伤因素、致伤部位及其严重程度与伤员受伤时所处位置及距爆炸中心距离有关;而且需要多学科密切合作,及时发现和治疗创伤并发症及隐匿伤,降低危重伤员的伤残率和病死率。

3.1 致伤因素：在本次事故中,致伤因素不仅与伤员受伤时距离爆炸中心距离有关,而且与其在室外或室内及体位等多种因素有关。近距离伤员无论在室外或室内,致伤因素均较多且复杂。中远距离时,室外组伤员火焰伤、破片伤及受冲击后摔伤情况多于室内组,考虑与房屋对火焰的隔离及对冲击波的阻挡有关;而室内组被砸伤者明显多于室外组,说明冲击波致伤因素波及距离远,是室内伤员受到重创的原因。破片伤也是近距离和远距离伤员中较多见的致伤因素,有时会损伤重要器官^[8-10]。本次事故中,室外组有1例伤员被金属片穿透腹壁进入腹腔并穿透横结肠,使肠内容物外溢;室内组有1例伤员被玻璃片穿透胸壁并冲破右心房。远距离伤员无论室内外,危重伤员较少,致伤因素主要为冲击波直接致伤和冲击物砸伤,且室内伤员仍有破片伤。

3.2 致伤部位：本次事故中的危重伤员无论在室外或室内,近距离或中远距离体表损伤均排第一位,室外伤员多为烧伤,室内伤员多为飞溅物擦伤或砸伤或被冲击后摔伤。面部听器损伤也较多,考虑为冲击波直接损伤所致,与既往报道相符^[11-13]。头部损伤是此次事故危重伤员的首要原因。胸部损伤以肋

骨骨折、气胸和血胸为主；肺部冲击伤会导致伤员出现严重急性呼吸窘迫综合征(ARDS),从而影响预后^[14-15],但本次事故中伤员肺部冲击伤相对较轻,与以往动物实验结果不同^[16-17],可能由于实验时动物被固定在一个固定距离上,在原地受到冲击波的直接作用,故肺部冲击伤更为严重。本次事故现场中,距离爆炸中心较近或冲击后被物体阻挡的伤员肺部冲击伤较重;但多数伤员在受到冲击波的作用后被冲出一定距离,从而泄掉冲击波的部分能量,故伤员冲击伤较轻,而摔伤较重,以肋骨骨折和血气胸较多。处于远距离的冲击伤危重伤员较少,损伤部位主要在体表和头面部。

3.3 病情危重程度和预后:ISS评分主要反映损伤严重程度,不反映并发症及伤员基础情况^[7, 18-19];MODS评分主要反映创伤主要并发症,不关注伤员基础情况^[20-21];而APACHE II评分则反映损伤造成的急性生理情况和伤员的慢性健康情况^[22-23]。将3个评分结合基本可反映伤员的整体情况。机械通气时间和ICU住院时间是反映预后的指标。本次事故中各项评分和预后指标表现为以下特点。

第一,室外伤员近距离组ISS和ICU 28 d病死率高于其他距离的伤员,说明距离越近损伤越重。室外组ICU 28 d内2例死亡者均为近距离组,其中1例死于烧伤后继发感染和MODS,1例死于开放性特重型颅脑损伤继发感染和MODS。而其他参数及预后指标没有明显差异,其原因考虑与室外近距离伤员部分死于现场而未纳入统计有关。室外中远距离伤员3项评分均高于远距离组,进一步说明在室外伤员距离爆炸中心越近损伤越重。

第二,室内伤员3个评分和预后指标也体现出距离爆炸中心越近损伤程度越重的倾向,但各参数缺乏明显的规律性,考虑与伤员在室内状态的偶然性大、个体差异明显不同有关。爆炸瞬间伤员位置、体位、朝向、是否有阻挡物和飞溅物以及身体基础状态等均可能影响到最终的损伤程度和预后。室内组ICU 28 d内死亡2例均属中远距离组,均为特重型颅脑损伤,到达医院时已无手术机会。

第三,同样距离时,处于近距离的室内外两组伤员伤情无统计学差异,而通常室外近距离组伤情应该重于室内组,原因考虑与室外近距离组伤员部分死于现场而无法列入统计有关。在中远距离和远距离伤员,室内组伤情不同程度地重于室外组,考虑与本次爆炸的特殊时间、空间及爆炸本身特点有关。

本次事故开始为现场物品燃烧和小规模的爆炸,之后发生两次大型的爆炸,根据爆炸科学与技术国家重点实验室模拟计算得出,第一次爆炸的能量约为15 T的TNT当量,第二次爆炸的能量约为430 T的TNT当量^[24]。第一次爆炸发生后,楼内居民有的正在走向阳台观望,有的从床上坐起,由卧位变为站立位,并在室内不同位置行走,因此容易受到冲击波的直接损伤和被冲倒的门窗等物体直接砸伤、摔伤,或是被震碎的玻璃等破片刺伤。这些因素导致在中远距离组室内的伤员伤情较重。

3.4 创伤并发症

3.4.1 全身反应和MODS:全身反应通常包括过度应激反应、高代谢反应、HCA和毛细血管渗漏综合征(CLS),是病情危重和预后不良的重要因素^[25-27]。MODS累及的器官和系统包括呼吸、肾脏、肝脏、心血管、血液、神经、胃肠等^[21, 28]。在本次事故中,多数伤员均不同程度地出现了全身反应和MODS等并发症,伤后1 d内和2~3 d的发生率分别在50%和30%以上,经过综合治疗后,4~6 d时并发症明显恢复,以全身反应中HCA恢复最快,而MODS中肝肾功能恢复较慢;7 d后仍然存在或新发全身反应和MODS,考虑是由感染等并发症二次打击造成。

3.4.2 感染:爆炸伤中伤员多且集中,往往导致伤口处理不及时^[29],为MODS和感染埋下了隐患。部位相关性感染通常分为颅内、颅窝腔、呼吸道、肺、胸腔、纵隔、腹腔、腹膜后、骨髓、软组织、烧伤创面感染等;医院获得性感染通常分为脑室炎、鼻窦炎、医院获得性肺炎、导管相关性血流感染、导尿管相关性尿路感染、伪膜性肠炎、第3类型腹膜炎等。本次事故中,感染主要集中在皮肤软组织、呼吸系统、神经系统和腹腔,主要原因是烧伤、重物砸伤、破片伤、摔伤及误吸。后期感染较复杂,主要集中在烧伤创面感染和颅内感染;医院获得性感染中,VAP发生率仅为1.4%。

3.4.3 附加损伤:本次事故中,由于采取了正确的气道建立及颈胸腰部脊柱、肋骨、骨盆、肢体等骨折部位的保护及固定^[30-31],避免各项搬动性检查的重复操作^[32-33],统筹各级医生的查房时间以减少搬动伤员的次数等措施,无一例伤员发生附加损伤。

3.4.4 其他并发症:指除感染外与损伤部位相关的并发症^[1],在本次事故中主要以颅脑、胸部和肢体相关并发症为主。由于早期实施了药物或非药物的血栓预防、康复师介入进行主动或被动运动等措

施,伤员无深静脉血栓形成和压疮发生。

3.5 隐匿伤:危重伤员就诊时,医生首先关注的是危及生命的损伤,往往忽略一些轻微或暂时表现不明显的严重损伤^[34]。另外,危重患者早期生命体征不平稳、意识障碍、全麻未醒或镇痛镇静状态等也是造成创伤漏诊的重要因素。因此,重症医学科医护人员在完成稳定生命体征和器官功能支持的前提下,要及时发现隐匿伤^[35]。本次事故中,伤后1 d内发现的隐匿伤最少,2 d后逐渐增多,考虑与上述因素有关。本次事故中隐匿伤多集中在面部和肢体,处理不及时容易致残。此外,一些少见的隐匿伤同样值得关注,在本次事故中,1例伤员入院时被诊断为头皮裂伤、右侧血气胸、双肺挫伤、多处皮裂伤和擦伤,经常规吸氧、右侧胸腔闭式引流等治疗后生命体征平稳。在之后的观察中发现其胸腔血性引流液增多,于伤后9 h进行开胸探查,发现右心房上有一小破裂口,考虑为飞溅的玻璃刺伤所致,行右心房修补和纵隔开窗术后,伤员恢复良好。

综上所述,天津港“8·12”特别重大火灾爆炸事故中,爆炸物质种类较多且复杂。现场先燃烧后爆炸,第二次爆炸强度明显高于第一次,且在爆炸瞬间,伤员距爆炸中心距离、体位、所处的具体位置等均有不同,导致本次事故致伤因素复杂多样,致伤部位较多,伤情纷繁复杂。创伤并发症是严重创伤救治的重要内容。本研究缺点为,为体现不同情况的伤情而分组过多,导致有的组伤员数量较少,可能导致统计偏差。本研究表现出伤员距离爆炸中心越近伤情越重、中远距离时室内伤员伤情重于室外伤员,ICU内伤员死亡原因主要集中在颅脑损伤等规律性,能够在一定程度上为今后类似事故的伤员救治提供参考;同时重症医学科作为创伤救治平台,应高度重视预防、发现并治疗创伤并发症及隐匿伤,按相应制度流程进行筛查^[36],与各专科密切合作,及早诊治创伤并发症及隐匿伤,最大程度地减少死亡和伤残。

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